Respiratory Medicine

*Series Editors:* Sharon I.S. Rounds · Anne Dixon · Lynn M. Schnapp


Patricia A. Kritek
Jeremy B. Richards *Editors*


# Medical Education in Pulmonary, Critical Care, and Sleep Medicine

## Advanced Concepts and Strategies

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*We help the world breathe®*
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ISSN 2197-7372 ISSN 2197-7380 (electronic)
Respiratory Medicine
ISBN 978-3-030-10679-9 ISBN 978-3-030-10680-5 (eBook)
https://doi.org/10.1007/978-3-030-10680-5

Library of Congress Control Number: 2019935146



This Humana Press imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

Medical education is changing. The way we teach students, residents, fellows, and faculty has evolved over the past decade, and teaching practices that endured for centuries are being replaced or retired. This evolution is informed by advances in cognitive psychology and by evidence from a growing body of medical education research. Awareness of how medical education theory and practice is changing is critical for pulmonary and critical care specialists to understand how to best teach our learners in the classroom, in the clinic, on the consult service, and in the intensive care unit.

There is now greater emphasis on learner engagement and involvement in teaching and learning. Rather than educational sessions being defined by an instructor *teaching* learners, the emphasis of educational sessions should be on working through problems collaboratively with learners actively engaged in answering questions and solving problems. Active application of knowledge serves to solidify core concepts and reinforce real conceptual and practical understanding.

This modern, effective, and evidence-based approach to teaching and learning is particularly relevant to pulmonary and critical care medicine. The mechanistic and dynamic basis of pulmonary physiology, pathophysiology, and clinical practice lends itself well to active application (as opposed to rote memorization and regurgitation). As emphasized throughout this text, regardless of the setting or the learner, pulmonary and critical care topics can be more effectively taught through active teaching strategies. Just as importantly, using active teaching strategies can increase the enjoyment and satisfaction of teaching for pulmonary and critical care educators! Shifting the focus of teaching sessions from trying to transmit information from the instructor to learner to prioritizing discussion, interaction, and problem-solving can be invigorating for both learners *and* faculty.

A prime example of shifting the focus of teaching sessions and increasing enjoyment for learners and faculty is the standard didactic lecture. An individual talking to a large audience in an effort to transfer information in a unidirectional manner has been consistently shown to be ineffective. Some studies have demonstrated that audience members remember as little as 10% of the content delivered in a standard lecture. As such, the traditional didactic lecture is an increasingly anachronistic teaching modality, as active teaching strategies are supplanting the "sage on a stage." Specifically, as described in the chapters "Teaching in the Classroom: Large Groups" and "Teaching Preclinical Students," educators have experimented with different teaching techniques in the large group setting. And, through medical education research studies, several of these techniques have demonstrated improved engagement of learners in the large group setting, improved retention of knowledge, and improved performance on quizzes and tests. From peer instruction to case-based collaborative learning, these novel and active teaching techniques are more effective than standard lectures, and they are changing how we teach our learners.

A pulmonologist who is preparing a "lecture" needs to know about changes in best practices in large group teaching in order to develop a session than is as effective as possible. A lecture founded entirely on reading through PowerPoint slides with minimal opportunity for interaction is both an outdated approach to teaching and a missed opportunity. Embracing the concepts of the flipped classroom and active teaching maximizes the chances of the audience effectively engaging with and retaining the material. As one example, the pulmonologist could use an audience response system to strategically encourage audience members to *apply* their knowledge and understanding of a topic to solving a relevant problem.

Changes in medical education are also occurring outside of the classroom. Historical approaches to teaching in clinical environments are evolving, and strategies for leveraging learners' autonomy, engagement, and application of knowledge result in more effective understanding and growth. As described in the chapters "Teaching in the ICU," "Teaching in the Clinic," and "Teaching on the Wards," active teaching strategies are both important and effective tools for these settings. An appreciation of the impact of system-based, environmental, and logistical considerations on the effectiveness of teaching in these different environments is essential. Specific examples of active teaching strategies discussed in these chapters range from the well-described "One-Minute Preceptor" model and the SNAPPS format for use in the ambulatory setting to the CARE (*c*limate, *a*ttention, *r*easoning, *e*valuation) model in the ICU or on the wards. These different strategies are evidence-based means of optimizing learner engagement and knowledge application. Furthermore, these approaches foster self-directed and lifelong learning skills which are critical for long-term success in training and clinical practice.

In the twenty-first century, not all teaching and learning occurs in a physical location – the ubiquity of the Internet and web-based education is part of our contemporary medical and educational practice. Despite this reality, resources guiding medical educators on how to use the Internet, social media, and other web-based tools are scattered, difficult to find, and sometimes contradictory. In the chapter "Web-Based Learning," approaches to effectively harnessing these powerful tools for in- and out-of-classroom teaching and learning are discussed. Specific themes covered in this chapter include strategies for assessing the accuracy of web-based content for teaching purposes, the role and utilization of learning management systems, blending in-person and online teaching, and best practices for using social media platforms for medical education.

In addition to considering active teaching strategies for different physical and virtual settings in pulmonary and critical care medicine, approaches to teaching learners of different levels are highlighted in this textbook. Strategies that may be effective for medical students in the classroom setting (see the chapter "Teaching Preclinical Medical Students") may not be appropriate or effective for teaching fellows (as reviewed in the chapter "Teaching Fellows"). PCCM educators and faculty also interact with resident physicians in a variety of educational and clinical venues including the ICU, pulmonary consult service, and the outpatient clinic setting. Strategies to consider for working with and teaching residents in pulmonary and critical care clinical settings are reviewed in the chapter "Teaching Residents." Finally, medical students in the clinical or clerkship setting are an important group of learners with unique educational and development needs. The strategies for incorporating students into clinical practice in a meaningful and appropriate manner are discussed in the chapter "Teaching clinical medical students." Blending the importance of allowing autonomous clinical reasoning and supporting professional development is key for clinical medical students, as passive observation (or "shadowing") is analogous to being a passive audience member in a lecture – the effectiveness, value, and retention of lessons learned in the moment are diluted and less likely to be sustained when compared to active, autonomous clinical teaching experiences.

The role of simulation for learners of all levels is reviewed in the chapter "Teaching with Simulation." Simulation is an unquestionably important educational tool as learners can practice active application and problem-solving in a low-stakes environment without risk of patient harm or adverse events. Understanding best practices in simulation is critical, however, as poorly designed or ineffectively organized simulation scenarios can have limited educational value for learners or even be counterproductive to the educator's intent.

Communication skills are essential to effective clinical practice, yet teaching communication skills is not consistently explicitly emphasized in medical education curricula. Considering how to effectively teach communication and teamwork skills to learners of different levels in pulmonary and critical care settings is explored in the chapter "Teaching Communication Skills." The importance of interprofessional education and clinical practice, the necessity of clear and understandable communication with patients and families, and the need for cogent and understandable documentation are incorporated into the discussion of best practices for teaching communication skills. From the pulmonary clinic to the intensive care unit, communications skills are a foundational and necessary component of training and practice in pulmonary and critical care medicine.

Finally, while feedback is considered to be a critical component of medical education and clinical training, it is frequently perceived as a challenge for both learners and faculty. In the chapter "Role of Feedback in Teaching," different definitions of feedback (formative versus summative, brief versus formal versus major) are reviewed, and best practices in preparing and delivering feedback are delineated.

Throughout this textbook, we emphasize that changes to medical education are a good thing. Active learning is evidence-based and yields better understanding and retention. Active learning lends itself well to pulmonary and critical care medicine, as emphasizing mechanisms and highlighting conceptual connections forms a foundation for understanding core principles in our field. And, active learning is more satisfying, enjoyable, and fun than passive, unidirectional, and hierarchical teaching methods. We hope that this textbook provides you with the perspective and teaching tools to engage in effective and enjoyable teaching of your learners in pulmonary and critical care medicine.

Seattle, WA, USA — Patricia A. Kritek
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# Chapter 1
# Teaching Pre-clinical Medical Students

**Jeremy B. Richards and Richard M. Schwartzstein**

## 1.1 Introduction

The classic paradigm for the undergraduate education of medical students is for students to spend a significant quantity of time in the classroom setting [1]. Historically, medical students would spend 2 years engaged in primarily classroom-based learning focused on the foundational science needed to diagnose and treat patients, followed by an intensive year of clinical learning in a series of clerkship rotations. Classroom-based learning was termed the "pre-clinical" or "pre-clerkship" component of medical school, while the clerkship rotations were defined as the "clinical" component.

Models of undergraduate medical education are changing, however, and the pure distinction between pre-clinical, classroom-based learning and clinical, clerkship-based learning is evolving [2, 3]. Contemporary approaches to undergraduate medical education (UME) include shortened pre-clinical experiences and/or blended classroom and clinical experiences. Some medical schools prioritize patient contact and clinical learning very early in the UME curriculum, while other medical schools incorporate longitudinal patient care experiences into classroom-based formats; the rationale for the early clinical contact is partly to provide a context for the learning of basic sciences, to increase the motivation of students by quickly offering relevance for the material they are studying, and to assist in professional identity formation [4]. It is worth noting that the intensive clinical clerkship experience remains a core component of most UME curricula in the United States, although the timing of the clerkships can vary between medical schools (some schools schedule the core

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_1

clerkships during the 2nd year of medical school, some during the 3rd year) and experiments with various forms of longitudinal clinical experiences continue [4, 5].

The result of these innovations in UME curricula is that a universal model of medical student education no longer exists. Despite the increased emphasis on early clinical experiences in UME, the classroom remains an important venue for teaching core concepts, as well as nurturing problem-solving abilities and critical thinking skills with medical students. Furthermore, with increasing use of new interactive techniques and strategies, classroom teaching can be fun and inspiring for the student. To use this venue to meaningfully teach students and promote personal growth and career development remains an enormous opportunity and responsibility of pre-clinical educators, including pulmonary and critical care physicians.

In this context, the classroom should be seen not as a constrained space to pound facts into the heads of unsuspecting young adults but as a laboratory to explore the mysteries of the human body and to create hypotheses, using physiological and molecular concepts, to explain health and disease. Consequently, the emphasis can be on an *approach* to learning, the development of problem-solving skills and critical thinking abilities in the pre-clinical setting, which will set the stage for future learning and thinking when students enter the clinical setting. Done correctly, teaching in the pre-clinical setting may impact how students think and function over their entire careers, as students can be provided the knowledge, skills, and attitudes to address novel problems encountered in clinical practice.

With this perspective, this chapter will review specific strategies for teaching students in the pre-clinical setting, with a focus on knowledge, skills, and behaviors relevant to pulmonary and critical care medicine (PCCM). Concepts of critical thinking and cognitive psychology relevant to pre-clinical medical students are discussed, and best practices in classroom-based teaching are elaborated. Teaching in the pre-clinical setting is an opportunity to positively influence future physicians in a meaningful and valuable manner, and employing effective and evidence-based strategies to achieve this goal will maximize educators' chances of success.

## 1.2 Teaching Pre-clinical Students How to Think

### *1.2.1 Theory and Practice: Cognitive Psychology and Critical Thinking*

In addition to practical considerations about how to teach and assess critical thinking skills in pre-clinical learners, understanding relevant cognitive psychologic theory is important when developing educational interventions and curricula for UME learners. Specifically, awareness of the role of working memory and cognitive load theory, the concepts of dissonance and interference, and the effects of heuristics and cognitive biases are all important foundational cognitive psychologic principles in teaching at any level, including when teaching pre-clinical students.

Working memory describes the concept in which a person has a limited cognitive capacity to truly consider and assess new information [6]. Working memory can be alternatively referred to as focus, bandwidth, or capacity to incorporate novel stimuli, knowledge, or concepts. Random access memory (or RAM) on a computer's hard drive is a rough analogy for working memory. There is no effective manner to accurately predict or quantify an individual student's working memory, but being aware of the risk of cognitive overload is a first and necessary step to avoiding overwhelming a learner's working memory [7]. One strategy to avoid overwhelming working memory is to dedicate time for learners' to grapple with new knowledge or concepts with the goal of truly internalizing this new information. In class discussions, problem-solving exercises and spaced education (e.g., returning to challenging concept iteratively over the course of a session or a curriculum) are strategies for acknowledging the concepts of working memory and cognitive load.

A specific example of acknowledging the concept of working memory would be for an instructor to pause during his lecture about LaPlace's law, encourage students to engage in an interactive classroom discussion about factors that influence alveolar surface tension. To allow for students' working memories to process these concepts, the instructor should ensure students have ample time to discuss the relevant physiologic concepts with each other and then *explain* their understanding of how different parameters affect alveolar surface tension to their classmates.

Dissonance is the cognitive psychological concept in which a person realizes that his or her understanding of a topic or concept is incorrect or incomplete [8]. The sense of discordance that accompanies such a revelation can be a very important motivator to apply cognitive effort to understanding a new concept or topic, and dissonance can be effectively used to stimulate independent, self-directed, and lifelong learning [9]. Of course, this may not feel "good" to the learner; this is effortful learning, which is more likely to lead to enduring knowledge, but human nature may put up resistance to doing the work. Determining what a student believes he or she understands about a topic or concept is a first step toward leveraging dissonance, and coupling dissonance with the concept of working memory and cognitive load is important to allow learners to address cognitive discord and dissonance [9].

A specific example of employing dissonance in teaching would be to challenge students' to explain the mechanism by which a pulmonary embolism (PE) causes hypoxemia. Working through the pathophysiology of pulmonary embolism will result in students realizing that a PE obstructing a pulmonary artery should increase dead space, resulting in hypoventilation but not necessarily hypoxemia. The dissonance invoked in students by this revelation can increase their motivation to and retention of how a PE *actually* causes hypoxemia.

Interference describes the role of internal and external distractors to engaging in cognitively effortful activities including learning and internalizing new concepts [10]. Internal interference can include processes such as competing obligations, personal or emotional distractors, and lack of motivation to learn. External interference can include environmental phenomenon (e.g., the physical learning environment), cognitive overload, and limited working memory. Educators should be aware of the potential impact of interference on students' abilities to engage in cognitively effortful activities, and educators should endeavor to address interference when possible to maximize students' chances of meaningfully engaging with and incorporating concepts into their working memory [11].

Cognitive psychologic theory describes two "modes" of thinking, referred to as System 1 and System 2 thinking [12–16]. System 1 thinking is a reflexive, pattern recognition mode of thinking in which information is rapidly processed and conclusions are made almost automatically [12, 13]. An example of System 1 thinking is when a patient who has smoked for 20 years states that she has heard herself wheezing and the physician immediately assumes the patient has COPD. The automatic, reflexive association between tobacco exposure, wheezing, and COPD comes easily and without much cognitive effort [16].

System 2 thinking is a more cognitively effortful, analytic mode of thinking [12, 13]. In the example of the wheezing patient, System 2 thinking would entail comprehensively reviewing all of the patient's symptoms, past medical history, laboratory, and imaging data and concluding that the patient's wheezing is due to chronic diastolic congestive heart failure resulting in increased airway edema. Teaching critical thinking skills in the classroom can prepare students to take data (history, physical exam findings, laboratory results) and work comprehensively, using a System 2 approach, and inductively create a solution to a clinical problem.

Heuristics are mental shortcuts used reflexively and intuitively in daily life as well as in clinical reasoning and problem-solving [17]. Heuristics include cognitive biases, which are a series of cognitive shortcuts or generalizations used to simplify problem-solving activities and decrease the cognitive effort required to reach a conclusion or solution. Cognitive biases include processes such as anchoring, availability bias, and base rate neglect (see Table 1.1) and are commonly used in daily and clinical settings

**Table 1.1** Types of cognitive bias

| Cognitive bias | Definition |
|---|---|
| Anchoring bias | Tendency to lock onto specific features in a patient's presentation too early in the diagnostic process and a failure to adjust the initial impression in response to new information |
| Availability bias | The propensity to judge diagnoses as being more (or less) likely to occur if those diagnoses more readily come to mind (or do not readily come to mind) |
| Base rate neglect | Tendency to ignore the true prevalence of a condition or disease by either exaggerating or diminishing the base rate of the disease |
| Diagnostic momentum | The propensity to carry forward a diagnostic label once it is applied to a patient's condition |
| Gambler's fallacy | The belief that if a coin is tossed ten times and lands on heads each time, the 11th toss has a greater than 50/50 chance of landing on tails |
| Outcome bias | The tendency to focus on diagnostic possibilities that increase the likelihood of a good outcome for a patient |
| Sunk costs bias | The more one invests in a given diagnosis as the explanation for a patient's symptoms, the less likely one is to be able to consider alternative possibilities |

to reach rapid and common answers to problems [18, 19]. Cognitive biases and heuristics are founded on System 1, pattern recognition reasoning [12, 13].

Understanding the ubiquity of heuristics and cognitive biases in human reasoning is necessary to allow medical educators to effectively address these mental shortcuts in students' approaches to solving clinical and conceptual problems. Strategies for addressing heuristics and cognitive biases primarily involve education, recognition, and prioritization of analytic reasoning strategies. Awareness and transparency about the presence and ubiquity of these cognitive shortcuts is a critical first step in teaching students how to understand and address them.

### *1.2.2 Critical Thinking in the Classroom*

Medical education, particularly classroom-based, pre-clinical education, is commonly compared to "trying to drink from a firehose" [3]. The quantity of medical knowledge is enormous and continuously growing, and to expect students to master the breadth and depth of contemporary medical knowledge is simply unrealistic. With our present technology, finding facts is easy; every student carries a computer in her pocket. Of course, one can't constantly look up every fact one needs to know as a doctor, but we can de-emphasize the rote memorization that once characterized the process of becoming a physician. Furthermore, medical educators who attempt to simply transmit knowledge to students are missing an opportunity to help students understand how to manage, interpret, and use information in an effective and efficient manner. Said differently, the focus of UME should not be on transferring information from educators to students; rather, teaching students how to critically appraise, synthesize, and use medical knowledge is a markedly more important goal for contemporary medical educators [2–4]. Bloom's taxonomy, as described elsewhere in the text, is a useful framework that medical educators can use to assess students' knowledge, understanding, and ability to apply information to solving problems and answering questions [20].

While academic and popular sources commonly refer to critical thinking skills, there is not a universally agreed upon definition of critical thinking. Various authors and experts have offered conceptual and practical definitions of critical thinking and critical thinking skills (see Table 1.2). A shared theme from these various definitions is the ability to synthesize and analyze information and apply the conclusions of synthesis and analysis to addressing a problem. Working with these core elements of critical thinking, medical educators may develop educational interventions and teaching strategies to prioritize synthesis, analysis, and application, as opposed to prioritizing transfer of information, memorization, and pattern recognition. These principles can be applied to teaching pulmonary and critical care content in the classroom setting, as students can develop critical thinking skills by asking questions about and solving problems regarding respiratory physiology or pathophysiology.

Best practices in clinical reasoning emphasize the importance of engaging in inductive reasoning to develop diagnostic hypotheses, as opposed to using a

**Table 1.2** Definitions of critical thinking

| Authors/groups | Definition |
|---|---|
| Croskerry [21] | Advanced (stage 6) critical thinking: Accomplished level of critical thinking – has systematically taken charge of their own thinking and continuously strives for improvement and to develop new insights into deeper levels of thought |
| Bacon [22] | Critical thinking is a desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to consider, carefulness to dispose and set in order, and hatred for every kind of imposture |
| Millennium Conference [23] | Applying higher cognitive skills (e.g., conceptualization, analysis, evaluation) to information either gathered from medical history or records or generated by physical exam or laboratory investigation, in a way that leads to action that is precise, consistent, logical and appropriate |
| American Psychologic Society [24] | Purposeful, reflective judgment which manifests itself in reasoned consideration of evidence, context, methods, standards, and conceptualizations in deciding what to believe or what to do |

hypothetico-deductive reasoning approach to clinical reasoning [25, 26]. Inductive reasoning is described as comprehensively reviewing all available data to develop a series of hypotheses, typically framed in terms of anatomy and pathophysiology rather than diagnoses that best fit the available information [25]. Comparatively, a hypothetico-deductive approach to clinical reasoning involves first identifying a discrete set of diagnostic hypotheses based on a limited set of data and then determining if the remaining clinical information fits those pre-specified hypotheses [26].

The risk of hypothetico-deductive reasoning is that diagnostic possibilities are missed due to a limited differential diagnosis based on the initial pattern or erroneous conclusions influenced by cognitive biases early in the diagnostic process. Assuming a patient who is wheezing has COPD is an example of hypothetico-deductive reasoning. Reciprocally, inductive reasoning is generally considered to be more cognitively demanding, as it is an analytic, comprehensive approach to reviewing all available clinical data before forming diagnostic hypotheses; it takes greater mental effort relative to intuitive pattern recognition.

The brain is built to recognize patterns. Doctors absorb illness scripts, which are short summaries of the common features of different disease states, as they gain clinical experience [27, 28]. One can easily categorize and teach illness scripts, which are then memorized by students [28]. But when discordant data appear, the learner is prone to dismiss the information and commit a cognitive error [12]. By emphasizing inductive approaches early in medical education in the context of critical thinking, students have the tools to reason through confounding pictures and gain confidence that they can solve problems on their own. Teaching critical thinking skills in the classroom setting can prepare students to adopt an inductive approach to reasoning in the clinical setting.

There are no universally agreed upon approaches to teaching critical thinking skills in the classroom setting, but using active learning strategies will prioritize application of knowledge as compared to rote memorization and regurgitation of facts [29]. In this context, increasing emphasis on discussion, active participation, small-in-large groups (e.g., think-pair-share strategies), and audience response systems are increasingly employed in classroom-based UME settings. Of course, simply *using* these education interventions is insufficient to truly promote critical thinking skills, and thoughtful development of content and activities intended to promote analytic reasoning is necessary to prompt students to cognitively engage with material in a meaningful manner [30, 31].

### *1.2.3 Assessing Critical Thinking Skills*

Similar to the lack of universally agreed upon strategies for teaching critical thinking skills, there is no consensus on the best means for accurately and reliably assessing critical thinking skills [23]. In general, conventional perceptions among medical educators indicate that closed-ended test questions (e.g., multiple choice questions) are less effective in accurately determining students' critical thinking abilities; cognitively, it is much simpler to recognize a correct answer than to generate an answer [32]. Open-ended questions and short answer or essay responses may provide more insight into students' ability to synthesize, analyze, and apply knowledge to solving a problem; however, the effort in grading open-ended questions is obviously much more significant than grading close-ended multiple choice questions [32]. Other potential means of assessing critical thinking skills include having students develop concept maps or mechanism maps [33], assessing students' performance in simulation scenarios [34–36] and oral examinations [37]; however, rigorous evidence for the accuracy, reliability, and predictive characteristics of these assessments is lacking.

**Vignette: Teaching Critical Thinking Skills**
You are invited to develop a teaching session about emphysema for first-year medical students in a core physiology course in the first semester of medical school. The students have had minimal patient contact at this point of their UME curriculum, but the physiology course does emphasize clinical application of physiologic concepts. You are interested in prioritizing clinical reasoning skills in your teaching session, and you develop a clinical vignette to serve as the basis for your session.

Your vignette features a 52-year-old man with a history of significant tobacco use who presents with several weeks of progressive dyspnea on exertion, audible wheezing, and a nonproductive cough. You develop questions intended to promote the application of knowledge to understanding and solving clinical problems:

1. Why is this patient wheezing? Describe specific pathophysiologic mechanisms to explain your answer.
2. How would administration of a beta-agonist affect his wheezing?
3. Why is this patient experiencing dyspnea on exertion? What findings would you expect to finding on spirometry to support your answer?

You are interested in teaching the students about the role of non-positive pressure ventilation (NIPPV) as a treatment for chronic obstructive pulmonary disease; however, you realize that for the time allotted for the session, trying to introduce the concept of NIPPV and to allow them time to truly consider and incorporate this concept would be a threat to their working memory and likely precipitate cognitive overload. As such, you do not try to include NIPPV into this session and instead focus on the learning objectives of applying physiologic principles to clinical manifestations and management of emphysema.

**Take-home points:** This vignette demonstrates the importance of appreciating and addressing *cognitive interference* in developing and implementing teaching sessions, the importance of asking "why" and "how" questions to stimulate higher-level System 2 reasoning, and the importance of developing an interactive session that is not simply a didactic lecture.

## 1.3 Strategies and Techniques for Applying Principles of Teaching that Emphasize Thinking Skills in Different Settings

A common mental image of pre-clinical teaching is of single instructor on a stage, lecturing to a large amphitheater filled with students [1–3]. While large group teaching settings remain a common and important component of pre-clinical teaching, there are numerous other settings in which pre-clinical students learn the content, concepts, and application of medicine. Small group teaching, medium-sized cohorts, and learning in the context of patient care are important settings in which pre-clinical teaching occurs, and specific considerations for providing optimized teaching in these settings are discussed below. Simulation-based learning, extracurricular activities, and learning in the context of research activities are other important educational opportunities for pre-clinical students but are beyond the scope of this chapter.

### *1.3.1 Large Group Teaching*

The reflexive image of large group teaching is of a classic lecture hall with an instructor unidirectionally speaking to students who passively receive the information. This picture is increasingly anachronistic and this teaching strategy is most likely ineffective. Some researchers have found that students recall as little as 10% of lecture content 3 days after the lecture [38]. The literature provides numerous examples of the benefits of active learning in the large group setting, and incorporating evidence-based practices for large group teaching is critical to optimize students' chances of meaningfully and effectively learning relevant material and concepts.

**Table 1.3** Active teaching strategies for use in large group teaching settings

| Active learning strategy for use in lectures | Description |
|---|---|
| Peer instruction [39] | Break lecture material into short segments interspersed with conceptual questions which learners answer first on their own, followed by discussion with 3–4 colleagues to develop a group consensus answer |
| ACTIVE teaching format [40] | *Assemble* learners into small groups, *convey* 3–5 learning points, *teach* a limited amount of content, *inquire* about how the content applies to patient management, *explain* answer choices |
| Buzz groups [41] | Divide a large group of learners into pairs or small groups at the beginning of a lecture, which then collaboratively answer questions posed throughout |
| Audience response systems [42] | Assess individuals' responses to questions in real time using technologic ("clickers" or web-based platforms) or manual responses (paper-based or show of fingers) |
| Assign in-class writing [43] | During or after a lecture, learners write a brief summary of what they learned during the lecture |
| Think-pair-share [44] | Divide learners into pairs, and ask them to *think* about questions posed during the lecture, discuss the questions in *pairs*, and then *share* their consensus answer with the group |

There are many different approaches to the incorporation of active learning into the large group setting (see Table 1.3). Some of these strategies can be categorized as "flipped classroom" activities [45]. The concept of a flipped classroom involves having students engage in study and pre-work prior to coming to class, such that the time in class can be dedicated to application of knowledge to solve problems as opposed to spending class time exclusively on being exposed to and starting to learn new knowledge. The term "flipped classroom" is sometimes used as if referring to a specific educational intervention, but it is more appropriately considered as an umbrella term or overarching category for a philosophy of teaching. Employing a flipped classroom approach to teaching indicates that the instructor is prioritizing class time for engagement and application as opposed to simple knowledge transfer. "Active teaching" strategies can be used in either a flipped classroom or more traditional classroom setting and describe specific educational interventions intended to allow students to apply knowledge to answer questions or work through problems.

The active teaching strategies described below are particularly effective for pulmonary and critical care topics. For example, the pathophysiology of asthma can be discussed and described in an iterative, interactive manner that involves students and emphasizes application of concepts. Similarly, the concepts of respiratory system compliance, with differential effects of the pulmonary parenchyma and the chest wall, can be the foundation for a problem-based, active learning session. The topics of pulmonary mechanics, physiologic and pathophysiologic mechanisms, and conceptual topics lend themselves well to active teaching and learning.

Specific flipped classroom and active teaching strategies to teaching in the large group include peer instruction, the use of audience response systems, think-pair-share, team-based learning, concept maps, and case-based collaborative learning.

#### 1.3.1.1 Peer Instruction

Peer instruction is an active learning strategy that was first described by Eric Mazur and colleagues in a large undergraduate physics class [39]. Peer instruction requires students to complete independent pre-work prior to the large group teaching session, including completing a set of pre-class "readiness assessment questions" to gauge their understanding of the required pre-class material. Instructors have access to the class's performance on the readiness assessment questions prior to the large group teaching session, which can be helpful in identifying areas of particular difficulty for students [39, 46].

The large group teaching session comprises a series of short lectures, on the order of 7–10 minutes, intended to emphasize core concepts covered in the pre-class preparatory materials. After a short lecture, using an audience response system, students must answer a multiple choice question related to the concept discussed in the brief lecture. If less than 70% of the class answers the multiple choice question correctly, students are instructed to discuss their answer choice and their explanation for why they chose that answer with another student(s). The instructor observes the students' discussions to assess their understanding of the concept in question. After 2–3 minutes of discussion, the students again answer the same multiple choice question, and the instructor identifies the correct answer and addresses any misconceptions or faulty reasoning he or she perceived when observing the students discussing their answers. After completing this process, the instructor provides another short 7–10 minutes lecture on a core concept, and the process is repeated.

Peer instruction has been demonstrated to significantly improve students' conceptual understanding of foundational processes in physics [39, 47]. Mazur and colleagues studied students' performance on the Force Concept Inventory (FCI), a test widely used to assess conceptual understanding of physics. Students who were taught using peer instruction performed significantly better on the FCI than students who were taught using standard lecture-based pedagogy. While there are not robust empirical data regarding the impact of peer instruction in UME settings [46–49], it has been employed in classroom-based teaching in various institutions with adequate acceptability and feasibility parameters [50].

#### 1.3.1.2 Audience Response Systems

Engaging learners through audience response systems is an increasingly common method used in large group teaching settings [42]. There are a variety of audience response systems for use, with varying functionality and cost associated with their use (see Table 1.4). Beyond the specific attributes and logistics of different audience response systems (ARS), however, the philosophy of active engagement and application of knowledge can be effectively leveraged by thoughtfully incorporating ARS into classroom-based teaching.

The key for effective use of ARS for pre-clinical learners is to develop questions that address conceptual understanding and that prioritize the application of critical thinking skills, and to have a concrete strategy for how one deals with students'

**Table 1.4** Audience response systems

| Audience response system | Comments | Website |
|---|---|---|
| Poll Everywhere | Poll Everywhere is free for use for up to 25 learners and primarily allows for use of multiple choice questions | www.polleverywhere.com |
| Turning point | Turning point is a proprietary system that embeds in PowerPoint and is not free for use | www.turningtechnologies.com |
| Kahoot! | Competition-based, user-friendly, mobile application for sending questions to participants | kahoot.com |
| Typeform | Survey delivery software that can be used for ARS questions | www.typeform.com |

"voting" [51]. Simply asking students low-level, recall-based questions is missing the opportunity and promise of ARS. Furthermore, questions should be strategically incorporated into the content and structure of the teaching session; questions that are simply added into a teaching session will be minimally effective at best and distracting or counterproductive at worst [52]. If a question yields a range of responses, students can be asked to explain their reasoning, after which they can vote a second time or speak to the person next to them for a minute or two and then revote (see Sect. 1.3.1.3 below). Do not assume that because the majority of students responded correctly that they all understand the reason why the answer chosen is correct.

Best practices for using ARS for teaching pre-clinical learners are primarily founded on consensus opinion and educational theory [42]. Data describing quantitative outcomes attributable to ARS in the pre-clinical, classroom-based setting are of variable quality and difficult to broadly generalize to all UME teaching settings.

#### 1.3.1.3 Think-Pair-Share

This educational intervention is a structured approach to promoting active engagement and discussion in a large group teaching setting. Think-pair-share is a methodology in which an instructor asks a conceptual question to the class and allows students time to think about and, ideally, write down their answers to the question [44]. Students then discuss their answer to the question, and their justification for their answer, with a partner. After having several minutes to discuss their answers and conceptual understanding, a series of "pairs" of students are asked to share their perspective on the questions with the overall class.

Think-pair-share is a powerful means of promoting application of knowledge, as students must not only commit to an answer, but they must defend and justify their answer – not only to their partner in the think-pair-share dyad but potentially to the entire class. The accountability intrinsic in the think-pair-share methodology and the emphasis on assessment, synthesis, and application of knowledge promote critical thinking skills and emphasize active learning [53].

Topics in pulmonary and critical care medicine lend themselves well to using the think-pair-share technique. For example, exploring the meaning of a high peak pressure with a low plateau pressure in a mechanically ventilated patient is a specific topic that can generate discussion and interaction using the think-pair-share method. The active discussion of knowledge application and problem-solving both engages and provides benefit to students.

#### 1.3.1.4 Team-Based Learning

Originally described by Michaelsen, team-based learning (TBL) is a medium or large group teaching modality that incorporates a regimented approach to student preparation, assessment, and participation in teaching sessions [54]. TBL relies on pre-class preparation, as students are expected to have completed pre-class work and reading, such that they have a shared foundation of knowledge and understanding prior to in-class activities; consequently, it incorporates many of the elements of the flipped classroom approach [54, 55]. To assess the degree of students' pre-class preparation, at the beginning of the class session, students complete a readiness assessment exercise, referred to as an "individual readiness assessment test" (iRAT), which involves a discrete series of multiple choice questions intended to demonstrate students' understanding of core topics and concepts.

After completing the iRAT, students share their individual answers with a prespecified group of students (their "team") and discuss the rationale and justification for their answer selections. With their team, students are expected to reach a consensus about the "best" answer to the readiness assessment questions; the exercise of reaching group consensus is referred to as a "group readiness assessment test" (gRAT). Each group is expected to be ready to share their consensus answers from the gRAT component with the entire class, and discussion regarding different conclusions, misconceptions, and conceptual understanding can occur in a facilitated fashion. The conclusion of the large group discussion should end with the instructor clearly identifying the correct answers and assessing for shared understanding among all students.

The cycle of iRAT, gRAT, and group discussion typically occurs two to three times during a TBL session, and strict time management and conscientious faculty facilitation are critical to ensure that the TBL session does not fall victim to tangents or unproductive discussions.

#### 1.3.1.5 Concept Maps

Concept maps or mechanism maps are visual representations of one's knowledge about and understanding of a topic or concept [33]. Concept maps are classically defined as a hierarchical flow diagram in which a primary topic or concept is defined based on its component or mechanistic parts (see Fig. 1.1). Mechanism maps are a variation of concept maps that are less explicitly hierarchical in nature and may be more appropriate for the complicated, interrelated nature of medical concepts (see

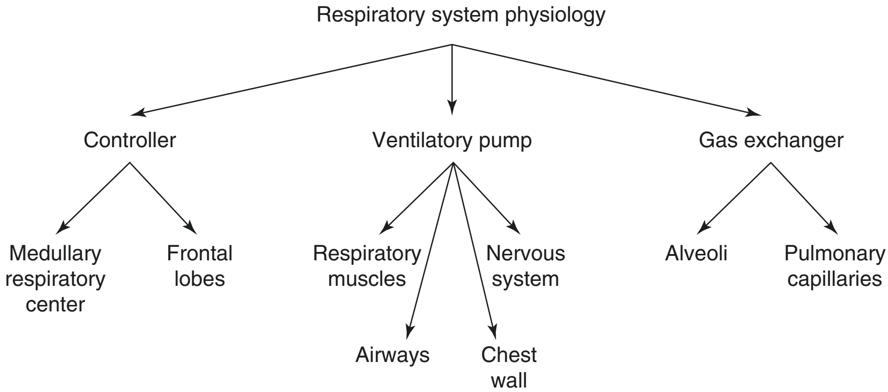


**Fig. 1.1** Example of concept map

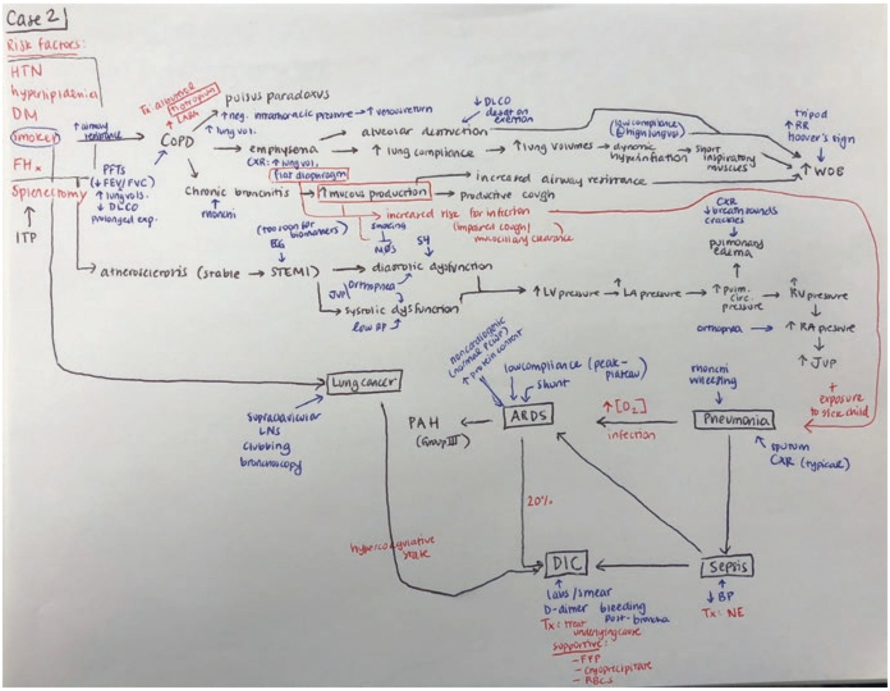


**Fig. 1.2** Example of a mechanism map

Fig. 1.2). Mechanism maps are particularly effective in visually representing interconnected physiologic or pathophysiologic mechanisms and can be powerful tools to teach, study, and review linkages between concepts and mechanisms for pulmonary and/or critical care topics.

Concept and mechanism maps can be used in a variety of educational settings, from individual study to small group teaching to large group educational sessions [33]. In the large group setting, concept or mechanism maps can be created as a component of a lecture-based or interactive teaching session to graphically represent how different medical topics and concepts relate to each other. Developing concept or mechanism maps in real time in the large group teaching setting can both model critical thinking skills (by explicitly demonstrating how to assess and synthesize data) and can encourage students to develop their own concept or mechanism maps for individual, self-directed learning and conceptual integration [56].

#### 1.3.1.6 Case-Based Collaborative Learning

Described in detail below in the *small group teaching* section, case-based collaborative learning (CBCL) is a flexible teaching modality that may be used in small, medium, or large group settings [57]. The principles and logistics of CBCL described below can be applied to larger groups of students.

#### 1.3.1.7 Expectations of Students

Pre-class preparation is implicit in all of the abovementioned active teaching strategies for the large group setting, and clearly delineating the need for independent, pre-class reading and studying is important to maximize the utility of such teaching modalities. While there is no single ideal strategy to optimize students' pre-class preparation, contextualizing the importance of student preparation as a component of professional responsibility and professional development may be effective. Furthermore, instructors must be consistent with regard to accountability – if some students have not completed the necessary pre-class work and are unable to meaningfully participate in the active teaching session, the responsibility for that outcome rests with the students. Instructors should avoid reviewing pre-work during the teaching session, such that students who did not prepare can be brought up to speed, as doing so will demonstrate that students do not actually have to complete pre-work independently prior to the teaching session [45].

#### 1.3.1.8 Challenges for Active Teaching in Large Group Settings

In addition to the challenge of students not preparing for large group active teaching sessions, there are other obstacles to effectively transitioning from didactic, lecture-based large group teaching to interactive, active teaching sessions.

Faculty resistance to change can be a significant barrier to curricular reform and to implementing novel, active teaching pedagogy in the classroom setting [58]. Faculty members may be suspicious of the utility of active teaching and may be concerned about the necessary reduction in content delivery that occurs with transitioning from lecturing to active teaching. In this context, faculty development is critical.

An emphasis on evidence-based outcomes associated with and attributable to active teaching modalities can be influential, and skills development sessions and resources for faculty are important to help instructors succeed in an active teaching format.

Transitioning from lecture-based classroom teaching to active teaching strategies is time-consuming [59]. One study documenting faculty effort when transitioning from a standard curriculum to a flipped classroom curriculum demonstrated that faculty time in preparing course materials increased by 127% [60]. Being cognizant of the time and effort needed to develop, implement, and assess active teaching modalities, particularly when transitioning from standard curricula, is important to optimize faculty buy-in and to minimize potential faculty resentment about using flipped classroom, active teaching strategies.

Other potential barriers to using active teaching strategies in the large group setting include technologic limitations and system-based issues. For example, while there are a number of ARS platforms available (see Table 1.4), if one's medical school does not have the technologic infrastructural or institutional experience with a given ARS, technical issues may arise during teaching sessions. Such technical issues can disrupt the flow and perceived value of a teaching session and can contribute to student and faculty disengagement or even resentment. Anticipating potential technical issues, test-running any ARS platform before a teaching session, and preparing non-technologic alternatives as a contingency plan are strategies to mitigate the distraction of computer or Internet failures during a teaching session.

System-based issues that can threaten implementation and sustainability of active teaching sessions include the challenge of inaccurate or inconsistent assessment methods of active teaching sessions. Students' perceptions of the utility of teaching sessions are consistently valued by medical school administrators, and while students' input is helpful, it has been demonstrated that while active teaching strategies consistently improve students' performance on exams, students may rate active teaching sessions less favorably than passive, didactic, lecture-based sessions [61–63]. This disconnection between the effectiveness of active teaching session and students' perceptions of the acceptability of these sessions is a challenge for instructors and administrators. Although the reasons underlying this observation are probably varied, interactive learning and generating solutions to problems are inherently more effortful for the learner than being told the right answer (recall the concepts of working memory, dissonance, and interference). Awareness of this disconnect is an important step in understanding students' evaluations, and identifying other metrics of effectiveness of teaching sessions beyond students' self-reported perceptions is important to accurately and reliably assess the value of these teaching sessions and teaching strategies.

Finally, a challenge of flipped classroom and active teaching strategies is that students are obligated to complete a significant quantity of out-of-class work. There is risk that students may feel overwhelmed by the workload, and rather than simply not completing pre-class work, they may not be able to keep up with the pre-class work [64]. Ensuring that pre-class materials are high quality, focused, and meaningful is important to maximize student engagement and decrease the risk of them not being able to complete pre-class assignments. Specifically, simply video recording lectures for students to watch is generally not effective pre-class work; rather, more focused and engaging resources are appropriate as preparatory materials. In addition, achieving a balance between pre-class and in-class work is important, as crucial learning objectives and key concepts can and should be reviewed in class to emphasize their importance and reinforce lessons learned by students from their pre-class studies.

**Vignette: Active Teaching in the Large Group Setting**

You have been giving a lecture about interpreting respiratory acid/base disorders as part of a first-year medical school physiology course for the past 3 years, and this year the course director informs you that the course will be adopting active teaching strategies for the large group teaching sessions. You are instructed to reformat your lecture from a didactic presentation to a more interactive active teaching session. After a faculty development session about active teaching strategies led by the course director for the course faculty, you decide to use peer instruction to reformat your respiratory acid/base disorder session.

You review the learning objectives for the session and reformat them to prioritize analysis, synthesis, and application of primary concepts from your lecture. You then divide the lecture into six subcomponents, and you develop brief 7–10 minutes "mini-lectures" for each subcomponent. You incorporate a conceptual multiple choice question from prior year's quizzes and final exams to present after each mini-lecture. You practice your teaching session with a small cohort of faculty and revise the length and some content of your new active teaching, peer instruction session based on their feedback.

On the day of your teaching session with students in the physiology course, the ARS you chose to use to present the conceptual multiple choice questions isn't working. You have the questions available as PowerPoint slides, however, and are able to display them to the class after your mini-lectures, although you are unable to determine the proportion of correct versus incorrect responses in real time.

After the session is over, you solicit feedback from students and co-faculty about what went well and what could be improved for next time. Beyond the issues with the ARS, several people comment that the "peer instruction" portion of the session, when students discussed their individual answers with colleagues, may have been too long. Otherwise, the feedback is generally positive, and you are satisfied with the transition from lecturing to actively teaching in the large group setting.

**Take-home points:** This vignette demonstrates the role of developing content, organizing material, practicing teaching before the session itself, and engaging in contingency planning when using active teaching strategies, particularly in the large group setting. Actively soliciting feedback is also an important consideration to ensure that opportunities to improve the teaching session are captured.

### 1.3.2 Small Group Teaching

Classically, discussion and interactive learning have occurred in small group teaching sessions in the pre-clinical, classroom-based component of medical school, and a variety of educational methodologies exist for approaching small group teaching.

#### 1.3.2.1 Problem-Based Learning

Problem-based learning (PBL) is a student-centered approach to small group teaching and learning. The philosophy of PBL is to prioritize students' curiosity and inquisitiveness [65]. PBL small group sessions tend to be case-based learning experiences, founded on a clinical scenario or vignette, and the agenda for PBL sessions is primarily set by students as opposed to faculty. Students receive a clinical vignette in advance of the PBL session and have time to independently review the vignette to identify questions or areas of confusion. Conceptually framed as a "safe space" for students to engage in active exploration about topics, concepts, or components of the clinical vignette that are of interest to them, PBL sessions leverage student engagement and participation by allowing them autonomy in determining the direction and depth of discussion [66].

PBL sessions are typically composed of six to ten students with a faculty facilitator. The facilitator is intended to act as a "guide on the side," rather than a leader of the sessions. The primary role of PBL faculty is to identify misconceptions or errors in students' reasoning as students discuss aspects of the clinical vignette of interest to them. The facilitator is not intended to drive the agenda of the PBL session or the direction of discussion. Facilitators may also participate by drawing out quieter students, to ensure their voices are heard in the group discussion, but the faculty facilitator is not supposed to dominate the discussion [67].

Students in PBL sessions may identify a "leader" for each session, and the student "leader" may help to determine the agenda and discussion topics for a given session. The role of student leader should rotate, as a single student, or cohort of students should not be identified as leaders for a longitudinal series of PBL sessions. Sharing leadership responsibilities underscores the democratic and collaborative nature of PBL sessions, emphasizing teamwork skills and a sense of community and shared responsibility [68].

PBL has been extensively studied and has several strengths. First, PBL prioritizes students' interests and thereby can optimize student engagement and participation. Having students set the agenda for their sessions hopefully translates to students who are invested in participating in their discussions [69]. Second, PBL explicitly emphasizes self-directed learning skills – if students cannot identify areas of discussion in the case vignettes, no discussion will occur [70]. Third, PBL facilitates the development of teamwork, interpersonal, and communication skills [67, 69]. Students need to work collaboratively and effectively for PBL sessions to be successful, and these skills are clearly important for success in clinical practice.

Fourth, PBL can allow for application and integration of concepts learned in other settings (e.g., readings, lectures, etc.). Having a "safe space" to explore and ask questions about difficult concepts has value for students who are struggling to learn challenging material [67, 68].

There are also negative aspects of PBL. Perhaps most prominently, students can frequently find PBL sessions to be meandering or directionless [71]. When faculty do not provide guidance regarding agenda items or session content, students can worry that they are not covering the most important material with regard to what will be on quizzes or exams. Furthermore, as the teamwork and interpersonal dynamics are primarily driven by the students (rather than faculty), ineffective or dysfunctional discussions can occur, which can frustrate students and can distract from learning.

Overall, however, PBL is a well-established and well-studied small group teaching modality that can effectively promote the critical lifelong learning skills of self-directed learning, critical thinking, and teamwork. These skills are particularly relevant to the interpersonal and teamwork skills necessary for the clinical practice of pulmonary and critical care medicine. Whether in an ambulatory clinic and working with receptionists, medical technicians, nurses, and case managers or in an ICU and working with nurses, respiratory therapists, pharmacists, and social workers, the ability to work effectively in a team is key to successful, effective medical practice. Being aware of the potential strengths and challenges of PBL as a small group teaching method is critical to implementing and promoting effective PBL teaching sessions and helping students develop the skills they will need to be effective, collaborative physicians.

#### 1.3.2.2 Case-Based Collaborative Learning

Team-based learning (TBL), as referenced above in the large group teaching session, can also be used in medium or even small group teaching settings. A modification of TBL, defined as case-based collaborative learning (CBCL), is another modality which can be used in small-, medium-, or large-sized teaching settings. CBLC was first described in 2016 in the setting of a respiratory physiology course and incorporates aspects of TBL and PBL teaching strategies into a novel classroom-based teaching format [57].

Similar to TBL, CBCL is characterized by a commitment to pre-work, as students are expected to complete independent readings and pre-class application exercises prior to the CBCL session. In addition, students are required to complete "readiness assessment questions" (RAQs) prior to the CBCL session (this is distinct from TBL, where the iRATs occur during the session itself). Instructors can review students' answers to the RAQs prior to the CBCL session to assess the group's understanding of the different topics and concepts highlighted in the RAQs.

During the CBCL sessions, students work through case vignettes in a structured manner. First, students are introduced to a new clinical vignette; unlike PBL, the students are not provided the vignette in advance of the teaching session. Students then are asked a series of one to three discussion questions and provided 5–10 minutes to develop their independent answers to the questions. Unlike TBL, in which the questions classically are posed in a multiple choice format, CBCL questions are open ended and intended to stimulate students to apply critical thinking skills (e.g., "Create a mechanistic hypothesis to explain why this patient has chest pain, shortness of breath, and low blood pressure").

Students write down their own answers, and after the period of independent thinking, synthesis, and answer development leading to a "commitment" to an answer, students pass their written answers to their colleagues to review in pre-specified small groups. Similar to TBL, students are assigned to small groups of four for the duration of the course, such that for each CBCL session, they are working in the same small groups [57].

After reading each other's answers, students then discuss their answer choices, rationalizations, and justifications for their answers within their small groups. Each small group is instructed to develop a consensus group answer and prepares to present their consensus answer to the overall larger group at the end of the group discussion period.

Faculty primarily act as observers during the small group discussion period. They can rotate through the classroom, listening to the students' small group discussions, and be available to answer questions, but will not necessarily correct mistakes. By hearing the nature of the discussions, the faculty develop a sense of issues and misunderstandings that will need to be addressed in the large group session. The main role of CBCL faculty is to moderate the larger group discussion in which several small groups report out their consensus answers and justifications for those answers. Faculty can select groups with different answers to a question to report initially, thereby promoting debate and discussion within the large group. At the end of the large group discussion, the faculty summarizes the correct answer, and a cogent way of thinking about the problem is initially presented.

CBCL sessions may be comprised of 16–45 students, although the small groups within a larger CBCL cohort are consistently three to four students. For a larger CBCL session (e.g., greater than 25–30 students), having two or more faculty to observe and facilitate may be desirable (i.e., co-teaching).

The active structure of CBCL sessions can be effective for teaching concepts and topics in pulmonary and/or critical care medicine. As noted above, CBCL was developed and first described in a first-year physiology course for medical students, and respiratory physiology and pathophysiology topics were featured in the CBCL cases, questions, and discussions. Developing questions that prioritize mechanistic understanding and critical thinking skills is important for CBCL sessions to be engaging; CBCL questions that lead to simple, memorization-based answers will be less engaging and less effective.

CBCL is less well-studied than PBL, but preliminary data indicate that CBCL is non-inferior to PBL in a heterogeneous group of medical and dental students [57]. Furthermore, CBCL may be beneficial for students struggling with material and/or students who have performed more poorly than their peers in prior classes.

### *1.3.3 Clinical Settings*

Pre-clerkship students are frequently focused on mastering medical knowledge content with the goal of performing well on quizzes and exams, such that the importance of clinical learning can be eclipsed by these more immediate demands. Instructors may be able to address the disconnection between students' priorities and the importance of clinical learning by explicitly emphasizing connections between the topics and concepts that students are learning in the classroom with clinical practice. For example, if students are studying for a quiz about the physiologic concepts of "flow through tubes," highlighting the role of airway inflammation, decreased luminal diameter, and increased turbulent flow in causing wheezing on exam can help link the classroom-based concepts with clinical practice.

Faculty can also encourage students to identify linkages between the topics and concepts they are studying in the classroom setting and clinical experiences [71]. Leveraging the principles of active teaching in the classroom to the clinical setting, one can ask students to identify linkages between basic science topics and clinical observations to underscore the importance of clinical education and solidify important lessons learned in the classroom. Such discussions between students and faculty can reinforce critical thinking skills that are important for both classroom and clinical learning.

As in any teaching setting, it is important to establish the goals and objectives of the teaching session up front. In addition, discussing expectations and students' responsibilities for the clinical teaching experience is important. While early clinical exposures for pre-clinical students may primarily involve observation, subsequent clinical experiences may involve skill development (e.g., interviewing and examining patients). Ultimately, "meaningful" work is key for students in the clinical setting; they want to know that what they are doing is, in some way, contributing to the care of the patient. Ensuring that the logistics and expectations of the clinical teaching experience are clear prior to the teaching encounter is important for maximizing the value of the educational experience for students.

## 1.4 Out-of-Classroom Learning

In addition to classroom-based and clinical activities, using technology to interact with and teach pre-clinical learners is a potentially effective strategy for augmenting students' engagement with medical education content. The ubiquity of technologic, online, and mobile tools for teaching represents a potentially significant opportunity for teaching pre-clinical students. And, as noted elsewhere in this textbook, Millennial and Generation Z learners are comfortable and facile with technology and accustomed to using technology for learning [72].

Furthermore, there is a solid foundation of evidence regarding the benefits of spaced learning, in which learners are exposed to content over time (rather than in one setting) [73–75]. Using technology for out-of-class teaching and learning can promote interweaving topics and concepts throughout a curriculum, unmooring learning objectives and educational content from a time-limited teaching session.

Using technologic, online, and/or mobile platforms to disseminate medical knowledge content to learners can also address the limited time available in the classroom to cover material in a face-to-face manner.

Content can include course materials disseminated by email, web-based platforms, or mobile devices. Alternatively or complimentarily, existing third party resources that are relevant to the students' learning can be disseminated. YouTube videos [76], Kahn Academy videos, and other existing online resources can be reviewed by instructors and sent to students as supplementary, spaced education material to complement course resources [77].

Beyond disseminating content, technologic platforms can engage learners in material and promote application and problem-solving skills. Concept questions can be delivered to students via email, ARS platforms, mobile apps, or other means in an out-of-classroom, less formal, and interleaved manner to leverage critical thinking skills and active application of knowledge to answering questions and solving problems.

## 1.5 Conclusion

The content and format of pre-clinical or pre-clerkship medical education has changed significantly over the past decade, with a transition from unidirectional transfer of information from a lecturer to students to a focus on interactive, active teaching and learning. This change in practice in medical education has manifested in both large group and small group teaching sessions for pre-clinical students. There are many different specific strategies for engaging in active teaching in large and small group settings. The flipped classroom philosophy, in which student preparation and accountability are necessary for successful teaching sessions, is a foundation on which specific active teaching strategies are founded. Ultimately, the goal of teaching students in the pre-clinical setting is not to effectively transfer knowledge but to promote and guide the development of critical thinking skills that can be employed in clinical practice and which can contribute to lifelong learning. Emphasizing application of knowledge to solving problems and prioritizing inductive reasoning, synthesis, and integration of content across topic areas are critical goals for classroom-based learning. The principles of critical thinking skills, self-directed learning abilities, and an orientation toward lifelong learning can lay the foundation for future learning in the clinical setting and in clinical practice. Pulmonary and critical care educators can use these principles and educational strategies to effectively engage and teach pre-clinical learners in the classroom setting.

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# Chapter 2
# Teaching Clinical Medical Students

**Mario C. Ponce and Jeremy B. Richards**

## 2.1 Introduction

Pulmonary medicine can involve longitudinal, episodic ambulatory care, as well as in-patient consultative, acute clinical care. Critical care medicine involves a patient population with multiple acute and complicated medical problems in the potentially intimidating and overwhelming environment of the intensive care unit (ICU). Combined, pulmonary and critical care medicine (PCCM) encompasses a wide variety of diseases in different settings leading to distinct medical decisions and interventions. The variability of PCCM offers both opportunities and challenges in teaching medical students in the clinical setting. Medical students feel more comfortable after completing a rotation in the ICU, and medical students who completed a rotation in the ICU increased the probabilities of choosing critical care as their specialty in the future [1].

Developing effective strategies for orientating, engaging, and teaching medical students in these heterogenous clinical settings can be daunting. The same techniques that may be effective in an outpatient clinic may not be effective for students in the ICU. Furthermore, the scope of teaching in the clinical setting can span from patient-based teaching at the bedside to didactic teaching in a conference room to structured educational interventions in a simulation center or with a simulated patient. Understanding the potential breadth of engagement with students in PCCM is a first step towards selecting and using teaching techniques to address their education needs and to achieve pertinent learning objectives.

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_2

There are few studies comparing different approaches to teach PCCM, and the best approach – if a "best approach" actually exists – has not been rigorously or definitively determined. In this chapter, specific teaching strategies derived from the medical education literature, practice guidelines, and professional society and licensing organizations are described with an emphasis on teaching medical students in the ICU and on the Pulmonary Consult service (teaching medical students in the ambulatory setting is discussed in detail in Chap. 8 "Teaching in Clinic.")

## 2.2 Different Clinical Settings and Methods for Teaching Medical Students: The ICU

The ICU can be overwhelming for medical students, as it is a different environment than other clinical rotations [2]. Severity of illness is higher and medical complexity can be more challenging. The clinical interventions used to support and treat critically ill patients may also be foreign to medical students, as mechanical ventilators, invasive hemodynamic monitoring devices, and vasoactive medications are not standard components of clinical care in most other medical settings. The unfamiliarity of the critical care setting must be appreciated by educators when considering how to orient, engage, and teach medical students in the ICU [2, 3].

The novelty of the ICU offers an opportunity to educators as students frequently do not have preconceived notions or "scripts" for what constitutes clinical practice in the ICU. This is an opening to effectively frame expectations for students with regard to their role, performance, and goals for a rotation in the ICU [1, 3].

### *2.2.1 Student Role*

While a student or educator may have specific, individualized learning objectives, the main goal of an ICU rotation is for medical students to develop their clinical knowledge and skills in managing critically ill patients. Critical care medicine (CCM) covers a broad range of diagnoses, treatments, procedures, and ethical and communication issues. As such, in addition to general exposure to and participation in the practice of CCM, it is important to thoughtfully prioritize aspects of CCM pertinent for medical students. There is not consensus at the national level with regard to components of medical knowledge, clinical skills, and/or attitudes in the practice of CCM that should be expected from a medical school graduate [1]. As such, priorities for medical student education and medical students' role in ICU rotations are currently derived from consensus opinion, common sense, and individual preferences.

In this context, it is generally accepted that the role of the medical student on an ICU rotation should be active and not passive [1, 3, 4]. Clinical medical students should not relegated to passive observation or "shadowing" on ICU rotations. The commitment, responsibility, and engagement derived from taking ownership of a patient(s) are critical to achieving deep and meaningful learning. The specifics of an active role will necessarily vary by practice considerations and an individual student's medical knowledge and clinical ability, but some degree of autonomy in gathering and synthesizing data and making clinical decisions is generally considered best practice for clinical medical students on CCM rotations [1, 3].

Medical students should also participate in communication with patient and families, either during or after rounds. Communication should be under the supervision of attendings, fellows, or residents, particularly with regard to any "high-stakes" updates, potentially contentious discussions, and/or formal or semiformal family meetings. As students demonstrate competency in communicating with patients and/or families in the ICU, however, students may engage in informal daily updates or discussions without direct supervision. Faculty should discuss expectations regarding communicating with patients and families very early in the rotation, so that students are aware of what is expected and allowed, and a shared understanding of supervision and evaluation of students' communication skills is made explicit.

Beyond assuming an active role in data gathering, synthesis, and preliminary, first-pass medical decision-making, a clinical medical student should have opportunities to participate in performing procedures for critically ill patients [5]. The student's active role in the ICU should include hands-on, interventional management of patients, particularly for patients the student is primarily following.

Finally, clinical medical students' role should encompass tasks and assignments that are meaningful for the entire ICU team and the team's workflow and responsibilities. Students are obviously engaged and interactive when presenting the patients they are primarily following and when performing procedures, but it is important to carefully consider the role of the student outside of those moments. Without some thought to a student's role and expectations when he or she is *not* presenting, the likelihood that the student will passively observe and not meaningfully engage is extremely high.

### *2.2.2 Student Responsibilities and Expectations*

Acknowledging that a student's responsibilities are intrinsically related to the student's role, it is still critical to clearly and effectively delineate the specific expectations for and responsibilities of a medical student at the beginning of the ICU rotation (Fig. 2.1) [1, 3]. Specifically, while it may seem obvious, clearly stating that the student is responsible for attending daily rounds is appropriate, as is designating expectations regarding presentations and other tasks (Table 2.1). Daily rounds are an excellent opportunity to expose students to the details of the clinical practice of CCM; however, daily rounds can be overwhelming and exhausting for medical students due to complexity of the patients and the amount of time typically required to complete rounds. Being aware of a student's level of engagement and energy level

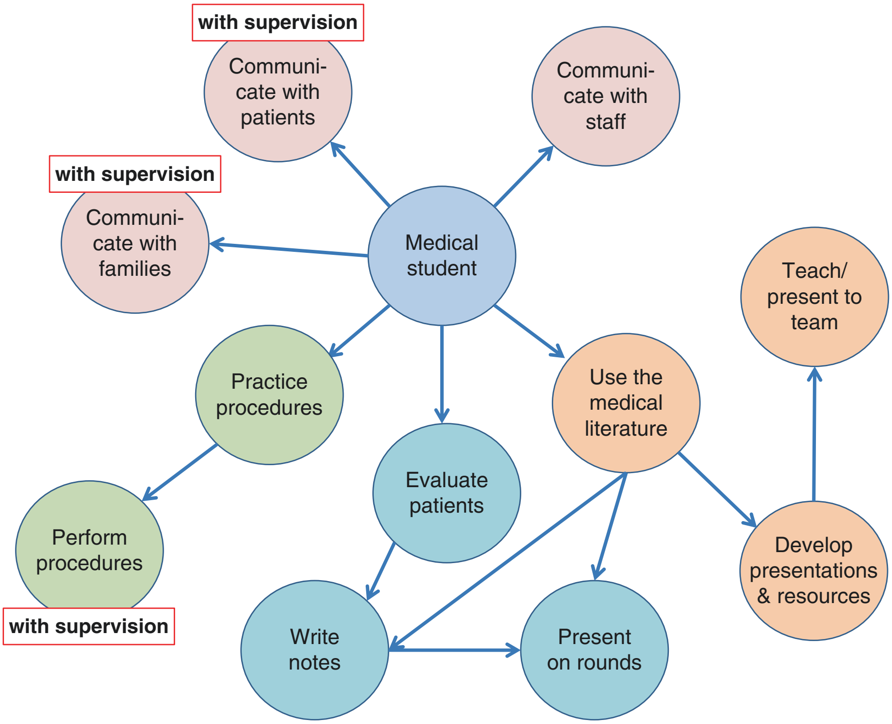


**Fig. 2.1** Student role in ICU

**Table 2.1** Potential tasks for a clinical medical student in the ICU

| |
|---|
| Complete daily goal sheets |
| Summarize the plan after each patient |
| Call consults |
| Perform basic procedures (e.g., Foley catheter insertion, naso- or orogastric tube insertion) |
| Perform some advanced procedure (e.g., arterial line, central venous catheter insertion) |
| Update hand-off or sign-out information |
| Provide updates to patients and/or families (with supervision) |
| Develop and provide brief teaching sessions for the team |
| Update or complete discharge summaries |

can help guide the appropriateness of teaching about a concept or topic versus simply moving forward with patient care in an effort to finish rounding.

With regard to participation in rounds, medical students should be assigned their own patients and present them in the standard format of the ICU in which they are rotating. The content, organization, and complexity of students' presentations will necessarily vary based on their level of training and experience, and expectations regarding the logistics of students' presentations should be explicitly discussed early in the ICU rotation.

It should be emphasized to students that learning opportunities are not limited to rounds. There are learning opportunities when pre-rounding, answering questions of patients, or working with other members of the interdisciplinary ICU team. Ideally, they should be involved in the care of their patients from admission until discharge and get a close view of a variety of disorders.

Additionally, they should get familiar with procedures that they might perform in the future as interns or residents such as Foley catheter placement or feeding tube placement [5]. More complex procedures with higher rate of complications like intubations, chest tube, or central catheter placement should be performed with very close supervision of attendings, or be independently performed by more advanced trainees (residents or fellows) or attendings.

Responsibilities regarding self-directed learning are critical to emphasize early in the ICU rotation [6]. Students may have an expectation that they will "be taught" during the rotation, whereas the realities of clinical practice are such that consistent and obvious student-directed teaching cannot always occur on a regular basis. As such, emphasizing the responsibility of independently reading about high yield topics in critical care is important [7, 8]. Finding and reviewing resources (Table 2.2) about the indications for, methods of performing, and clinical practice principles of common ICU procedures are similarly relevant to the student's ability to participate meaningfully in patient care. Contextualizing these self-directed learning responsibilities as an aspect of professional development and life-long learning is appropriate, as the ICU may represent an inflection point in students understanding of their role in their own education.

Providing medical literature (web-based, presentations) at the beginning or during the rotation can help to increase the knowledge of the medical students by the end of the rotation, and encouraging students to independently seek and share medical knowledge resources can promote self-directed learning and retention of core concepts and topics [8].

Finally, supervision of medical students in the ICU is a collaborative effort. Faculty observations, guidance, and supervision are critical and necessary for students' education and growth, but interns, residents, and fellows all significantly

**Table 2.2** Suggested online medical knowledge resources for medical students in the ICU

| Resource | Web link |
|---|---|
| Critical Care Reviews | https://criticalcarereviews.com |
| The *New England Journal of Medicine* videos about ICU procedures | https://www.nejm.org/multimedia/medical-videos |
| Maryland Critical Care project | https://maryland.ccproject.com |
| Life in the Fast Lane | http://lifeinthefastlane.com |
| Social Media and Critical Care (SMACC) | http://www.smacc.net.au |
| The Bottom Line | http://www.thebottomline.org.uk |
| PulmCCM.org | http://pulmccm.org |
| Mastering Intensive Care | http://masteringintensivecare.libsyn.com |
| Intensive Care Network | https://intensivecarenetwork.com |
| Women in Intensive Care Network | http://www.womenintensive.org |

contribute to supervising, teaching, and assessing students. Discussing expectations regarding the supervision and education of students with interns, residents, and fellows is an important component of ensuring a student rotating through the ICU has as valuable an educational experience as possible. Nurses, respiratory therapists, pharmacists, physical therapists, social workers, and other health-care professionals also play important roles in educating medical students in the ICU, and awareness of and coordination with these stakeholders for optimal student education can further optimize the student's learning and overall clinical experience.

## 2.3 Specific Clinical Teaching Methods for the ICU: Teaching on Rounds

### *2.3.1 Teaching in the Context of Presentations*

Medical students should learn to present their patients in a succinct manner yet be encouraged to provide appropriate detail when clinically indicated. Medical students should be supported in presenting the history and physical for newly admitted patients and a focused delineation of events of the last 24 hours for established patients. Different institutions have different local expectations regarding the precise formatting and content of presentations, and ensuring that a medical student is aware of local expectations is important.

Regardless of the format and content of the presentation of historical, subjective, and/or objective data, the most critical aspect of the presentation is the assessment and plan. Vigilance on the part of supervising physicians is necessary to ensure that a student is not simply repeating a plan that she read from a note or was told by an intern or resident. Even though a student may be able to recite the clinical plan of care, she might not understand the reasoning for the plan. Assessing a student's understanding of the clinical assessment and plan of care requires careful observation of the presentation, active listening to the student's plan, and targeted questioning using "how" and "why" questions [9].

Asking the student to explain "how" he reached a clinical conclusion provides a window into the student's thinking [9, 10]. For example, "How did you determine that the patient had a pulmonary embolism?" can allow the student to delineate his thought process: "We noted that the left lower extremity was swollen, the patient was more tachycardic, and when we calculated the patient's Wells score, it was consistent with a venothromboembolism being 'likely.' That prompted us to get the chest CTA." This answer demonstrates well-developed data gathering and synthesis skills, as opposed to the student simply stating "The chest CTA showed a PE."

In this context, it is important to emphasize that critically ill patients have many teaching points and not all have to be brought up on rounds every day. Being cognizant of time pressures, cognitive fatigue, and the team's engagement and energy level are necessary to allow for value-added teaching.

### 2.3.2 Teaching at the Bedside

The benefits of bedside rounds are numerous, and while the physical exam has been de-emphasized in critical care medicine in favor of radiographic, ultrasonographic, laboratory, and invasive hemodynamic monitoring data, the appropriateness of de-emphasizing the physical exam has been recently questioned. Teaching at the bedside is discussed in more detail in Chap. 7, but the opportunity to engage in patient-appropriate language, demonstrate best practices in physical exam skills, and review ICU monitoring and mechanical support devices is invaluable [11]. Spending time at the bedside in a meaningful and thoughtful manner can significantly improve trainees' clinical skills. Balancing the time spent teaching with time pressures of rounding and prioritizing patient care is important, as bedside teaching can prolong rounds [12].

## 2.4 Specific Clinical Teaching Methods for the ICU: Teaching Before and After Rounds

Teaching before rounds is typically characterized as a time-limited, content-specific teaching session ranging from didactic lectures to more interactive, discussion-based teaching [13]. The morning ICU teaching session is not specifically focused on the clinical medical student and instead is typically characterized as a "one room schoolhouse" with learners from multiple different levels participating. As such, while these teaching sessions can certainly benefit medical students, they are not typically designed for or focused on students [14].

In many ICUs, 30 minutes teaching sessions are held with the medical students and residents. These sessions are led by the attendings or fellows. Teaching sessions can be before or after rounds. At many institutions, sessions are done before rounds to avoid delaying the flow of work after rounds. Sessions are characterized by interactive teaching techniques (e.g., discussion is promoted as opposed to didactic lectures), and these sessions include a variety of ICU topics (see Table 2.3.) [15]

There is little guidance in the literature or from expert consensus about how to best use the time after rounds for teaching and education [16, 17]. The competing obligations of patient care (e.g., completing consults, performing procedures, completing progress notes, and entering orders) and education present a challenge to identifying the optimal time, duration, and content of after-rounds teaching. The flow of work is very helpful to find the best teaching times for different ICUs. For example, in surgical ICUs, the best time for teaching sessions may be after rounds, before postoperative patients begin arriving from the operating room.

One strategy for approaching teaching after rounds is to provide focused reviews on pertinent topics not fully explored during rounds. Prioritizing patient-centered and clinically pertinent teaching is rational, as topical content is much more likely to be engaging and relevant to the clinical medical student as compared to less immediate topics. Given the multiple competing obligations for interns, residents, and fellows in the afternoon, one-on-one teaching sessions with medical students

**Table 2.3** Recommended topics for ICU teaching sessions

| |
|---|
| ARDS |
| Hypoxemia and hypercapnia |
| Sepsis |
| Mechanical ventilation |
| Noninvasive positive pressure ventilation |
| Hemodynamic monitoring |
| Intoxications |
| Delirium |
| Acute liver failure |
| Acute kidney injury |
| Diabetic ketoacidosis and hyperosmolar hyperglycemic nonketotic syndrome |
| Utilization of blood products |

may be more logistically possible and preferable teaching activities for the team after completing rounds.

## 2.5 Specific Clinical Teaching Methods for the ICU: Teaching Using Students' Notes

Documentation is a critical skill that must be developed during medical school and residency training; however, little time is spent reviewing student documentation in ICU settings. Developing a plan to specifically review a student's note is important, and identifying a specific date and time to accomplish the review is ideal. When reviewing a student's note, identifying opportunities to better explain her thinking and clinical reasoning should be a priority. Students on critical care rotations typically have sufficient clinical experience such that the basics of formatting and objective content do not require significant attention. Of course, there are exceptions to this generalization, and some students may need remediation regarding the basics of clinical documentation.

For most students in the ICU, however, reviewing notes is an opportunity to evaluate their assessments and plans [18]. Pointing out when a student's reasoning is not clear, and providing examples of more transparent and cogent clinical reasoning, is an opportunity to help the student develop better writing and documentation skills. Following up on the student's notes later in the rotation allows supervising physicians to assess whether the student has instituted any changes or improvements in his documentation.

## 2.6 Specific Clinical Teaching Methods for the ICU: Asynchronous Teaching

There are many tools that can help with teaching. Attendings or fellows can send an email with a summary of the teaching points for the day. The email can summarize teaching points for the day and include key articles in the topic. Blogs or websites can be very useful to guide students' reading and asynchronous learning (Table 2.2) [19]. Providing students with specific references about core topics in critical care medicine can decrease the activation energy of students having to independently search for relevant resources.

**Teaching Vignette**

The ICU day starts with a 30 minutes teaching session by the fellow. Rounds start immediately after the teaching session, with medical students and residents presenting their patients. The fourth-year medical student on the team presents the following case in rounds: "Ms. Liu is a 40 year-old woman with hypertension who was transferred from an outside hospital due to respiratory failure."

The resident interrupts the student to ask what type of respiratory failure the patient has, and the medical student does not know the answer. The intern quickly interjects "She has hypoxemic respiratory failure." The medical student continues with her presentation: "About 2 weeks ago, Ms. Liu was admitted to the outside hospital with flu-like symptoms. On arrival to outside hospital, pulse oximetry was 85% on room air, she was hypotensive and tachycardic. She received intravenous fluids, ceftriaxone, and azithromycin. Influenza nasal swab was positive, oseltamivir was added. Her respiratory failure has worsened since admission and she was intubated 48 hours ago. Her oxygen requirement has continued to increase, and prior to transfer, her ventilator settings were pressure-regulated volume control with a tidal volume of 400 mL, respiratory rate of 12 breaths per minute, positive end-expiratory pressure of 10, and $FiO_2$ of 80%. The $PaO_2$ was 100 mmHg."

The medical student then continues to past medical, surgical, social, and family history, all noncontributory. The physical exam is notable for a sedated and intubated patient with bilateral crackles. The chest radiograph was read by the intern and demonstrated bilateral diffuse patchy infiltrates. The medical student proceeds to the assessment and plan and mentions hypoxemic respiratory failure as the most important problem. The attending asks the student if they have heard about acute respiratory distress syndrome (ARDS). The attending asks for the definition and the team (students, interns, and residents) put it all together. The medical student then mentions that the patient is receiving lung-protective ventilation and the patient's tidal volume is set at 6 mL per kilogram (ideal body weight). The nurse then mentions that tidal volume was just changed to 500 mL. The attending noticed that the peak pressures are at 38 cmH2O, and he asks the team about lung-protective ventilation strategy. A resident mentions that lung-protective ventilation means that the tidal volume is 6 mL/kg and "pressure" should be less than 30 cmH2O. The fellow and attending explain the lung-protective ventilation and adjust the ventilator settings. The team then continues to address the patient's remaining medical problems and then move to the next patient in the ICU.

**Take-home points:** During rounds, the attending and the fellow should ask questions to the medical students, interns, and residents. Furthermore, it is important to clarify if the concepts and reasoning behind the decisions of the team, including the medical student, are correct. In this case, the team did know about lung-protective ventilation, but the application of the concept and the mechanical ventilator settings were incorrect.

## 2.7 Different Clinical Settings and Methods for Teaching Medical Students: The Pulmonary Consult Rotation

### *2.7.1 Student Role*

The Pulmonary Consult service can be a challenging environment for a clinical medical student, particularly if he or she does not have experience in consultative settings [20, 21]. The student's level of experience is, therefore, an important determinant in his or her initial role on the consult service. An inexperienced student without prior exposure to or practice experience in consultative medicine will require guidance and modeling early in the rotation, with an emphasis on demonstrating best practices in receiving a consult request, determining the consult question, assessing the patient and the available clinical data, and providing appropriate recommendations to the requesting team [21].

If a student has substantive prior experience in consultative medicine, and/or after the student develops experience on the Pulmonary Consult team, the expectation should be that the student progresses to increasing autonomy. A clinical student on the consult service should have the opportunity to respond to an initial consult request, including being the first point-of-contact with the requesting team, determining the consult question, and performing the initial assessment of the patient and the clinical data. The student should be expected to develop preliminary recommendations for the requesting team and present those recommendations to the Pulmonary Consult team for discussion and modification.

Emphasizing the importance of developing clinical skills to achieve autonomy and the capacity for progressing to the less-supervised graduate medical education setting is an important component of the clinical medical student's participation on the Pulmonary Consult service.

### *2.7.2 Student Responsibilities and Expectations*

As above, when they are determined to be sufficiently familiar with the parameters and idiosyncrasies of the Pulmonary Consult service, students should be expected to act as the primary point-of-contact for the team requesting the consult (Fig. 2.2) [20]. Responding to the initial consult request to determine the content and nature of the consult question is an extremely valuable learning experience for students

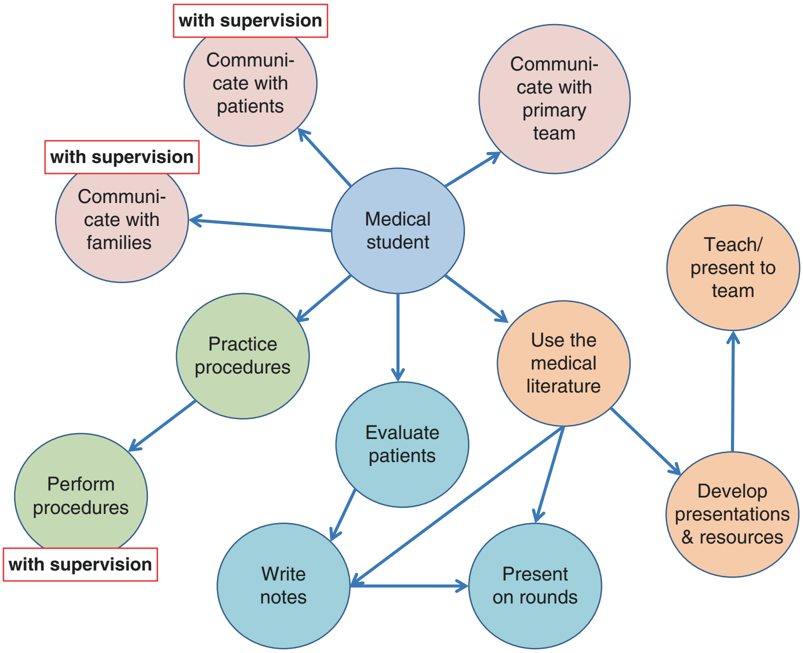


**Fig. 2.2** Student role on Pulmonary Consults

[22]. A best practice may be to have the pulmonary fellow be physically present during the calls with the requesting team to determine the consult question, as occasionally issues or miscommunication can occur. In addition to responding to the initial consult request, the student should be the primary team member to evaluate the patient and synthesize the clinical data to develop a preliminary recommendation in response to the consult question. In addition to obtaining a history of present history, the medical student should then review all the medical information relevant to answer the consult (Table 2.4). Similarly to being present with the student when she or he calls the requesting team back, the pulmonary fellow should review the patient's data in parallel with (but separate from) the medical student, to develop an independent assessment of the appropriate responses to the consult question.

The student should present the results of his or her assessment and preliminary recommendations to the consult team [23]. The student is responsible for justifying her recommendations and should be prepared to discuss the "how" and "why" of her recommendations. It is reasonable to expect students to have read in some depth about the patient's clinical condition and diagnostic and/or treatment options, such that by the time the students present patients to the consult team, they have familiarity with the literature and practice guidelines.

The student is responsible for primary documentation for the patients that he or she is assessing and following. Writing initial consult notes and subsequent consult notes is a critical component of being a member of the consult service, and students are expected to engage in that component of clinical practice and clinical care [20].

## 2.8 Specific Clinical Teaching Methods on the Pulmonary Consult Service: Teaching on Rounds

### *2.8.1 Teaching in the Context of Presentations*

As students are expected to have read about their patients prior to presenting them on consult rounds, the depth of discussion should be relatively advanced and clinically pertinent. While reviewing core concepts (e.g., foundational physiologic mechanisms) can be a component of teaching during consult rounds, a focus on clinical practice topics is more common. The relevancy of discussing clinical practice issues, from diagnostic strategies to optimal therapeutic management plans, is significant due to the direct applicability to the consult question and developing recommendations.

Students' clinical reasoning, processing, and synthesis skills should be probed on rounds with "how" and "why" questions being prioritized [24, 25]. As students are expected to have read about their patients' problems prior to presenting them on rounds, basic "what" questions tend not to yield insight into the students' analytic reasoning skills.

Given that students have engaged in some pre-reading and pre-work prior to rounds, there is an opportunity to engage in more in-depth discussion of the literature. Rounds can therefore be an opportunity for reviewing evidence-based practices and assessing a student's understanding of the literature, including his understanding of statistics, types of studies and trials, and generalizability of study results. Emphasizing the tenants of evidence-based practice in the context of consultative medicine represents a novel and valuable component of consult rounds.

### *2.8.2 Teaching at the Bedside*

Physical exam maneuvers can be observed and modeled for the student. Patients on the Pulmonary Consult service frequently have interesting and important physical exam findings, and taking time to review best practices for performing core

**Table 2.4** Pertinent information for Pulmonary Consult write-ups and presentations

| |
|---|
| History of present illness |
| Exposure history: tobacco use |
| Pulmonary function tests (PFTs) |
| Imaging: chest x-ray, CT chest, PET scan |
| Echocardiogram |
| Microbiology: sputum cultures |
| Pathology: lung biopsy, mediastinal lymph nodes |
| Previous Pulmonary Consults |
| Previous procedures |
| Outpatient pulmonary clinic notes |
| Specific current laboratory data – ABG, BMP |

pulmonary physical exam maneuvers is an important educational component of the rotation.

Additionally, having the clinical medical student take the lead in communicating the Pulmonary Consult team's recommendations to the patient (and/or to the patient's family) is a valuable opportunity for the student to practice patient-centered communication skills. How to deliver news to patients and/or families should be discussed beforehand with the medical student to ensure that he has a strategy for delivering news and to maximize the likelihood that he delivers a clear message. Feedback on the student's communication behaviors after the patient encounter can allow for reinforcing effective strategies and for modifying less effective techniques.

## 2.9 Specific Clinical Teaching Methods on the Pulmonary Consult Service: Teaching Before and After Rounds

Teaching conferences before or after Pulmonary Consult service rounds are a common component of Pulmonary Consult rotations. However, these teaching sessions are not typically exclusively focused on the medical students on the team. Rather, similar to the morning ICU teaching conferences, Pulmonary Consult teaching sessions are frequently a "one room schoolhouse" with learners from multiple different levels participating. As such, while these conferences can be valuable for medical students, they are not typically designed exclusively for them.

Independent teaching sessions with a medical student(s) on the Pulmonary Consult rotation are encouraged and beneficial for students. However, time pressures, competing obligations, and the extent of teaching and learning achieved on rounds and/or at the bedside may affect the time and energy available for performing such one-on-one teaching sessions. Examples of topics for teaching sessions are listed in Table 2.5.

**Table 2.5** Examples of Pulmonary Consult teaching session topics

| |
|---|
| COPD (emphysema, bronchitis, bronchiectasis) |
| Asthma |
| Cystic fibrosis |
| Pneumonia |
| Thromboembolic disease |
| Pulmonary hypertension |
| Hypoxemia |
| Lung cancer |
| Pulmonary fibrosis/idiopathic interstitial pneumonias |
| Occupational exposures/pneumoconiosis |
| Acid/base disorders |
| Tuberculosis |
| Neuromuscular diseases |

## 2.10 Specific Clinical Teaching Methods on the Pulmonary Consult Service: Teaching Using Students' Notes

As with the ICU (see above), teaching with notes is a powerful and underused educational opportunity on the Pulmonary Consult rotation. Reviewing students' notes is valuable for students, particularly with an emphasis on clinical reasoning, data synthesis, and developing (and relaying) a rational set of recommendations. Students may feel compelled to provide more recommendations than needed, in an effort to "satisfy" the consulting team, and discussing the importance of providing clinically appropriate recommendations is an important teaching point that can be emphasized when reviewing notes [18, 26].

Ensuring that students are aware of expectations and best practices for content and formatting of consult notes is important, as while students may be familiar with standard history and physical and progress notes, they may have little or no experience in writing consult notes. The importance of framing the note around the consult question being asked is critical, and encouraging students to clearly delineate their assessment and specific recommendations is important [27].

## 2.11 Specific Clinical Teaching Methods on the Pulmonary Consult Service: Procedural Teaching

Procedures are a common component of both the ICU and the Pulmonary Consult service. While procedural teaching is discussed in more detail in Chap. 13, it is important to emphasize the role of and best practices for teaching procedures to clinical medical students. Students should participate in procedural training with other team members (e.g., if the interns have a simulation scenario to learn and practice placing central lines during their ICU rotation, the clinical student should attend that session.) If determined to be adequately competent with regard to performing specific procedures using local criteria, students should be allowed to perform components of procedures with direct faculty supervision [5].

Some programs have trainees on the Pulmonary Consult service participate in task-training activities for both thoracentesis, and at least to gain simulated exposure to the procedure, bronchoscopy. Simulated scenarios are the trainee's first encounter with the equipment and skills needed to perform these procedures. After demonstrating adequate mechanical and cognitive procedural competency in the simulation setting, trainees are determined to be ready to perform components of procedures for patients in a supervised manner. As is discussed in the chapter on Procedural Training, it is best to have trainees only perform a procedure in its entirety after they have demonstrated competency in the component parts of a specific procedure.

To emphasize, in order to promote autonomy and to foster students' professional identity formation, it is best practice to have medical students are considered equivalent to interns and residents with regard to procedural training and performance and are encouraged to participate in all procedural training and, if appropriate, to participate in performing procedure for their patients in a supervised manner.

**Teaching Vignette**

The Pulmonary Consult service day starts with table rounds followed by patient rounds. Medical students, residents, and fellows present new patients to the attending physician. Updates on the patient the consult team is already following are discussed, as well as new diagnostic test results and image studies.

The medical student presents the first patient. “Mr. John Doe is a 60 year-old male patient with very severe COPD ($FEV_1$ 20%), class D, admitted for a COPD exacerbation. He was admitted 5 days ago, after sudden onset of shortness of breath at home. He was started on prednisone, antibiotics and inhalers by the primary team. His symptoms have partially improved.” The fellow asks for the differential diagnosis. The medical student notes that most likely he needs a longer course of prednisone and would continue inhalers and antibiotics. The residents add “Mr. Doe usually improves slowly and stays as inpatient for 2 weeks.” The attending asks for his usual activity level at home; the medical student does not know the answer. The fellow then comments that 25% of patients admitted for COPD exacerbation have a pulmonary embolism and references a specific trial to justify his claim. The team then discusses the common causes of COPD exacerbation.

After table rounds, they go at bedside to see the patient. Mr. Doe mentions that he has a very sedentary life due to his severe shortness of breath with any activity. He still feels short of breath, minimally improved despite the treatments provided in the hospital. The team decides to obtain a CT angiography of the chest to evaluate for pulmonary emboli. The medical student relays the recommendations to the general medicine team. The CT angiography shows a pulmonary embolism. The patient is started on a direct thrombin inhibitor. His symptoms continue to improve and he is discharged home within a few days.

**Take-home points:** The team allowed the medical student to be autonomous in evaluating the patient and developing her initial assessment and plan, and then provided further contextual input into and commentary about her reasoning and integration skills. The student was provided the opportunity to write the consult note and relay recommendations to the primary team.

## 2.12 Evaluating and Providing Feedback to Students

Feedback is a critical component of medical training and is necessary to allow clinical medical students to effectively progress through their training. Feedback is discussed in more detail in Chap. 15, but a brief contextual review of best practices for assessment, evaluation, and feedback for clinical medical students is appropriate.

Briefly, while local practices for assessment and evaluation vary from institution to institution, it is important for supervising physicians and medical educators to be familiar with the framework of entrustable professional activities (EPAs) [28]. Developed through the Association of American Medical Colleges (AAMC), the EPAs provide a detailed structure of specific professional activities for which a student must demonstrate evolving ability and improvement in to be able to progress to residency training. Being aware of and using the EPAs to guide evaluation and feedback for medical students on clinical rotations is important, such that attendings' assessments of students are grounded in contemporary and consensus best practices [28, 29].

With regard to feedback, use of frequent, behaviorally targeted, formative feedback is helpful for all learners. Formative feedback is immediate and focused and targets a specific behavior or skills. This approach is more effective and meaningful than intermittent, comprehensive summative feedback [30, 31]. Strategies for providing feedback effectively and strategies for getting feedback from students are discussed in more detail in Chap. 15.

## 2.13 Summary

The breadth of PCCM is an opportunity for engaging medical students in a variety of clinical settings and in managing a spectrum of disease processes. Exposure to patients in the inpatient consultative setting contrasted with critically ill patients in the ICU can demonstrate the scope of PCCM to students, and is an opportunity to emphasize the varied and meaningful clinical practice opportunities within PCCM. Simple exposure to different sites of care and different disease states is insufficient, however, as actively engaging students in clinical practice in a meaningful, autonomous, and supported manner is how deep learning and longitudinal interest in PCCM can be achieved.

In this chapter, specific strategies for engaging, working with, and teaching clinical medical students in PCCM have been reviewed. While there are opportunities to further study these teaching strategies to develop more evidence confirming or refuting their effectiveness, these strategies represent contemporary best practices for optimizing medical student learning in the clinical setting. Hopefully, the topics covered in this chapter will help you to employ these strategies in your own teaching encounters with clinical medical students in the ICU, on the Pulmonary Consult service, or on the medical wards.

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# Chapter 3
# Teaching Residents

**Jonathan M. Keller and Başak Çoruh**

## 3.1 Why This Matters

Recent data indicate that nearly 10% of graduating internal medicine (IM) residents plan to pursue pulmonary and critical care medicine (PCCM) as a career [1]. During residency training, more trainees change their career plans to PCCM than any other subspecialty, a more than 60% increase compared to the self-reported career trajectory of 1st-year residents [1]. Residents are attracted to the field because of opportunities for the application of complex physiologic principles, and the degree of career interest is associated with the amount of time spent on PCCM rotations [2]. For residents not entering the specialty, the systematic approach of PCCM can provide valuable clinical insights [3]. There are many challenges to effective resident teaching in PCCM including clinical workload, documentation burden, patient complexity, and severity of illness requiring rapid intervention. While the body of knowledge and number and complexity of procedures in the field have grown, the time for resident education has not. In addition, the current generation of trainees is less responsive to passive forms of teaching such as lectures and reading [4]. Active learning that is problem-based and collaborative is highly valued. Fellows and faculty who are teaching residents need to modernize traditional educational materials and create curricula with a focus on active learning. Strategies to improve educational efficiency and incorporate new teaching methods are of paramount importance to the next generation of physicians.

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_3

## 3.2 Teaching Settings

### *3.2.1 Intensive Care Unit*

The intensive care unit (ICU) offers many teaching opportunities: it is fast-paced and collaborative, and the interplay of intervention and physiologic response is dynamically highlighted. Three hours per day is spent teaching residents in the average U.S. ICU, indicating ample time for education, though generally not in traditional didactic formats [5]. Faculty and fellows often work with residents more closely in the ICU relative to other clinical rotations. There is more direct supervision of residents in the ICU, such as in procedures and family meetings, and rounds tend to be longer than other rotations. In addition, many ICUs have overnight in-house attending coverage, which has been associated with educational value and positive resident perceptions of overall patient care [6].

Despite abundant opportunities for teaching in the ICU, there is no standardized educational approach to teaching residents, and teaching methods can vary widely across settings [5, 7]. There are competing demands of education and clinical care of patients of high complexity and acuity. The nature of critical care teams, typically composed of trainees across multiple learning levels, adds further educational and clinical complexity. Diverse teaching strategies are necessary to ensure optimized learning for all levels of trainees, from students to fellows.

The most comprehensive review of current teaching practices in the ICU is a 2010 survey of U.S. PCCM Program Directors queried about IM resident education in the ICU [5]. Bedside teaching was the most common teaching modality, used "often or daily." Other teaching practices included informal lectures (91%), procedural training (91%), and didactic lectures (75%). Fewer programs supported audiovisual- (58%) or simulation-based (46%) training. Core curricular materials were available online for 53% of programs. The time dedicated to teaching varied from 10% to 80% of ICU rounds with a mean of $41 \pm 15\%$ of rounds being devoted to education. A mean of $3.0 \pm 1.2$ hours per day was spent on teaching during weekdays, compared to $1.9 \pm 1.3$ hours per day during weekends. Faculty (84%) and fellows (65%) were considered major sources of teaching by Program Directors. Rotations with a night float system (22%) or admission cap (34%) offered more teaching time, and self-directed learning was more frequent in these systems. Medical ICUs and ICUs with more than 20 beds were also associated with more teaching time. Maintaining outpatient duties while in the ICU was associated with less teaching time, and duty hour restrictions were perceived as compromising to education by 58% of Program Directors.

The American College of Critical Care Medicine has identified 13 clinical critical care topics in which resident physicians should develop measurable knowledge and observable skills (Table 3.1) [8]. Frequent and in-depth patient encounters are proposed as the primary source of learning, though supplementation with a core critical care curriculum is recommended, recognizing that each resident may not encounter every clinical problem during their training. Attempts have been made to develop a standardized core curriculum by prioritizing teaching topics in the ICU, though these attempts have been limited to descriptive studies of house staff and

**Table 3.1** Clinical critical care topics for resident physicians identified by the American College of Critical Care Medicine

| Clinical critical care topics |
|---|
| Identify when a patient requires ICU-level care |
| Diagnose and stabilize patients with impending organ failure |
| Identify the need for and initiate cardiopulmonary resuscitation |
| Diagnose and prevent hemodynamic instability or initiate treatment for shock |
| Identify and treat life-threatening electrolyte and acid-base disturbances |
| Suspect and treat common poisonings |
| Use data from invasive and non-invasive monitoring to titrate therapy appropriately |
| Understand basic infection control techniques |
| Understand basic nutrition support principles |
| Understand basic sedation and analgesia principles |
| Understand basic concepts of therapeutic decision-making and medication safety |
| Recognize, use, and help integrate the unique skills of ICU nurses and ancillary personnel |
| Consider ethical issues and patients' wishes in making treatment decisions |

faculty opinion [9]. Nonetheless, when topics are rank-ordered according to "how life-threatening, how commonly seen, and how reversible," there is high correlation among residents and faculty with regard to the relative importance of subjects.

### *3.2.2 Pulmonary Clinic*

The 1980s saw a rise in ambulatory care experiences for resident physicians due to increasing recognition of the meaningful educational benefit of this clinical setting [10]. Ambulatory training has become even more important with decreasing lengths of hospital stays and increasing transition of medical care to the outpatient domain [11]. The most comprehensive review of ambulatory education research reveals several important considerations for teaching residents in this setting: teacher behavior and role modeling powerfully influence the perceived success of clinic experiences, teaching effectiveness is associated with learner perception of effectiveness rather than achievement of specific educational goals, and the logistical variables of clinic (such as clinical workload or pace) have little influence on perceived teaching effectiveness [12].

While many residents choose subspecialty electives to explore career opportunities, the primary reason is to overcome a perceived gap in knowledge [13]. The core focus of specialty clinic rotations should therefore be the resident's educational development, and the Pulmonary Clinic offers several unique learning opportunities for residents. The Pulmonary Clinic may be a resident's only opportunity to learn about rare lung diseases or advanced therapeutic interventions, to manage patients pre- and post-lung transplant, and to see pulmonary function testing in action. Some clinics also provide procedural opportunities, such as outpatient pleural procedures, and more detailed radiography review than other ambulatory experiences.

Compared to resident primary care clinics, however, there are several challenges associated with Pulmonary Clinic. For example, residents may not have continuity with patients or familiarity with preceptors. Furthermore, the Pulmonary Clinic can have rigid schedule constraints, at times limiting teaching to less than a minute in length [14]. Being cognizant of these logistical considerations is critical to providing an optimized educational experience for residents working and learning in Pulmonary Clinic.

### *3.2.3 Consultation*

The consultation encounter presents multiple opportunities for resident learning, and many of the same principles from the ambulatory setting apply. For residents requesting consultation, diagnosis of the learner, identification of learning objectives, and the delivery of succinct, problem-focused teaching occur in a compressed time period, often over the phone [15]. The requested assistance in caring for a patient is typically focused on a discrete question and a deliberate invitation for information exchange. Actions as simple as explaining the reasoning behind consultative recommendations are perceived as teaching [16].

In focus group studies, improved patient care is viewed as the primary goal among requesting residents and subspecialty fellows performing consultation. Resistance to consultation from the consultant, even through abrasive vocal tone, is viewed as unnecessarily frequent by residents and the largest barrier to teaching and overall communication [16]. Consultants have the opportunity to facilitate rich learning environments for residents seeking consultative assistance through courteous assistance and discussion of their medical decision-making.

In addition, residents on Pulmonary Consultation teams can learn from being the consultant, serving as a content expert and practicing good communication techniques with the primary patient teams. In this role, residents may recognize for the first time, as receivers of information, the importance of a well-formulated clinical question and having specialty-specific data on hand, with significant implications for improving their future consultative interactions. Similar to Pulmonary Clinic, the consultative experience is an opportunity for procedural teaching, advanced radiography review, and exposure to infrequently encountered lung diseases.

### *3.2.4 Classroom*

Classroom-based teaching is less common for resident physicians as graduate medical education activities increasingly involve direct clinical practice activities. Most studies of classroom learning in residency evaluate knowledge acquisition in the form of test performance, or acceptability of the educational intervention in the form of resident satisfaction [17–20]. When surveyed, residents recognize the importance of facilitated knowledge dispersal to complement clinical activities. Most residents strongly value exposure to expert clinical reasoning and the sense of community the classroom environment affords [21].

An important consideration for classroom-based teaching sessions in the ICU is the timing of didactic sessions, as instruction in the morning prior to rounds is associated with improved knowledge acquisition [22]. Methods to improve teaching effectiveness include active teaching concepts such as the flipped classroom and incorporation of interactive technology [23–25]. The goal of flipped classrooms, or "blended teaching," is to reduce the amount of time spent on passive lecturing. Rather, requisite material is introduced outside of the classroom and consumed individually, often through videos or short reading assignments. Learners then enter the classroom setting ready to pursue more advanced topics or participate in problem-based learning facilitated by a content expert to build on foundational knowledge.

Flipped classroom teaching is particularly applicable to resident education in the ICU, where fundamental concepts in critical care can be acquired individually, followed by the collaborative application of the knowledge in case studies. An interactive classroom session, however, can be well-suited to certain topics difficult to facilitate elsewhere, such as respiratory physiology, pulmonary function testing, and chest imaging interpretation. In addition, important topics that are infrequently encountered can be explored in the classroom environment, such as pulmonary artery catheter waveform analysis, review of balloon tamponade for bleeding esophageal varices, and differentiation of pneumoconioses.

## 3.3 Who Cares?

### *3.3.1 Theory*

Residents are a unique learner group for which several learning theories are applicable; appreciation of these theoretical principles is important to provide effective teaching. Growing independence and responsibility with clinical care are foundational themes for residents [26]. Residents function primarily involves direct patient care, with the majority of learning emanating from work-related clinical tasks [27, 28].

Adult learning theory, or "andragogy," identifies several educational assumptions that differ from child learning theory and coincides with the learning principles of residents [29]. First, residents bring an abundance of prior knowledge to the learning environment. Contrasted with children who mostly integrate information *de novo*, experience, including making and learning from mistakes, is the basis for adult learning. Accordingly, resident education should be focused on thought processes and application of knowledge rather than on knowledge acquisition.

Second, residents are self-motivated. The locus of educational control transitions from external to internal, as there is more direct applicability of educational tasks to work activities and personal achievement. This also means residents may question or avoid educational activities that are perceived to be superfluous or external to their area of professional interest.

Third, residents are problem-centered rather than content-oriented. Learning is best limited to a single concept and is most fulfilling within the context of real problems encountered in their actual clinical practice. In this problem-centered context, the pathway to a problem's solution becomes more important than the answer, and learning becomes an active and personalized process.

Finally, residents are time-constrained. Learning opportunities oppose the myriad competing demands on the resident's time. In part due to this perspective, the Accreditation Council for Graduate Medical Education restriction on duty hours is perceived by many as prohibitive to learning goals [5, 7, 30]. Efficient, directed, and just-in-time learning become paramount when time is limited and competing demands are ubiquitous.

Medical educators must also recognize the learning needs of the current generation to optimize their teaching [31], as failure to recognize generational differences can lead to frustration in the learning environment. Current residents are primarily Millennials, or "Generation Y," having been born between 1982 and 2005. Generation Y has come of age during a time of uncertainty, with formative experiences including terrorism, globalization, and economic recession [32]. Teamwork, collaboration, free expression, and problem-solving are highly valued, and work-life balance is prioritized over income [4]. Generation Y is technologically savvy and multitasking is routine. Group experiences with hands-on problem-solving are desired over reading or passive lecturing. Stereotypically, members of Generation Y are confident, desire close relationships with authority figures, and seek validation and a sense of achievement. Immediate feedback is desired, though individuals are often ill-equipped for remarks perceived as negative [31]. When interacting with residents, understanding these generational traits can help educators approach residents in as effective a manner as possible, including prioritizing interactive teaching and clear communication.

### 3.3.2 Evidence and Best Practices

The evidence for teaching residents in PCCM is limited. Many best educational practices are based on assumptions given the lack of substantial guiding evidence. Judgments for what should be taught usually derive from tradition and expert and consensus opinion. The available evidence and best practices for the various teaching environments and teaching strategies used in resident physician learning are reviewed below. Table 3.2 summarizes these best practices by teaching modality.

#### 3.3.2.1 Bedside Teaching

Bedside teaching is a core teaching process in medicine, though justification for its centrality is mostly based on theoretical considerations. Bedside teaching is enjoyed

**Table 3.2** Best practices for teaching residents by teaching modality

| Modality | Best practices |
|---|---|
| Bedside teaching | Prepare prior to the encounter |
| | Select the appropriate patient(s) for the encounter |
| | Ensure content is relevant to trainee-identified goals |
| | Deliver content within disease-specific illness scripts |
| Teaching with limited time | Obtain commitment to a diagnosis |
| | Probe for clinical reasoning |
| | Teach a general principle |
| | Provide positive feedback to reinforce correct reasoning |
| | Amend errors with suggestions for improvement |
| | Think aloud |
| Procedural teaching | Review procedural techniques away from the bedside |
| | Use simulation or other virtual technology when available |
| | Prepare the learner for interruptions |
| | Use interruptions as an opportunity to provide teaching |
| | Debrief after the procedure |
| Simulation | Define learning objectives |
| | Connect simulation to prior learner experiences |
| | Debrief after the simulation and encourage ongoing reflection |

by patients, and residents are viewed as more competent when presentations are delivered at the bedside [33]. Residents also believe bedside teaching is important, though one study indicated that only 48% report they have received enough of it [34]. The bedside environment is especially well-suited to physical examination instruction, a skillset thought to be declining in contemporary residency training. Resident trainees recognize less than half of common respiratory auscultatory findings, with little improvement per year of training [35].

For residents in PCCM clinical settings, bedside teaching can go beyond teaching history and physical exam skills, as there are ample opportunities to assess and teaching clinical reasoning and decision-making skills. For example, in addition to reviewing the Wells' score in considering pulmonary embolism, educators can highlight the application of likelihood ratios for various exam findings with regard to the diagnosis of pulmonary embolism. In addition, the physical environment of the ICU includes more technology and tools than many other hospital environments, allowing for bedside teaching about topics such as arterial waveforms and mechanical ventilators.

When approaching the bedside environment, there are several valuable teaching principles outlined by Gonzalo and colleagues, which are relevant to the principles of adult learning theory in resident education [36]. Their four general commendations are (1) teaching should be specific to trainee-identified goals, as uncovered during orientation or preparation for rounds; (2) teaching should be disease-specific, allowing for creation of illness scripts and teaching points by the instructor; (3) patients should be carefully selected for teaching moments, highlighting those with high acuity, new admissions, and those with diagnostic uncertainty; and (4) mental preparation and educational goal setting should occur prior to the bedside encounter to provide a framework for instruction and a centering point when distractions inevitably arise.

#### 3.3.2.2 Teaching with Limited Time

There are several effective strategies for teaching residents when time is limited. The use of teaching scripts for commonly encountered diagnoses linked to learner level allows for rapid dissemination of fundamental concepts [37]. Teaching scripts are not static and can be modified to clinical scenarios within a theme. With improvisational teaching, targeted learning is key when time is limited [38]. The teaching focus can be determined by simply asking questions of the resident or conducting deliberate observation of the learner in the clinical environment to help determine practice areas needing refinement [39].

Another well-validated strategy for teaching with limited time is the one-minute preceptor model, which is designed to efficiently diagnose the learner and provide teaching and feedback in five steps [40–42]. First, a commitment by the learner to a diagnosis or thought process is pursued, followed by probing for clinical reasoning, after which a general principle is taught. Positive feedback is provided for correct reasoning, and errors are corrected with specific, behaviorally focused suggestions for improvement. Feedback alone can be an effective teaching tool when time is limited and can stimulate self-reflection and learning even after leaving the clinical environment [43].

McGee and Irby's review of practical outpatient teaching skills describes several teaching methods that apply to the Pulmonary Clinic. The clinical encounter is approached from three different perspectives: preparation for the visit, teaching during the visit, and teaching after the visit [44]. The pre-visit discussion can be critical to orienting the resident to the time limitations of the clinic and providing guidelines for efficient presentations to allow time for teaching, especially in a subspecialty clinic where residents are less familiar with the diseases encountered. Priming is a maneuver to prepare learners immediately prior to seeing a patient, providing guidance about high-yield information that needs to be collected or diagnostic interventions likely to be needed. For example, a resident's clinic encounter with a patient undergoing evaluation for pulmonary fibrosis would be enhanced by a pre-visit orientation reviewing the appropriate occupational and environmental exposures that should be explored during the patient interview.

During the p ideally broadly applicable to other clinical scenarios, and modeling by thinking aloud. In the case of pulmonary fibrosis, the attending could query the resident about medications commonly implicated in the pathogenesis of lung fibrosis or ask about expected pulmonary function testing findings as strategies to assess understanding.

After the encounter, additional teaching can be generated through directed feedback, focused analysis of the literature, or case reviews during post-clinic conferences. Promoting self-directed learning is particularly beneficial, as encouraging and supporting residents to independently seek out medical knowledge resources is an important means of modeling skills for lifelong learning.

#### 3.3.2.3 Procedural Teaching

Procedures are a fundamental component of PCCM and are often encountered in the setting of a decompensating patient needing acute intervention in the ICU. Decreasing opportunities to perform procedures with duty hour restrictions and poor procedural performance despite self-reported experience and confidence are now commonplace [45]. Residents feel uncomfortable performing many procedures unsupervised, and one study demonstrated that 65% of residents are uncomfortable performing thoracentesis [46].

Current evidence supports procedural learning and evaluation away from actual clinical practice through the use of task trainers, computerized scenarios, and simulation [47]. Especially in the ICU, technology-enhanced procedural training is recommended prior to performing emergent high-risk procedures. Nonetheless, some component of real-time procedural teaching is unavoidable, often fraught with tension when learners are unprepared.

There are several strategies to improve this interaction, based on principles outlined by Back and colleagues in teaching communication skills: "priming" the learner, purposeful interruption, and debriefing [48]. Expert procedural teaching requires facilitation of (1) expertise and deliberate practice; (2) understanding of the procedural benefits, risks, and alternatives; and (3) comfort requesting assistance. Foundational elements should be reviewed prior to the procedure, which allows the teacher to diagnose the learner's strengths and weaknesses. The expectation of interruption is introduced to the resident and patient, if possible, with explanations as to how this may occur and when control will be returned to the resident. Debriefing following the procedure recognizes the interruption as a teaching moment and adds further value [49]. Procedural teaching is covered in more depth in Chap. 13.

#### 3.3.2.4 Simulation

Advances in simulation technology and application have dramatically altered the medical education environment, and, as indicated in a study from over 10 years ago, many critical care training programs intend to use more simulation in educating residents and fellows [50]. Simulator-enhanced curricula have been shown to improve resident recognition of common critical illnesses, including shock and respiratory failure [51]. Simulation can significantly improve resident cognitive knowledge and performance of critical actions in mechanical ventilator management [52].

Similarly, resuscitation and team leadership skills can be taught through simulation. In a survey of Canadian IM residents, nearly half felt unprepared to lead cardiac arrest teams, suggesting that traditional advanced cardiac life support classes do not provide adequate leadership training [53]. A randomized controlled trial demonstrated significant improvement in cardiac arrest management attributable to simulation, with residents in the simulator-based teaching group reporting better preparation for code leadership [54]. Procedural skills such as thoracentesis and central venous catheter placement can also improve with simulation curricula; in one study, simulation training also resulted in decreased catheter-related blood stream infections. [55]. Simulation is discussed in more detail in Chap. 12.

## 3.4 Making It Happen

To consolidate the theoretical and practical considerations delineated earlier in this chapter, the following section provides examples of teaching in real-world practice; Table 3.3 lists additional potential teaching topics by teaching modality.

**Table 3.3** Selected examples of teaching topics by teaching modality

| Modality | Examples |
|---|---|
| Bedside teaching | Assessment of pulsus paradoxus |
| | Blood gas interpretation |
| | Differentiation of cardiac murmurs |
| | Neurologic examination of the comatose patient |
| | Percussion technique for pleural effusion |
| | Point of care ultrasound for evaluation of shock |
| | Ventilator waveform analysis |
| Teaching with limited time | Blood gas interpretation |
| | Review of electrocardiographic findings of right heart strain |
| | Review of differential diagnosis for cavitary nodules on chest imaging |
| | Review of differential diagnosis for reduced diffusion capacity on pulmonary function testing |
| | Selection of an appropriate inhaler regimen for a patient with COPD |
| Procedural teaching | Arterial catheter placement |
| | Central venous catheter placement |
| | Paracentesis |
| | Thoracentesis |
| Simulation | Cardiac arrest resuscitation |
| | Donning and doffing of personal protective equipment |
| | Procedural teaching |
| | Teamwork during crisis |

### 3.4.1 Bedside Teaching

Best practices for bedside teaching include:

- Preparing prior to the encounter
- Selecting the appropriate patient(s) for the encounter
- Ensuring that content is relevant to resident-identified goals
- Delivering content within disease-specific illness scripts

There are many practical applications of bedside teaching in PCCM. Opportunities for bedside instruction are especially plentiful in the ICU, as illustrated below.

#### 3.4.1.1 Ventilator Waveform Analysis

Education about mechanical ventilators is a priority for many residents as the ICU may be the only environment where they encounter this technology. In some ICUs, ventilator management is primarily managed by fellows or respiratory therapists, and intention is required to highlight teaching moments for residents. Cues for the teaching moment could include ventilator alarms while at the bedside. High-pressure alarms are common in the ICU and can lead to a rich discussion of pathophysiologic mechanisms that could cause high pressure, how to select ventilator settings to address this alarm, and how to clinically troubleshoot high peak pressures. Ventilator maneuvers can be demonstrated, such as performing a breath hold to determine plateau pressure or temporary augmentation of positive end-expiratory pressure as a recruitment maneuver.

#### 3.4.1.2 Blood Gas Interpretation

Residents are routinely exposed to acid-base disorders in PCCM. Blood gas data may emerge on rounds as novel information, and a resident can be prompted to interpret the blood gas. The interpretation of a patient's acid-base status can then be applied to clinical decisions about ventilator management or to expand the differential diagnosis.

#### 3.4.1.3 Physical Examination

Physical examination skills are best taught at the bedside. While a critically ill patient in the ICU is often unable to participate in the exam, this environment affords the ability to review the neurologic examination of the sedated, encephalopathic, or comatose patient, including the importance of a detailed reflex assessment that residents may not have considered. A focused evaluation of a patient in shock can also be demonstrated at the bedside, allowing for demonstration of point-of-care ultrasound use to assess for fluid responsiveness. Physical exam teaching in the Pulmonary Clinical or on Pulmonary Consult rotations can be important in developing residents' skills in differentiating between various lung sounds, performing percussion, and evaluating for egophony or tactile fremitus.

### *3.4.2 Teaching with Limited Time*

Best practices for teaching with limited time include:

- Obtaining commitment to a specific diagnosis
- Probing for clinical reasoning
- Teaching a general principle
- Providing positive feedback to reinforce correct reasoning
- Amending errors with suggestions for improvement
- Thinking aloud
- Encouraging self-directed, independent learning

Residents often have ample learning opportunities on PCCM rotations, but education may be restricted by the urgency of providing clinical care, clinical workload, or other logistical barriers. With planning and the use of efficient educational interventions, teaching can be effective despite these challenges.

#### 3.4.2.1 New Diagnosis of Pulmonary Hypertension

The clinic environment is busy: multiple patients need evaluation within limited time, and attending physicians may be working with several trainees. The one-minute preceptor can be an effective educational strategy in this environment. Consider a resident evaluating a patient with a new diagnosis of pulmonary hypertension and a history of lupus. The preceptor could ask the resident to consider the possible etiology by World Health Organization groups to generate commitment to the diagnosis and ask for supportive reasoning. Teaching can be focused on a general principle, such as expected right heart catheterization findings, the echocardiographic variability in estimation of pulmonary arterial pressures, or electrocardiographic findings that can be seen in pulmonary hypertension. Feedback can reinforce correct reasoning and errors, all in a short period of time.

#### 3.4.2.2 Asthma

Teaching in clinic can be used to reinforce primary care management and add to the resident's knowledge of more routinely encountered pulmonary diseases. A resident may care for patients with asthma in their own primary care panel, though the

Pulmonary Clinic experience can be used to discuss advanced therapeutic interventions for patients with uncontrolled symptoms despite standard therapies.

#### 3.4.2.3 Cardiac Arrest Resuscitation

There are times in the ICU, such as during cardiac arrest resuscitation, when elaborated teaching is impractical. In these situations, verbalization of clinical reasoning and real-time interpretation of available data provides valuable learning for residents. This is also an opportunity to role model effective leadership and teamwork skills during crisis for residents.

Another effective strategy when time is limited is teaching through feedback and reflection. Providing formative feedback can build on the resident's prior knowledge, identify progress, encourage reflection and metacognition, and provide pearls of wisdom. Examples include thanking the resident for including proposed ventilator changes in the plan for the day and encouraging the team to do this more, or asking the team to consider after rounds how the team could improve communication with patients and families.

### *3.4.3 Procedural Teaching*

Best practices for procedural teaching include:

- Reviewing procedural techniques away from the bedside
- Using simulation or other virtual task-trainer technology when available
- Preparing the learner for interruptions
- Using interruptions as an opportunity to provide teaching
- Debriefing after the procedure

Thoracentesis is a commonly performed procedure in PCCM, and many residents want to improve their procedural skills with input from an expert practitioner. Just-in-time teaching can be provided by reviewing the procedure with videos or models beforehand. Next, a collaborative plan can be formulated between the teacher and resident for interruption if needed, such as a hand signal to pause the procedure, as well as a plan to return procedural control to the resident after corrections are made. Debriefing and encouraging the resident to identify areas of difficulty after the procedure, away from the patient, is an important teaching strategy to encourage self-reflection and recognizing areas of needed growth (see Chapter 13, pages 235–254).

### *3.4.4 Simulation*

Best practices for teaching with simulation include:

- Defining learning objectives
- Connecting simulation to prior learner experiences
- Debriefing after the simulation and encouraging ongoing reflection

Simulation is frequently used for procedural instruction on task trainers, though its utility extends to areas of cognitive skills and teamwork. Simulation training is optimized when learning objectives are defined up front, the task is connected to prior learner experiences, and debriefing is performed after the simulation to promote ongoing reflection. As an example, residents are often placed into the role of leading cardiac arrest resuscitation teams in the hospital. They may feel uncomfortable in this role, especially early in their training, and there are few opportunities to practice this skill. Simulation experiences can be used for practice and can have an interdisciplinary focus. Residents, along with nurses, respiratory therapists, and pharmacists, could perform brief simulations with in-room observers to provide feedback on leadership qualities and cardiac arrest management, all in a safe learning environment (see Chapter 12, pages 213–234).

## 3.5 Conclusion

Residents are a unique learner group, as they are physically and cognitively focused on patient care activities and on developing their clinical practice skills. Understanding the principles of adult learning theory is critical to developing educational interventions and employing teaching strategies that are appropriate for residents. Prioritizing active teaching techniques both at the bedside and in the classroom is critical to maximizing engagement and retention, and contextualizing lessons in relevant, contemporary clinical cases is important. In general, residents are internally motivated to learn when there is opportunity to apply existing knowledge to new situations, to improve their clinical skills, and to progress toward independent practice. The framework provided in this chapter can help PCCM educators identify and implement educational strategies for residents in PCCM.

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# Chapter 4
# Teaching Fellows

**Avraham Z. Cooper, Kristin M. Burkart, and Jennifer W. McCallister**

## 4.1 Why This Matters

Teaching pulmonary and critical care medicine (PCCM) fellows offers unique opportunities and challenges for medical educators. Learning both procedural and medical content, with patient care occurring in clinical environments spanning the entire acuity spectrum, PCCM fellows must master multiple skills: ultrasonography, critical care procedures and resuscitation, bronchoscopy, radiologic interpretation, clinical reasoning, and end-of-life care, among many others. They must supervise and be supervised. While still in training, they are expected to learn to train others.

This diversity of learning environments presents program directors and supervising faculty with the opportunity to employ relevant educational constructs and theories while preparing fellows for independent practice. The sections below discuss the application of these constructs to the education of PCCM fellows in various learning environments and summarize underlying evidence. The chapter concludes with concrete examples of how to put these strategies and theories into practice.

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_4

## 4.2 Theory

PCCM fellows are adult learners with significant experience in and exposure to formal education. All have been in medical training for at least 7 years, including medical school, and some have been in independent practice as internists prior to starting fellowship. Most learning during PCCM fellowship happens on-the-job, at the bedside, or with independent reading, outside of the classroom. There are numerous educational theories that apply to this learner population. Three that are most relevant are summarized below with explications of their relevance for PCCM fellows. They include adult learning theory, self-determination theory, and self-directed learning.

### *4.2.1 Adult Learning Theory*

Adult learning theory was codified by Knowles and others late in the twentieth century as a comprehensive description of what influences how effectively adults learn [1]. Aggregating several foundational educational theories, adult learning theory comprises six core components, all of which have direct relevance for the training of PCCM fellows:

(a) *The need to know*: A critical contributor to the motivation for fellows to learn new material involves the recognition that their knowledge is incomplete, an awareness known as learner dissonance [2].
(b) *Learner's self-concept*: Fellows decide how much to engage with an educational activity, a decision based on their own assessment of dissonance and goals (e.g., improving a procedural skill or mastering a concept such as cardiopulmonary exercise testing) [3].
(c) *Influence of personal experiences*: Lev Vygotsky, an early twentieth-century psychologist, formulated the concept of the zone of proximal development, that to learn effectively learners need to link new knowledge with prior experiences [4]. One of the primary goals of fellowship training is to extend a fellow's zone of proximal development.
(d) *Readiness to learn*: In order to successfully engage in educational activities, fellows must be cognitively, psychologically, and physically ready to learn. If they are distracted by competing influences for their attention, they will experience interference (see Chap. 1) and their learning will be less effective.
(e) *Orientation to learning*: Fellows are more likely to engage with material if they perceive it as directly relevant to their current situation [5, 6]. Information that cannot be used and applied immediately is given lower priority.
(f) *Motivation to learn*: As adult learners, PCCM fellows respond to two different types of motivation – extrinsic and intrinsic. Learning as a response to intrinsic motivation involves the learner's self-perception of the importance of the encountered material or skill. Extrinsic motivation occurs in response to external factors compelling the learner to acquire knowledge [7].

### *4.2.2 Self-Determination Theory*

While numerous educational theories address and explain the motivation to learn, self-determination theory and the closely related concept of self-directed learning (discussed below) are foundational to training adult learners in graduate medical education (GME). Self-determination theory (SDT) focuses on the actualization of three critical psychological needs and how these affect intrinsic motivation to learn: autonomy, competence, and relatedness to the surrounding social environment [8].

(a) *Autonomy*: Autonomy reflects a person's ability to exercise free will in decision-making and goal setting [9, 10]. For trainees, autonomy manifests in both clinical and curricular domains. Clinically, trainees who have autonomy are able to independently make decisions and learn from errors, without constant direct input from supervisors [8]. A closely related concept, and a real-world manifestation of trainee autonomy, is "entrustment": the state where a supervisor feels comfortable allowing learners to work independently. For curricular autonomy, trainees have choices as to content and timing of learning.

(b) *Competence*: Objective competency as a rubric for achievement in medical education should be distinguished from the trainee's need for the self-perception of competence, a sense that one has achieved a certain level of mastery of performance for a given task or skill [9]. This sensation is influenced by external perceptions such as feedback, rewards, and communication with colleagues, and a feeling of competence can enhance intrinsic motivation to continue to improve [11]. The concept of experiential learning, that for adults to develop learned behaviors they must have access to adequate practice and educational experience, undergirds the acquisition of the self-perception of competence – adequate practice is necessary for trainees to feel competent and acquire the associated intrinsic motivational benefit [2].

(c) *Relatedness*: Fellows' need to experience relatedness during their training involves a feeling of connectedness to others and belonging to a larger social group and community. This sense of belonging contributes to their intrinsic motivation to learn and grow in a self-determined fashion [12]. The educational climate created around fellows is crucial to their sense of relatedness; the closely related concept of "psychological safety" is a helpful lens through which to view this goal. Psychologically safe learners are those who trust, feel connected to, and respect their colleagues and supervisors, feel themselves valued and respected, and do not fear humiliation or intimidation [13].

Barriers to achieving learner self-determination have been described in three domains: personal, systemic, and educational. Personal barriers can include burnout, inadequate sleep, suboptimal time management, and lack of social supports. Systemic barriers are issues such as lack of patient care continuity, high paperwork and administrative requirements, and rigid workplace regulations. Examples of educational barriers are inadequate feedback, passive learning, and lack of time for personal reflection [10]. Awareness of these barriers is crucial for program directors and faculty to establish a working and learning environment around fellows that is conducive to self-determination.

### 4.2.3 *Self-Directed Learning*

Self-directed learning can be viewed as a practical manifestation of the self-determined learner. Given implications for lifelong learning and professionalism after postgraduate training completes, it has been argued that self-directed learning is a core characteristic to be fostered and developed in residency and fellowship programs [14].

Numerous theoretical models for self-directed learning have been published, most focusing on the interaction between the learner and the surrounding environment. Sawatsky and colleagues developed a model for how self-directed learning occurs and what factors contribute to its success. The factors, which are closely related to the barriers to self-determined learning, are divided into three types: person, process, and context.

- Personal factors include the personality and motivation of the learner.
- Process factors focus on the identification of a knowledge gap, formulation of an educational goal, use of resources to acquire and apply knowledge, and self-evaluation of the success of the educational endeavor.
- Contextual factors involve external guidance and the structure and culture of the training program around the learners [15, 16].

The process of self-directed learning is anchored by appropriate goal setting: learning goals, and the associated self-formulated learning plan, are the maps by which trainees navigate their own education. Li and colleagues identified several barriers to self-directed learning and educational goal setting (Fig. 4.1), as well as

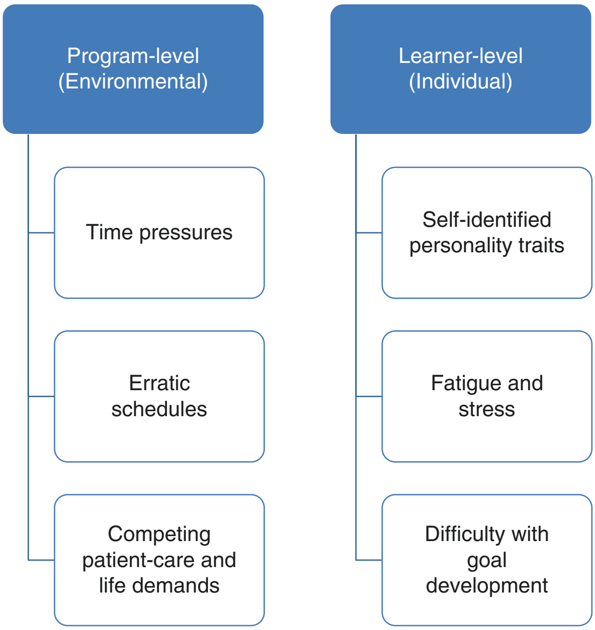


**Fig. 4.1** Selected barriers to self-directed learning and educational goal setting [14]

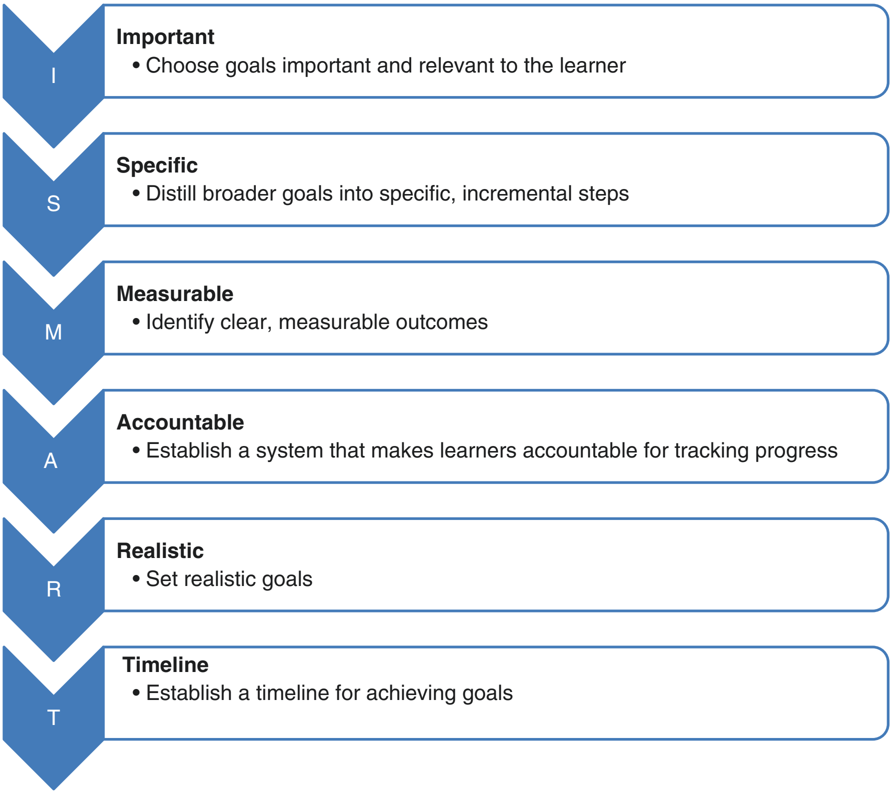


**Fig. 4.2** ISMART framework of strategies for overcoming barriers to self-directed learning and setting educational goals (Li et al. [14]): choosing learning goals that are important to the learner; breaking broader learning goals up into smaller, incremental steps; formulating learning goals that are specific, achievable, accountable, and incorporated into a daily routine

strategies to overcome these barriers. They distilled these strategies into the ISMART framework (Fig. 4.2) [14].

## 4.3 Learning Environments and Contexts

There are numerous environments and contexts in which PCCM fellows are taught. These include the fellow as a teacher, leadership and team management, effective communication, procedural training, clinical reasoning, and entrustment and autonomy determinations. Each context and environment has unique curricular demands on the educator, and leverages the above theories and constructs differently. In addition to descriptions of these clinical learning contexts and environments, the role of active learning in teaching conferences is described below.

### *4.3.1 Clinical Learning Environment*

#### 4.3.1.1 Fellow as Teacher

PCCM fellows are expected to grow as teachers during their fellowship. Whether rotating on consult services, leading rounds in the ICU, working with trainees in ambulatory clinics, or presenting at case conferences, fellows have regular educational encounters with residents, medical students, and their peers. Indeed, the Accreditation Council for Graduate Medical Education (ACGME) includes within its practice-based learning and improvement competency the requirement for residents and fellows to participate in the education of those around them [17]. Similar to clinical skills, fellowship program directors and faculty are responsible for helping fellows become better teachers during their training.

Evidence and Best Practices

A survey of PCCM fellows, from a single program, reported that fellows valued and were interested in learning teaching skills during their fellowship, although many fellows disagreed with attendings' assessment of their teaching abilities, and felt they, as PCCM fellows, did not know which new skills were needed to become better teachers [18]. Furthermore, a national survey of PCCM program directors that queried attitudes and practices toward developing teaching skills for fellows found that only one-third had a formal curriculum dedicated to teaching skills. Programs cited barriers that included financial resources, time, and lack of expert faculty [19].

Unique challenges and barriers to fellow-as-teacher development and curricula, when compared to residency, have been described for teaching on consultative services [20]. Teaching encounters on consult rotations are brief, generally not longitudinal, and rarely associated with attending feedback on fellow teaching [18]. Strategies to improve fellows' teaching skills implemented at the division and fellowship program level can cultivate a culture of education by supporting faculty development and educational activities (Table 4.1) [20].

**Table 4.1** Strategies to improve fellows' teaching skills in the clinical environment [20]

| Divisional strategies | Fellowship/fellow-specific strategies |
|---|---|
| Provide faculty development on teaching and feedback skills | Incorporate medical education content into core curricular lectures |
| Support educators within the division who will model effective teaching | Identify fellow teaching opportunities on clinical services and provide feedback |
| Ask expert faculty educators to observe and provide feedback on fellows' teaching skills | Obtain trainee feedback on fellows' teaching skills |
| **Combined divisional and fellowship strategies** | |
| Support a culture of education | |
| Set expectations that daily teaching on clinical service is a fellow responsibility | |

A group published their experience implementing a fellow-as-teacher curriculum for PCCM and rheumatology fellows on consultative services at two separate institutions. The curriculum was delivered during two sessions and centered on the PARTNER framework for fellows to use when working with residents (Fig. 4.3). They found a durably positive impact on fellows' teaching skills, and participating fellows rated the curriculum highly [21].

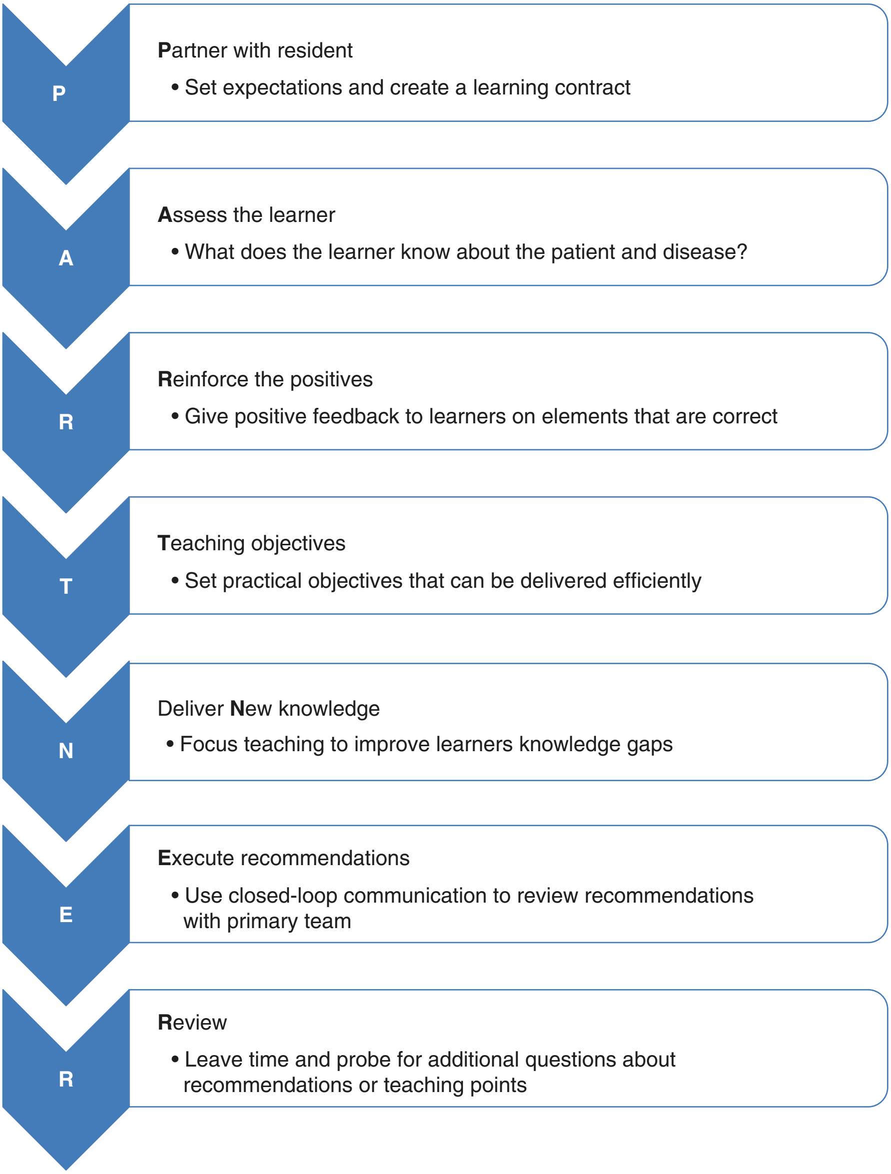


**Fig. 4.3** The PARTNER framework for teaching on consultative services (Miloslavsky et al. [21])

The PARTNER framework imparts the principles of adult learning theory and self-determination theory to fellows in their own teaching practice. For example, assessing the learner's knowledge gaps leverages cognitive dissonance and "the need to know." Partnering with the resident and creating a learning contract use the "learner's self-concept." Concretely summarizing learning objectives in advance can help expand the resident's zone of proximal development. Giving fellows skills for and ownership over teaching responsibilities offers them autonomy and competence.

#### 4.3.1.2 Clinical Leadership

Team leadership and personnel management, also known as clinical leadership, are crucial skills that PCCM fellows must master. While data suggest appropriate clinical leadership positively impacts patient outcomes, postgraduate trainees receive little formal training in leadership micro-skills: managing interpersonal relationships, situational leadership in a team environment, reflective capacity, and emotional intelligence [22, 23]. Most literature and pilot curricula on leadership training in GME have centered on residents.

##### Evidence and Best Practices

Several best practices to help effectively develop physician organizational and managerial roles have been described. Adapting these recommendations specifically for fellow training includes encouragement of fellows to deliberately role model effective leaders around them, incorporation of leadership topics and literature into longitudinal curricula (even without a formal leadership development program), provision of opportunities for real-world application of skills acquired, and focused feedback to fellows on achievements and areas for improvement [22–25].

There are several descriptions of clinical leadership curricula in the literature, although most provide examples of content delivered during residency training. Many of these leverage principles (and faculty expertise) from business school experiences, applying them to the clinical environment. A clinical leadership program for first-year internal medicine (IM) residents, delivered in twelve 90-minutes sessions throughout the year, included topics differentiating leading from managing, emotional intelligence, conflict management, communication, and decision-making on a team [25]. Another leadership course described best practices to help achieve full implementation, including a focus on achieving cultural change within the department, offering extended learning periods between sessions to allow for self-study, and encouraging an ownership of outcomes [23].

Viewed through the lens of self-directed learning, personal factors and intrinsic motivation for individual fellows clearly play an important role in successfully developing and maintaining leadership skills. Process and contextual factors, which are potentially amenable to manipulation by program directors, emerge as equally crucial. Using resources available within the institution (such as collaborating on content with business school faculty), encouraging fellow self-reflection on leadership behavior, and cultivating a culture that encourages fellows to become clinical leaders will help promote development of clinical leadership skills.

#### 4.3.1.3 Communication

PCCM fellows are expected to gain mastery of multiple types of clinical communication, including professional interactions with primary teams while on consultative services, longitudinal relationship-building with patients in continuity clinic, and end-of-life discussions with patients and families in the ICU. Fellows have reported that their training in communication, such as leading family meetings, is lacking [26]. At the same time, the ACGME requires formal training of fellows in communication [27].

Evidence and Best Practices

Published communications curricula for PCCM fellows center on communication with patients and families, including facilitating family meetings and competency in essential communication skills in the ICU. Crucial skills to be acquired include explaining invasive procedures, discussing patient prognosis, fostering shared decision-making, facilitating advanced directive planning, empathic demonstration, and delivering bad news [28, 29].

In collaboration with palliative care providers, a 12-month longitudinal communications curriculum improved 1st-year PCCM fellows' skills, confidence, and self-assessed competence in leading simulated family meetings. Using an internally developed family behavioral skills checklist, McCallister and colleagues provided structured, formative feedback to fellows on leading family meetings [29]. Similarly, a month-long curriculum for critical care fellows on end-of-life discussions, bioethics, and palliative care using simulated family meeting encounters improved fellows' ability to verbally define an agenda for the meeting at the outset and summarize a care plan going forward. Furthermore, the curriculum increased fellows' confidence when discussing difficult topics such as foregoing life-sustaining treatment in terminally ill patients [28].

The use of formal communication curricula paired with simulated, observed family meetings and communication drills allows for low-stakes practice and structured feedback. This approach also facilitates an expansion of fellows' zone of proximal development, linking learned content and skills with concrete behaviors. It acknowledges that clinical communication is a procedural skill appropriate for simulated practice, just like endotracheal intubation or thoracentesis.

#### 4.3.1.4 Clinical Reasoning

The focus of assessment in PCCM fellowship has shifted toward quantitative, competency-based metrics. The need to teach fellows fundamental clinical reasoning skills prior to entering independent practice remains a core component of training, although its achievement is difficult to quantify. After completion of their training, fellows must be prepared to manage complex clinical scenarios, some of which they may have not encountered before. While traditionally much of the education fellows received in clinical training happened stochastically through clinical work, PCCM faculty could benefit from advances in cognitive psychology to facilitate the active development of clinical reasoning skills in their fellows.

## Evidence and Best Practices

Two types of clinical reasoning relevant to training PCCM fellows have been described: hypothetico-deductive and inductive reasoning (see Chap. 1). Descriptions and relevant clinical examples of each are delineated in Table 4.2. An inductive approach allows for flexibility and adaptability in clinical situations, particularly ones without a clear initial diagnosis. Clardy and Schwartzstein describe this type of expertise as adaptive (as opposed to routine expertise, which results from mastery of hypothetico-deductive reasoning) [30]. Conversely, hypothetico-deductive reasoning is often performed more quickly and is particularly useful in emergent circumstances that require minute-to-minute clinical decision-making.

Clardy and Schwartzstein also advocate for the use of concept mapping, where clinical data is visually mapped on a white board and linked with disease mechanisms and differential diagnoses, to instruct fellows in the use of inductive reasoning [30]. This may be particularly helpful for fellows struggling to synthesize clinical data in real time but can be incorporated into clinic workflow or case conferences for fellows in general. Another way to promote development in clinical reasoning skills is to ask fellows to deliberately self-reflect upon their clinical reasoning practices and experience. If their self-assessment is inconsistent with observations by supervising faculty then remediation can be pursued, both regarding clinical reasoning and accurate self-assessment [30].

**Table 4.2** Types of clinical reasoning

| Type of reasoning | Description | Clinical example |
|---|---|---|
| Hypothetico-deductive | Uses Bayesian analysis and pattern recognition, allowing for rapid clinical assessment. Best suited for situations encountered previously | "This patient's presentation is similar to other patients I have seen with pulmonary embolism, and therefore I am concerned about that diagnosis" |
| Inductive | Attempts to circumvent cognitive biases by building differential diagnoses based on a combination of available clinical data, mechanisms of disease, and physiological principles. Can be used in clinical situations whether encountered previously or not | "The combination of hypotension, jugular venous distention, and right ventricular strain on echocardiogram is concerning for either an acute pulmonary vascular event or primary right ventricular process. Because the patient recently was hospitalized and has unilateral leg swelling, I am most concerned about a pulmonary embolism" |

Clardy (2015) [30]

Pattern recognition and quick-response thinking also play important roles for PCCM fellows, particularly when leading resuscitations in the ICU or during cardiac arrest responses. For example, OODA loops, a rapid, high-stakes decision-making model developed for fighter pilots, consist of cycles of "observation, orientation, decision, action." Some have advocated for using OODA loops in approaching the care of decompensating patients in first-responder and emergency department settings [31, 32]. This model, and others like it, is implementable in ICU settings and could be taught during simulation training.

While not imparting specific medical knowledge, focused, formal education focused on clinical reasoning are crucial for fellows' maturation into independent practitioners. Combining such focused, formal education with deliberate self-reflection can foster self-directed learning in fellows as they progress through their program, particularly regarding process factors such as specific, achievable goal setting ("I need to improve on 'X' aspects of my clinical reasoning approach"). It also encourages a sense of self-ownership over this vital clinical skill ("I am responsible for improving my clinical reasoning skills") and helps fellows become concretely cognizant of their own "need to know."

#### 4.3.1.5 Procedural Training

Procedural teaching for fellows comprises some of the highest-stakes, and potentially most rewarding, faculty educational encounters. From bedside ultrasonography to endotracheal intubation, fellows must become independently adept at multiple types of technical skills while, at the same time, being appropriately supervised to ensure patient safety. Core principles in procedural teaching for PCCM fellows are reviewed below; for a more in-depth consideration, see Chap. 13.

Evidence and Best Practices

A meta-analysis of the general procedural training literature noted the trend in procedural training away from the traditional apprenticeship model (e.g., "See one, do one") toward prospective, deliberate teaching practices. The authors found that simulation- and competency-based approaches were associated with the best educational outcomes [33].

A blended, multimodal approach to teaching procedures to IM residents has been studied and found to be effective. This schema involved baseline assessment of knowledge and skill with the use of mannequins, instruction of the procedure via video module and discussion and demonstration of content with faculty, simulated practice, and assessment of knowledge and procedural skills gained [34]. This general format is relevant to teaching procedures in the clinical realm as well, as described by the Walker and Peyton method (Fig. 4.4) [35]. This model is generalizable to PCCM fellows, particularly those early in the 1st-year and acclimating to high-stakes procedures such as intubation or bronchoscopy.

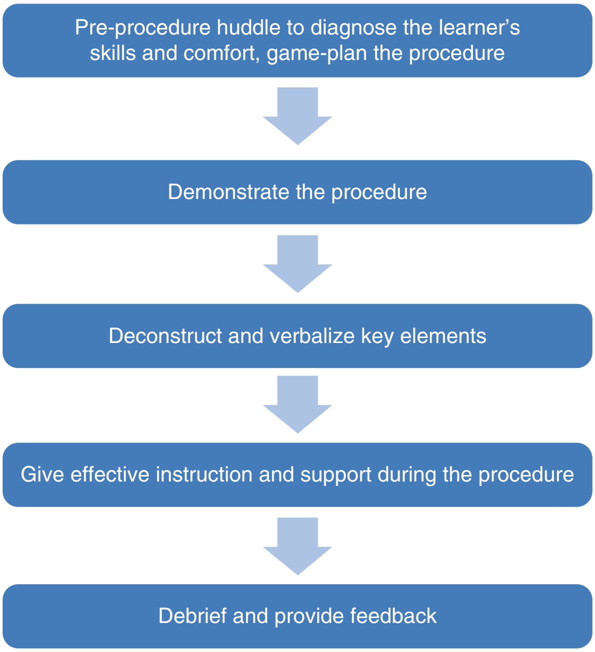


**Fig. 4.4** The Walker and Peyton method for procedural teaching [35]

Simulation has been shown as an effective way to teach airway management [36]. A national survey found variety in content of curricula and level of responsibility regarding airway management given to fellows. While almost all programs have formal airway training, including utilizing airway simulation, only a minority reported significant usage of difficult airway equipment (such as fiber-optic intubation) by fellows [37]. Faculty and procedural instructors can apply the Walker and Peyton method described above when teaching airway management in patient care settings.

Another procedure for which the approach to training varies across programs is endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA). EBUS-TBNA is a procedural skill particularly amenable to direct teaching as ultrasound guidance allows for immediate feedback between fellow and attending. The BSTAT and EBUS-STAT evaluation tools offer validated, standardized assessment of fellows' performance in bronchoscopy and EBUS [38, 39]. Some have advocated for the use of virtual reality simulation for EBUS training, and the performance of the EBUS-STAT was found to predict who would benefit from this training intervention [39].

In a meta-analysis, simulation training for bronchoscopy was found to be effective, though different modalities within simulation appeared more effective than others. Authentic clinical context within the simulated environment was important, and animal as well as synthetic models (which offer haptic feedback) may be more effective than virtual simulators (which are often more expensive) [40].

Point-of-care ultrasound has emerged as a crucial skill for PCCM fellows to master. Simulation and blended learning with multimedia tools, such as instructional videos and online tutorials, may improve skill acquisition and proficiency [41]. Furthermore, implementation of a curriculum that included didactics and hands-on-training, along with a standardized minimum number of scans to be performed and reviewed with feedback by faculty, resulted in new diagnoses and change of care in ICU patients [42].

Determinations of procedural entrustment and level of autonomy for fellows are important aspects of supervision by faculty. These issues are discussed in detail in the Entrustment and Autonomy section below.

#### 4.3.1.6 Entrustment and Autonomy

Determining when to grant autonomy to fellows, whether in scenarios involving clinical decision-making, leading rounds or teaching in the clinical setting, can be a significant challenge for supervising attendings. Inevitably they must walk the delicate line between too much autonomy (potentially impacting the quality and safety of patient care) and too little (impeding fellows' growth and transition into independent practice). Competency-based medical education of trainees in active medical practice requires learners to simultaneously learn new material and apply it in a progressively independent manner [43]. When learners must perform and become competent in high-stakes skills, such as leading resuscitations and endotracheal intubations, a crucial question emerges: how does one know when to step back and entrust fellows with minimal or no direct supervision of practice?

##### Evidence and Best Practices

In one study, pediatric faculty were more likely to grant autonomy to residents if they were perceived as motivated and competent, and less autonomy to those they perceived as passive [9]. Baldwin and colleagues describe autonomy-supportive education as that which acknowledges learners' perspectives, encourages personal responsibility, and gives constructive personalized feedback. The same group has implemented and described a comprehensive curriculum aimed at engendering self-determined and autonomous learning in residents [8, 10].

Five stages of entrustment and responsibility have been used to describe the level of autonomy granted to learners (Table 4.3) [44]. Individual fellows will operate within these different stages for different tasks, with commonly identified factors contributing to the level of entrustment granted (Table 4.4) [44].

Entrustable professional activities (EPAs) are discrete skills and tasks that trainees are expected to be able to do independently. Twenty EPAs for PCCM fellows have been delineated, spanning the spectrum of clinical skills that fellows are expected to acquire, from procedures to end-of-life communication. These can serve as an overall guide for program directors in structuring global

**Table 4.3** Stages of entrustment and representative examples for PCCM fellows [44]

| Stage of entrustment | Example of applicable clinical task |
|---|---|
| Be present and observe | First-year fellow observing ECMO cannulation |
| Perform with direct supervision | First-year fellow performing endotracheal intubation |
| Perform with indirect supervision | Second-year fellow discussing ICU admission with attending by phone |
| Perform without supervision | Third-year fellow leading goals-of-care discussion in ICU |
| Supervise others | First-year fellow observing intern placing central venous catheter |

**Table 4.4** Factors that influence decisions of entrustment in clinical training [44]

| Determinants of level of entrustment afforded to a trainee |
|---|
| Skills, attitude, and experience of trainee |
| Experience of supervisor in clinical context and role of supervisor |
| Context and environmental circumstances |
| Urgency or complexity of task |
| Nature of relationship between trainee and supervisor |

curricular goals for their program and for PCCM faculty in teaching fellows in clinical care settings [45].

## 4.3.2 *Nonclinical Learning Environments and Contexts*

### 4.3.2.1 Teaching Conferences

Despite trends toward active teaching modalities and flipped classroom curricula in undergraduate medical education, teaching conferences remain a common way for training programs to deliver content to PCCM fellows. Traditionally delivered in a standard lecture format, with fellows passively exposed to content projected on a screen, teaching conferences present an opportunity to use strategies to enhance fellows' learning that leverage the principles of cognitive psychology and adult learning theory. While lectures will likely remain a mainstay of core curricula for PCCM fellows, the traditional, passive model should give way to evidence-based, active learning strategies to deliver content to and engage fellows.

Evidence and Best Practices

Deliberate construction of lecture format and setup are major modifiable factors when developing educational materials for fellows. Two main decisions include how long lectures last and how content is delivered and synthesized. Cognitive psychology describes what cognitive factors contribute to learner retention of new information. Particularly important is the adult attention span for retaining newly encountered information, which wanes significantly after approximately 20 minutes. After this time learners' working memory, which requires active attention and is used to organize new information to form lasting memories, becomes interfered with by whatever additional content to which the learner is exposed [3]. It becomes harder and harder to assimilate and learn new material if there is interference with working memory. While teaching conferences for PCCM fellows are often an hour in length, the use of active learning strategies can help overcome the attentive limitations of working memory (Table 4.5) [3]. A 60-minute teaching conference can become three 15- to 20-minute sub-lectures broken up by active learning techniques. Such a strategy is more labor intensive than simply building and reusing a slide set – it requires consideration of the limits of the learner's attention span and deliberate construction of the lecture itself.

Most of the literature regarding active learning strategies derives from nonmedical, classroom-based educational studies but still has relevance for PCCM fellow learners in conference contexts. For example, a 2005 study in college-level biology students found that students who were taught with interactive techniques, including peer-to-peer and group discussions and low-stakes real-time testing, had larger knowledge gains and better conceptual understanding of material than students who received traditional lectures [46]. Similarly, studies of learners ranging from undergraduates to graduate and medical students have demonstrated that active learning strategies (including those described in Table 4.5) promote increased classroom learner attention and understanding, and improved performance on subsequent assessments [47–50]. Interactive approaches to teaching physicians in continuing medical education contexts have also been shown to more significantly influence subsequent changes in clinical practice patterns [51].

**Table 4.5** Active learning strategies that can be used use in PCCM teaching conferences [3]

| Active learning strategy | Description of use during PCCM teaching conferences |
|---|---|
| Buzz groups | Divide learners into small groups at the beginning of the conference and have them discuss and answer questions posed during the session. Consider pre-identifying discussion points and ask the groups to discuss them during the conference |
| Audience response systems | Acquire responses to multiple choice questions using electronic (such as web-based platforms) or manual responses (such as show of fingers). Board review questions are particularly amenable to this format |
| Think-pair-share | Divide learners into pairs, asking them to *think* about questions posed during the conference, discuss the questions in *pairs*, and then *share* their answers with the group. Case-based questions can conveniently be posed this way |

#### 4.3.2.2 Teaching Fellows to Teach in Nonclinical Situations

PCCM fellows are often expected to teach and give presentations in nonclinical environments. This can include presenting to small or large groups such as faculty and co-fellows at case conferences, larger groups of students or residents, or at regional or national meetings. Fellows must develop skills in public speaking and fluency with presentation programs.

Evidence and Best Practices

As many nonclinical teaching encounters by fellows include public speaking, it is important to provide training and feedback on these skills. Early exposure to best practices, whether in modeling sound presentation skills by faculty or in fellow-as-teacher curricula, can help form good habits [52]. It is commonly accepted that giving focused and immediate feedback after a presentation at a clinical conference or research seminar can be a powerful tool for improvement.

Small group teaching, particularly for preclinical medical students, is another venue in which PCCM fellows can be paired with teaching faculty to gain experience. In one report, fellows who served as small group tutors in a preclinical pathophysiology curriculum found the experience rewarding, acquired teaching skills, and recommended that such opportunities be available to fellows [53].

The development of clinician-educator tracks within PCCM fellowships has expanded over the last few years. As one example, the clinician educator track at the University of Washington includes education in nonclinical environment teaching skills such as presentations, formal assessment, curriculum development, matching learning goals and context, and incorporating technology into small group teaching. The program also offers structured mentoring, ongoing feedback from faculty and learners, and a requirement for scholarly work with a medical education focus [54].

## 4.4 Making It Happen

This section presents practical examples of the learning theories, contexts, and environments discussed in the chapter. Using fictional case vignettes with real-world applications, we present ways for program directors, supervising attendings, and curriculum developers to implement these strategies when training fellows.

### *4.4.1 Fellow as Clinical Teacher*

A program director from an academic PCCM fellowship receives feedback from the hospital's Internal Medicine residency program that residents have raised concerns about the fellows not engaging in enough teaching on busy consult services. The teaching that does occur is generally informal and relatively rushed. She reviews the current "fellow-as-teacher" curriculum and sees that it incorporates two noontime conferences per year, which focus on the application of general teaching principles. She speaks with her chief fellows and a few of the first-year fellows who were recently on consult services and finds that barriers to teaching include the need to simply keep up with clinical work, the brief nature of the educational encounters with residents on consults, and a lack of feedback on the efficacy of their teaching. After conferring with a colleague, she swaps a scheduled noon conference lecture for a dedicated teaching skills session, focused on teaching on consultative services. She teaches the fellows the PARTNER framework and has them role-play brief teaching encounters with residents using clinical contexts as prompts [21]. She then plans to touch base again with the residency program director and fellows after a few months have passed, to assess for any perceived change in the efficacy of the fellows' teaching on consult services.

### 4.4.2 Leadership

During his quarterly meeting with his mentor a first-year fellow discusses difficulty transitioning to a team leadership role in the ICU. In particular, he has struggled to remain in a supervisory role with residents during rapid responses and cardiac arrests, as he continues to feel the need to take control. A similar situation occurs on rounds when his plans usually supersede those of the residents and he finds himself talking more often than anyone else. He and his mentor decide, after discussing with the fellowship's program director, that one of the chief fellows will join him on rounds and provide peer-to-peer feedback and coaching on how he can improve his team leadership and delegation skills.

### 4.4.3 Communication

A new PCCM faculty member, who also has formal palliative medicine training, is approached by her hospital's palliative medicine division director about creating a joint communications curriculum, focusing on leading family meetings and end-of-life discussions, for both PCCM and palliative medicine fellows. After reviewing the literature of other described curricula, they decide to provide two teaching conferences, delivering critical content and then utilizing simulated patient encounters with professional actors for structured practice. The fellows work on setting an agenda at the outset of a family meeting, delivering bad news, counseling on end-of-life decision-making to patients and families, and demonstrating empathy in challenging clinical circumstances. The fellows are observed by faculty and peers, and are provided with immediate feedback.

### 4.4.4 Clinical Reasoning

Two program directors from the Emergency Medicine residency and PCCM fellowship sit next to each other at a meeting, discussing the opening of a new emergency department ICU. After the meeting they discuss ways for the programs to coordinate training given the anticipation of more shared clinical duties. After discussing several topics they settle on clinical reasoning as an area of collaborative focus, specifically teaching how to use inductive and hypothetico-deductive reasoning and under what clinical circumstances they are each best applied. They coordinate brief teaching sessions on clinical reasoning content for fellows and residents, followed by simulated cases involving both acute resuscitations and slower, complex decision-making. They are observed by faculty and debrief after the cases conclude.

### 4.4.5 Entrustment and Autonomy

After a series of sentinel events involving procedures performed or supervised by first-year PCCM fellows, the program director meets with her division's leadership and several senior faculty members. They discuss the need to train fellows for proficiency and independent practice while at the same time ensuring the safety of patients in their hospital, and plan to meet again after the program director meets with the fellows. After meeting with several fellows, it becomes clear that many are unsure of what level of supervision is required for specific procedures and how many times they need to perform a procedure before being allowed to do it alone. She decides to adapt a five-stage entrustment scale reported in the literature and map it for each fellow for relevant procedures, with a progression along the scale (from observation to being able to supervise others) determined by attestation from supervising faculty or fellows [44]. She discusses her plans with division leadership and meets with fellows individually to begin to map their entrustment for each procedure.

### 4.4.6 Teaching Conferences

With fellow attendance at daily teaching conferences dwindling, a program director meets with his chief fellows to discuss ways to make these conferences more interesting and engaging. Various positive and negative incentives are considered, though the chief fellows emphasize that the most educationally effective conferences historically have involved the faculty facilitating active fellow participation. At the next faculty meeting, the program director brings up the conference attendance trend and a desire to make the program's teaching conferences more active and engaging for fellows. He mentions three techniques that have worked well for him in the past (think-pair-share, quiz questions, and audience response) and advocates for the faculty to consider incorporating these or other techniques into their teaching conferences. While not all faculty members are interested in this change, several immediately begin to incorporate strategies to facilitate fellow participation into their upcoming conferences. The chief fellows and program director notice an increased energy of engagement at conference, and attendance slowly begins to improve. They have preliminary plans to assess fellow and faculty satisfaction with the more active learning approaches via questionnaires.

### *4.4.7 Teaching Fellows to Teach in Nonclinical Situations*

A first-year PCCM fellow approaches a faculty mentor with concerns about her public speaking skills. She cites significant anticipatory anxiety prior to presenting at case conference and feels that her presentations have generally not gone as well as she would have hoped. She is scheduled for another case conference presentation next week, as well as an oral presentation at an upcoming regional research conference, and is seeking help preparing for the latter. Her mentor suggests that he observe her during her upcoming case conference and provide feedback on public speaking points that may translate to her research presentation. He notices that she says “um” frequently, does not make eye contact with the audience, has illegible font on her slides at times, and used blurry pictures for some of her images. They sit down immediately after her presentation and discuss the above identified issues, none of which she previously had been aware. Prior to the upcoming research talk she practices presenting several times in front of her spouse, and then an audience of her peers and faculty mentor, focusing on the identified points of improvement. Her anxiety level has decreased considerably leading up to the regional conference.

## 4.5 Conclusion

The education of PCCM fellows is a vital task for training programs, faculty, and clinician educators. Fellows represent the future of the field and we must invest in their education. Adult learning theory, self-directed learning, and self-determination theory represent foundational constructs for the deliberate approach to educating PCCM fellows. In developing fellowship curricula, and in day-to-day teaching by program directors and clinical faculty, it is vital to be cognizant of the impact of specific learning environments and relevant learning theories on fellows’ ability to learn and synthesize new information, as well as develop clinical reasoning, communication, procedural, teaching, and leadership skills.

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# Chapter 5
# Teaching in the Classroom: Large Groups

**Andrew M. Luks and Shobha W. Stack**

## 5.1 Why This Matters

Large group teaching sessions have long been a staple of medical education, with the primary benefit thought to be an economical delivery of information to a sizeable group of learners at one time. These sessions have traditionally been delivered as didactic lectures marked by a unidirectional flow of information – and often quite a lot of it – from expert to learner. However, based on a growing body of evidence that standard didactic lectures are associated with limited retention of information, there has been increased emphasis on applying concepts of adult learning theory and changing the standard approach such that large group sessions are now marked by bidirectional flows of information and more content manipulation by the learner in the classroom. With an increased emphasis on active participation by the learner in the teaching session, rather than passive absorption of information, these sessions should more appropriately be labeled *large group learning* (LGL) sessions rather than lectures.

## 5.2 Who Cares?

Lectures that target specific educational objectives and are delivered in a clear, concise, and engaging manner at a level appropriate for the learners can provide a good educational experience. However, when teaching sessions move beyond the traditional unidirectional flow of information and learners process and manipulate

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_5

information as the session progresses, there is potential to create a more useful learning experience. The theoretical underpinnings and evidence base for this approach are described below.

### *5.2.1 Theory*

While lectures are viewed as an efficient way for an expert to disseminate content to many learners at one time, the volume of content presented does not correlate with the volume of content retained by the learner. According to cognitive-load theory, for example, there is a limited amount of difficult content (*intrinsic load*), concept processing (*germane load*), and content that does not directly contribute to learning (*extraneous load*) that an audience can absorb over one lecture before learning is impaired [1]. Given this issue, the question that follows is how best to use the time in the classroom. While there is no universal ideal mix of intrinsic and germane load for a teaching session, the principles of adult learning theory emphasize the need to include a sufficient germane load.

One way to increase germane load is to emphasize active learning, a learner-centered approach, in which students interact with the material and receive feedback on their application of the content. This is as opposed to passive learning, a teacher-centered approach, whereby students simply receive information from the instructor with no feedback on how well they comprehend or process that information. The active learning approach is based on the observation that adults learn best through concrete experiences and reflection on abstract concepts rather than passive receipt of visual or auditory information.

To implement a more active learning approach, the lecturer and learner must alter their perceptions of their traditional roles in the classroom [2]. In addition to conveying content through slides and the spoken word, lecturers must now monitor understanding by their learners and seek feedback through various forms of interaction. Learners no longer passively absorb information, but rather, as content is delivered, must mentally organize the information, integrate it with existing knowledge, and apply what they have learned to solve problems or reason their way to conclusions.

Such active cognitive processing is referred to as constructivist learning, whereby learners construct new knowledge on the foundation of what they already know [3]. This approach requires that the lecturer go beyond simply aiming for *retention* of knowledge through presentation of factual content and instead seek to *transfer* knowledge by incorporating tasks that require application of knowledge to another context.

Transfer of knowledge can be achieved through application of five cognitive processes in the large group learning session. These processes, in increasing order of complexity, are:

1. *Understand* – Learners determine the meaning of the instructional message.
2. *Apply* – Learners solve a problem based on a concept covered before or during the session.

3. *Analyze* – Learners break material into its constituent parts and detect how the parts relate to one another and to an overall structure or purpose.
4. *Evaluate* – Learners make judgments based on criteria and standards.
5. *Create* – Learners put elements together to form a new, coherent whole or an original product.

The interactive strategies discussed later in this chapter are based on these cognitive processes and facilitate engagement of learners in knowledge construction. Notably, these processes also constitute the Cognitive Process Dimension of Krathwohl's revised *Bloom's Taxonomy*, which can be helpful in writing active learning objectives for a large group learning session [4].

## 5.2.2 Evidence and Best Practices

### 5.2.2.1 Attention Spans

A review of studies on attention spans suggests adult learners can focus on a lecture for no more than 15–20 minutes at a time [5]. Of note, these studies were performed using traditional didactic lectures with a unidirectional flow of information. Although the studies are limited by methodological concerns, such as varied measures of content retention, a consistent finding is that attention fluctuates throughout a lecture and audience members must be stimulated on a recurrent basis. This need for reengagement provides further impetus for utilizing interactive learning activities [6, 7].

The concept of the primacy-recency effect can inform decisions about when within a large group learning session to engage and interact with the audience [8]. Learning sessions can best be viewed as a series of cycles, each of which is comprised of three distinct periods. Learners best remember what they were taught during the first and last periods, referred to as "prime-time-1" and "prime-time-2," but struggle to retain information during the intervening period, referred to as the "downtime." Multiple prime-time and downtime cycles can occur within a session of sufficient length. It is during the "downtime" of the cycle where strategies should be employed to engage and interact with the learner (Fig. 5.1). Stimulating cognitive processing during "downtime" both reengages learners and provides a segue to "prime-time-2" where information can be summarized and consolidated prior to moving on to the next learning cycle. Use of this strategy can counteract the negative effects of periods of low attention during a lecture.

### 5.2.2.2 Interactive Learning

There are a variety of strategies that can be used to build interaction into large group learning sessions. A common element between these strategies is the attempt to create bidirectional flow of information whereby learners receive and apply content to

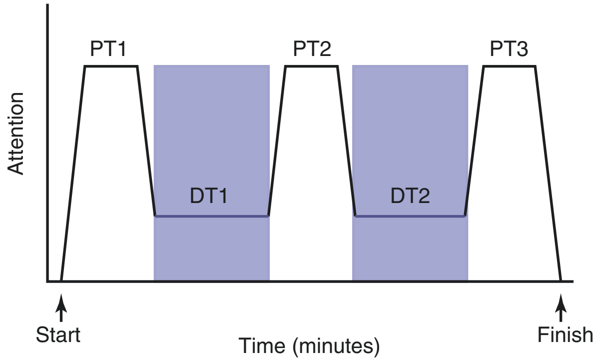


**Fig. 5.1** The primacy-recency effect. Each learning session has cycles consisting of periods of prime time (PT) where attention is high and learners best retain information and downtime (DT) where attention lags and learners struggle to retain information. Activities to engage the audience should be included during periods of downtime (purple shading) to increase attention and facilitate retention of information

solve problems or reason to conclusions and the teacher assesses the learner's understanding of the core concepts [9].

One model of such interactions is the flipped classroom, in which students independently learn foundational knowledge prior to class and then use the classroom for guided application of that knowledge [10]. Such an approach is more suited to the classroom rather than other large group settings where faculty may be asked to teach, such as at a professional society meeting or institutional grand rounds. While more restricted than the medical school classroom, such venues are still amenable to other forms of interactive learning [11].

Another model for building interaction into large group learning sessions is the interactive lecture. Although this can take many forms, one method consists of 10–15 minutes periods of didactics interspersed by a variety of activities in which students work together to apply content to solve new problems. Miller and colleagues compared this approach to that of traditional lectures among first-year dental students and found that the interactive lecture group had statistically higher exam scores, more favorable student evaluations of teaching effectiveness, and higher confidence with the material [12]. Similar results have been seen in studies of undergraduate science, technology, engineering, and mathematics (STEM) courses [13] and medical student lectures [14]. Perhaps most convincing, a meta-analysis of CME interventions found that as the educational strategy became more interactive, the positive effect on physician knowledge, physician performance, and patient perceptions increased [15]. Physician performance was assessed by analyzing prescribing practices, clinical guidelines implementation, and referral rates, while patient outcomes were measured by assessing patients' overall satisfaction and perception of physician communication skills. When compared to passive interventions such as conferences, didactic lectures, and videos, the effect sizes were greater with active interventions such as case-based training, interactive small groups, and workshops.

#### 5.2.2.3 Audience Response Systems (ARS)

Audience response systems allow a distinct feedback loop of engagement and assessment. The instructor poses questions to the learners in the audience who, in turn, derive an answer and provide that information back to the instructor. The overall results are then related back to the audience. This can be done informally using a show of hands on the part of the learners but is increasingly executed using more formal systems consisting of an input device controlled by the learner, a receiver, and a display linked to the input controlled by the instructor. In such formal systems, learners typically input their responses using dedicated ARS clickers or through software contained on their smartphone or laptop computer, while the data is displayed using software embedded in the PowerPoint presentation. An example of such a technique would be to provide a short clinical vignette to the learners and the results of an arterial blood gas and then poll the learners on the appropriate interpretation of the patient's acid-base status. When used fluently, these tools can facilitate interactive learning by providing both a medium for learners to apply knowledge and commit to an answer and feedback to the teacher of the audience's comprehension. Although the effect on short- and long-term knowledge retention is mixed due to an insufficient number of comparison studies, a best evidence medical education (BEME) systematic review suggests that ARS improves learning outcomes when compared to noninteractive lectures [16]. This same review also found a large increase in knowledge gain when ARS was utilized by internal medicine residents, suggesting that ARS may mitigate the effects of sleep deprivation and subsequent impaired attention typically present with this group of learners.

## 5.3 Before You Start

Having reviewed some of the theoretical underpinnings and evidence base for moving from the traditional didactic lecture to a more interactive approach, we now consider the methods for creating and delivering effective large group learning sessions. A critical part of this process is the work that should be done before one even starts assembling a PowerPoint presentation or other session materials.

### *5.3.1 Who Are Your Learners and What Do They Already Know?*

A common mistake in medical education is to deliver the same lecture to learners at different of levels of training. To avoid this pitfall, instructors in large group learning sessions should always determine who their learners are, including their stage of training, and tailor the session accordingly. For example, is the session directed toward preclinical medical students who will first apply the content on exams, potentially

**Table 5.1** Example of differences in expected skills between learners at various stages of training

| | |
|---|---|
| Preclinical medical students | Can identify opacities on a plain chest radiograph |
| Internal medicine residents | Can localize opacities on plain chest radiograph to particular lobes |
| Pulmonary and critical care medicine fellows | Can distinguish lobar collapse from routine opacities |

years before applying it in a clinical setting? Or is the session geared toward senior level residents and fellows who already understand basic principles, but require more emphasis on the nuances of their use? Both questions consider (1) the level of the learner and (2) the context in which the material is both learned and applied. When an existing set of material is slated for reuse, it should be refreshed with the knowledge base of the audience in mind in order to facilitate constructivist learning (Table 5.1).

In some cases, large group learning sessions must be targeted toward mixed groups of learners that span a range of training levels. In such cases, it is critical to ensure the session contains content appropriate to each level. One tactic for engaging all levels is to pose problems to the audience that they solve within groups in which more senior members mentor and teach the junior members before sharing their responses with the entire audience.

Another important consideration is where the large group learning session falls within the context of a course or curriculum. Redundant material from a prior session risks disengaging the audience, whereas, *intentional* revisiting of previously covered material can add value by allowing learners to build upon their foundation of knowledge, using retention to prime the learner for transfer of knowledge. For example, a medical student lecture on acute respiratory distress syndrome and other forms of hypoxemic respiratory failure can build upon the prior lecture on normal gas exchange by stimulating learners to both retrieve knowledge and apply it to a new problem on clinical management. Such an approach has the additional benefit of reinforcing to learners that prior content contributes to understanding future content.

### *5.3.2 What Are the Learning Objectives?*

The purpose of a large group learning session is not to show the depth of your knowledge as an instructor but, instead, to meet the specified learning objectives. What should the learners take away from the session? What skills should they be able to demonstrate during or after the session? Knowledge of the learning objectives is critical for determining the appropriate level and amount of content for the session. When teaching as part of a formal course, discuss the objectives ahead of time with the course director, whereas when teaching as part of a more open forum where the objectives are up to you, consider using the revised *Bloom's Taxonomy*, as described in *Theory*, to facilitate cognitive processing in your session [4] (Table 5.2).

**Table 5.2** Examples of how to improve learning objectives

| Examples of poor learning objectives | Examples of good learning objectives |
|---|---|
| Understand pulmonary function testing | Distinguish between obstructive and restrictive defects on pulmonary function testing |
| Recognize a patient with COPD | Interpret clinical and laboratory data to distinguish between COPD and pulmonary fibrosis as the cause of dyspnea |
| Explain why a patient is hypoxemic | Interpret arterial blood gas and clinical data to determine the causes of hypoxemia in a patient with acute respiratory failure |

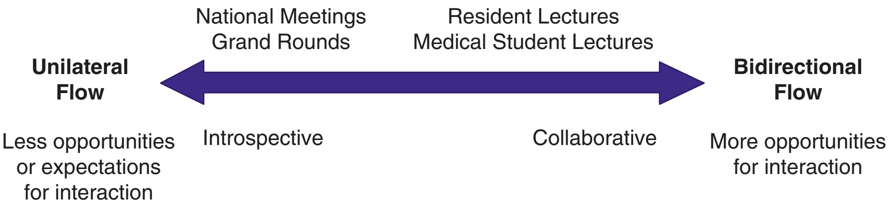


**Fig. 5.2** The spectrum of information flow in large group settings. Large settings are biased toward unidirectional flow of information and limited opportunities for interaction while smaller settings provide more opportunities for bidirectional flow information and extensive interaction

### *5.3.3 What Is the Setting?*

The setting in which the session takes place affects the kind of interaction that is feasible. At one end of the spectrum are sessions delivered to very large audiences (hundreds or perhaps thousands of people), such as at national or international conferences. Such sessions tend to be biased toward unilateral knowledge flow of information (Fig. 5.2) and provide more limited opportunities for interaction such as introspective tasks or audience response, although many professional societies are now making use of audience response technology and other tools in their large audience settings. Venues such as faculty development workshops, resident conferences, and medical student courses, however, provide far more opportunities for learner collaboration, learner-instructor interaction, and assessment of whether the learning objectives are being met. Determining where a planned session falls along this spectrum allows one to properly tailor the interactive features of a large group teaching session.

### *5.3.4 What Is the Appropriate Presentation Format?*

While PowerPoint is the most commonly used tool for large group presentations, it is useful to consider when another modality, such as a chalk talk, may be feasible. Although generally not appropriate for presentations at professional society meetings, chalk talks are very well-suited for less formal settings including medical school classrooms or planned or *ad hoc* didactics with clinical teams. They are effective for constructivist learning where concepts build upon each other or are compared and contrasted with each other to demonstrate overarching principles. Respiratory physiology is one particular area that is well-suited to use of chalk talks as the approach allows more flexibility to develop key concepts than a structured PowerPoint presentation.

### *5.3.5 Time Allotment*

In the era of traditional didactic lectures, a common question was how many slides should be included in a presentation. As the emphasis in medical education shifts toward engaging the audience and ensuring a bidirectional flow of information, a more fitting question is how many slides *and* interactive elements are appropriate for the allotted time. In the end, there is no single answer as the best approach varies based on the instructor's speaking style, the volume of content on their slides, and the types of interactive elements used during the session. For example, ARS questions can be completed in a short period of time, whereas pair-share activities require more time to execute.

The more interactive the session and the greater the potential for questions from the learners, the more difficult it is to know the precise time needed to cover planned content. To deal with this uncertainty, a good rule of thumb is to aim for a length of time far below the allotted limit. Rarely is anyone unhappy with a speaker who ends early, provided that the learning objectives are covered sufficiently. On the other hand, exceeding time limits disengages learners as they become anxious about getting to their next session and frustrates course directors who are trying to keep their course running on time. If you do finish early, consider using the extra time for questions to assess understanding, especially in less formal settings.

When planning how to fit the desired content within the allotted time, it is important to avoid the tendency to show learners everything one feels the learners need to know about the topic, a problem that often befalls speakers teaching in their area of expertise. Providing detail beyond the core learning objectives for a session can spark interest on the part of learners but risks overburdening their cognitive load, at which point the extra detail becomes counterproductive.

## 5.4 Building the Large Group Learning Session

Effective large group learning sessions require a good deal of preparation time, including time for creating a coherent framework for the session, planning the interactive features, building effective slides, and anticipating questions that may arise from the learners. Devoting time in advance to these issues will increase the likelihood of a successful session and decrease the risk of a "high iPhone factor," whereby a high percentage of the audience starts to check their smartphones or other devices as they become steadily disengaged during the session.

### 5.4.1 Structure

Effective large group learning sessions are not a disparate set of slides on a topic but rather have a coherent structure, including an introduction, sections of main content, and a conclusion [17].

The goals of the introduction are to draw the audience into the session and give them a reason to participate, followed by the objectives and structure for the subsequent material. In medical education, a useful way to lure the audience into the session is by presenting a case (e.g., a patient with chronic obstructive pulmonary disease) or clinical question (e.g., why is the patient I just described hypercarbic?) relevant to the content, with the goal of priming the audience's cognitive processes for transferring knowledge. This is then followed by a clear delineation of the learning objectives and outline for the session. If the setting allows, probe the learner's assumptions and knowledge coming into the session by way of a pre-class survey or open-ended questions such as "What is your image of a patient with emphysema?"

Once the learners are primed in this manner, the session can proceed to the core material. The main content should be delivered in a coherent manner that flows logically from concept to concept. Often, it is helpful to divide the main content into distinct sections. Sections can be preceded by transition slides and conclude with their own mini-summaries or deliberate pauses, if the forum allows, for questions from the learners (Fig. 5.3). Such periodic breaks consolidate content and allow a clear transition to the next topic while refreshing attention for a new prime-time period. Within these transitions, find connections to link the topics, for example, moving along a spectrum such as benign to malignant lung masses or acute to chronic states of respiratory failure. If the session began with a clinical case about a patient with chronic obstructive pulmonary disease, consider returning to a subsequent iteration of the case with each transition to a new section of the session (Table 5.3).

All large group learning sessions should have a distinct conclusion focused on reviewing the key content or take-home messages of the session. Use repetition strategically, and tell your audience what you just told them. This facilitates consolidation of their new knowledge. It is also helpful to leave time for questions, which allow a final check of the learners' understanding and the opportunity to clarify concepts.

### 5.4.2 Planning the Interactive Features of the Session

As noted above, the adult learner's attention tends to wane after about 15–20 minutes. To avoid this problem, it can be useful to deliberately include interactive elements in the session at least every 10–15 minutes as a means to maintain audience

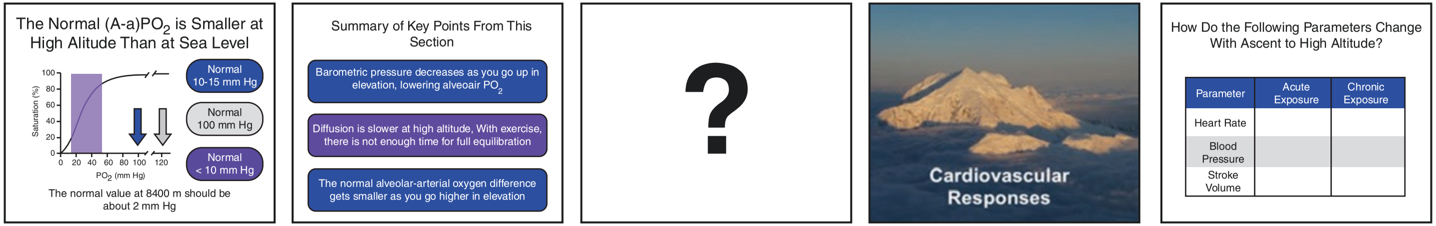


**Fig. 5.3** Five slides from a PowerPoint presentation shown in slide sorter mode to demonstrate elements of presentation structure. Slide 1 is the last content slide of a section, while Slide 2 summarizes the key points from that section. Slide 3 is a deliberate pause for questions from the learners before moving to the next section as indicated by a transition slide at Slide 4 that precedes the first content slide of that section (Slide 5). Slide 5 can serve as a point of interaction by asking the learners to fill in the sections of the table on their own

**Table 5.3** Structure for a large group learning session on obstructive lung disease

| | |
|---|---|
| Introduction | "What is your image of a patient with chronic obstructive pulmonary disease?" |
| Section 1 | Pathophysiology of obstructive lung disease |
| Section 2 | Clinical features of asthma and COPD |
| Section 3 | Diagnosing obstructive lung disease |
| Section 4 | Management |
| Conclusion | Review key features of asthma and COPD using a table to lay out comparison |

engagement. This can take the form of time for questions from the audience, deliberate questions posed to the audience (Fig. 5.4), or one of a series of different techniques listed in Table 5.4. The goals of these strategies are to increase learner attention and motivation by changing pace and stimulating cognitive processing [18].

Which strategies are most appropriate for a given session depends on variety of factors, including whether concepts are suitable for manipulation by the learners, the time required for the activity, and even the layout of the room and whether it supports the type of interaction desired.

Timing is particularly important and requires careful thought ahead of the session, as each period of interaction comes at the expense of time for speaking on the part of the session leader. If the session was previously delivered as an entirely didactic lecture, it will be necessary to remove and/or reorganize slides to create space for interaction and allow the audience time to participate in a meaningful way. How much time should be allotted varies based on the interactive strategy. Session leaders often struggle with the concern that if they don't deliver the content with their spoken word, the learners will not understand it. However, in reality, well-designed interactive features consolidate material in learner's minds better than material delivered with a standard didactic approach.

Finally, in planning for interaction, it is worth noting that members of the Millennial generation are adept at working in teams and often prefer and expect to work in groups [19]. For example, whereas grand rounds with established faculty may be better suited for individual processing, learners throughout undergraduate and graduate medical education may more effectively engage in team activities such as small group breakout sessions. Either way, with enough advance planning, an active learning approach can be used in most venues. Strategies and examples divided in this way are listed in Table 5.4.

### 5.4.3 *Incorporating Audience Response Systems*

ARS is a popular technique to promote interaction and provide feedback on comprehension to both teacher and learners. Best practices for using this technique in large group learning sessions are discussed below [20, 21].

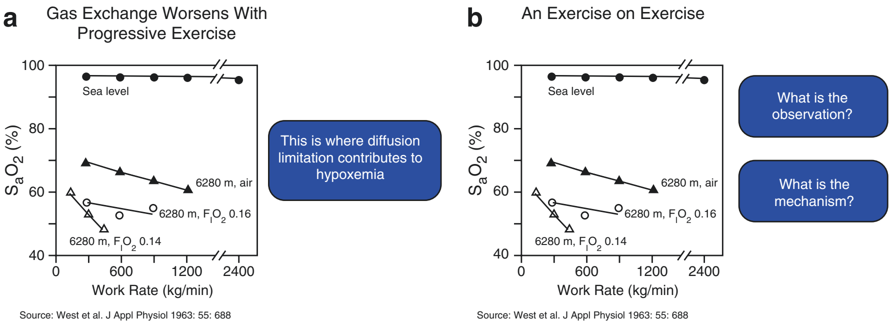


**Fig. 5.4** Redesigning a slide to move from a unidirectional to bidirectional flow of information. Panel (**a**) represents the original manner in which the information was presented. The speaker explained the findings in the figure to the audience and then provided the mechanism for the observation. Panel (**b**) demonstrates a redesigned slide that provides opportunity for interaction. The learners are provided the context for the figure by the session leader (i.e., the research study design) and are then asked to determine the key findings in the figure on their own and, drawing on previously learned material, the mechanism for the observed findings. This can be done using a pair-share exercise

As with any technology incorporated into the learning environment, the tool should not be the focus of the lecture, but rather a means to achieve the learning objectives. Testing factual content using the questions may not have as positive an effect on knowledge retention as posing questions that require the learner to process information in order to formulate an answer. The principles of writing good exam questions also apply to the use of ARS. Overly simple, overly difficult, or poorly worded questions risk detracting from the utility of the exercise (Table 5.5).

When considering the number of ARS questions to include in a large group teaching session, less is more. Plan on one question up to every 10–15 minutes to correspond with the need to refresh attention spans. For each question, allow sufficient time for posing the question, learner processing, provision of the answers, and sufficient debriefing on why the answer is correct. Note that ARS itself is not an interactive strategy, but rather a means to facilitate interaction. Hence, when determining the time allotted for each question, consider the particular interactive strategy that will be used. Questions posed as pair-share activities require more time for adequate discussion than questions in which the learners are expected to answer on their own without consulting their colleagues.

The principles of slide design, described below, also apply to creating slides for ARS activities. The questions and answer choices should be clear and concise, as information overload can decrease the response rate by deterring learners with an overly daunting task. Similarly, limit the answer choices to no more than five to avoid a cluttered screen.

A critical element of effective ARS is ensuring proficiency in the ARS software platform ahead of the planned session. One should devote time to learning how to

**Table 5.4** Interactive learning strategies. Adapted from Selected Active Learning Strategies. Lynne Robins, PhD. University of Washington

| **Individual processing** |
|---|
| *1-minutes paper*: pose a question about a concept; ask learners to write a response in 1–2 minutes. Collect responses, share sample responses anonymously, and give feedback |
| *Muddiest point*: give learners 1–2 minutes to write the "muddiest point" or most confusing concept. Provide clarification in real time or through email/online discussion |
| *Defining feature matrix*: hand out a table of information and ask learners to decide if a defining feature is present or absent. For instance, while learning about pulmonary function testing, the learners are asked to decide which values correlate with restrictive or obstructive lung disease |
| *Teach back*: learners show their understanding of concepts or demonstrate and explain a technique. Open-ended questions are used to assess the learner's understanding and/or ability to transfer that understanding to a related but new topic |
| *Pass the pointer*: project an image, such as a CT Scan, and ask for volunteers to borrow the laser pointer to identify key features or ask questions about items they do not understand |
| **Teamwork** |
| *Think-pair-share*: pose a question, such as "why is this patient hypoxemic?" learners spend 1–2 minutes thinking about the problem with their neighbors. Pairs are asked to report to the entire class |
| *Pause and clarify*: pause the lecture for 2 minutes, while learners chat with neighbors about their respective understanding of key or difficult conceptual content. The aim is for each learner to clarify their own understanding by comparing their perspective with that of their partner |
| *Critical thinking activity*: provide a small group breakout session designed around a thought-provoking question, a case about material just presented, or concepts covered in previous lectures. After the breakout, select a learner(s) from a group to respond to the question or task |
| **General strategies** |
| *Knowledge probe*: prepare 2–3 short-answer questions or five multiple-choice questions from the lecture content. Have the learners work in pairs or individually to answer the questions at the start of the session, and then save their answers. The questions can be readdressed in a mid-lecture or end-of-lecture activity |
| *Quick thinks*: pose a question such as select the best answer, correct the error, complete a sentence starter, compare or contrast, support a statement, reorder the steps, reach a conclusion, or paraphrase the idea. Participation options vary: learners can record their responses individually, and then explain their answers to a neighbor; they can verbally generate an answer with a neighbor, or they can silently think about a possible response |
| *Mini-case*: begin the lecture with a realistic case involving the concepts that will be discussed that day. Include a brief question that requires the application of key concepts. Learners work on the question, and then report their answers when called upon |

navigate the software and to logistical planning for the proposed venue. The instructor should be familiar with all features of the software, both to take advantage of all the available tools and to troubleshoot when problems inevitably arise. When the session leader cannot handle a software malfunction, valuable time and audience engagement are quickly lost. These risks can be minimized by practicing ahead of time, including projecting the planned question, testing receipt of answers through the ARS, and ensuring the answers display appropriately. If possible,

**Table 5.5** Features and examples of high- and low-quality ARS questions

| Quality of ARS question | Features | Examples |
|---|---|---|
| Low | Excess information in question stem introduces extraneous cognitive load | What percentage of patients with scleroderma develops pulmonary hypertension? |
| | Prioritizes retention and factual recall | Which of the following medications work by inhibiting phosphodiesterase-5? |
| | Overly simple | |
| High | Concise | Based on your interpretation of the clinical and right heart catheterization data, what is the underlying cause of the patient's pulmonary hypertension? |
| | Prioritizes processing of information and knowledge transfer | |
| | Stimulates discussion | Your patient with pulmonary hypertension would like to become pregnant. Is this safe? (Yes/no) |

rehearse in the actual session venue and know whom to call when technical help is needed. The day of the actual session, allow plenty of time to set up and test the ARS before the session begins.

## 5.5 Slide Design

Even as medical education moves away from standard didactic lectures and incorporates more active learning approaches, it is unlikely that slide presentations using PowerPoint, Prezi, or other software platforms will disappear entirely. In fact, even well-designed active learning sessions often involve some use of slides displayed on a screen. As a result, it remains imperative for session leaders to understand the principles of effective slide design. Well-designed slides provide clarity and coherence to the delivered material and signal investment in the audience's learning. The following strategies for effective design, which apply regardless of the software platform used, are based on the experience of the authors and review of the literature [22].

Slides should be built upon a simple and consistent background, ideally monochromatic and non-textured. Preset slide designs may seem attractive at first glance, but quite often the design elements either take up valuable space on the slide or distract learners. Similarly, color schemes should be consistent to keep the lecture cohesive as you move from topic to topic. Use light-colored text (white, yellow) on a dark background (black, blue) or dark colors on a light background to maximize contrast, and ensure all text can be read easily. Chest radiographs and CT scan images are best displayed on slides with a black background to maximize contrast and facilitate identification of key findings. Note that in any large audience, you can expect some learners to be color-blind. For this reason, avoid concurrent use of red and green text, lines, or arrows on the same slide.

Slide layout should vary throughout the talk, as repetitive use of the same layout may disengage the audience. Bullet point slides are suitable for certain material but should not be the basis for every slide. Clutter should be avoided. Slides are not meant to be academic posters packed with information. When a slide becomes too crowded, it can be useful to divide the content into multiple slides. This will not add time to the presentation but rather makes it easier for the learners to process the information on each slide. A useful rule of thumb is that if one feels they will need to preface a slide with comments such as "I know you can't read this but..." or "this is a very busy slide but..." then slide redesign is in order.

It is also important to ensure the slide content is clearly visible regardless of the learner's position in the venue. Sans-serif fonts such as Arial, Century Gothic, and Calibri are much easier to read than serif fonts such as Times New Roman and Courier New. Notably, serif fonts are more difficult for learners with dyslexia to efficiently and accurately read without becoming overly fatigued [23]. Font sizes less than 24-point should be avoided in large classrooms as smaller fonts are too difficult to read from the back of the room. If the words appear small on the computer screen as the session is being prepared, they will be too small when projected on a screen in the class.

Finally, care should be taken with figures copied from other sources. Figures from published manuscripts are typically designed to be viewed in a journal rather than on a screen with a large audience. As a result, when displayed as part of a PowerPoint presentation, text or lines may be hard to discern. In addition, figures copied from a PDF of the manuscript often lack adequate resolution and display poorly on a large screen. When such problems are recognized, figures can be relabeled to improve legibility or, in some cases, redesigned using the original data (Fig. 5.5).

## 5.6 Preparing Chalk Talks

As noted above, chalk talks are especially effective for topics, such as respiratory physiology that require active constructivist learning [24]. Advanced planning is key to delivering a successful chalk talk, particularly in more formal settings such as the medical school classroom or a formal residency program lecture. One aspect of planning is development of a "chalk talk map," in which the speaker develops a story board that lays out the progression of concepts and figures to be covered in the session. It includes all of the content that will ultimately be drawn on the white- or blackboard and provides a bird's-eye view of the overarching framework that will hold all of the material together. Practical tips for constructing such a map are described in Table 5.6.

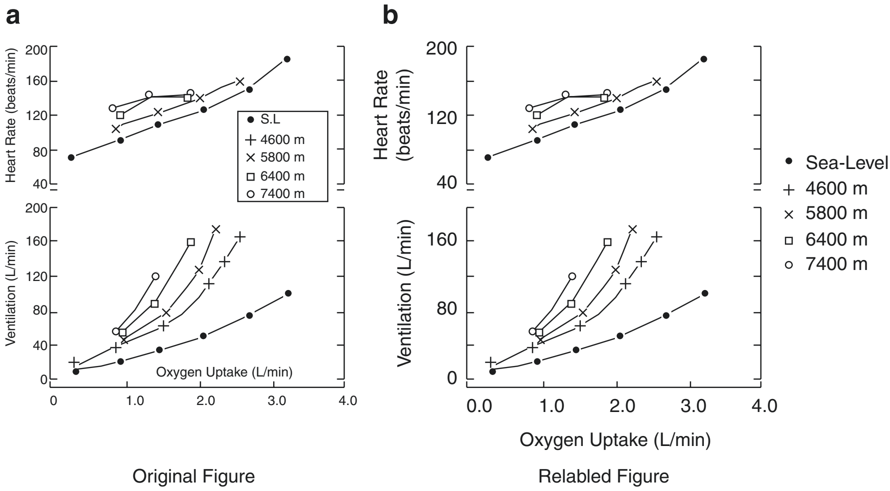


**Fig. 5.5** Redesigning a figure to improve visibility and comprehension for the audience. Panel (**a**) demonstrates the original figure as taken from a PDF of a journal article. Note that the axis labels and legend are difficult to read. Panel (**b**) demonstrates a redesigned figure in which the old labels were covered with white text boxes and new labels added to improve clarity and ease of viewing in a large lecture hall

**Table 5.6** Practical tips for creating a chalk talk map

| |
|---|
| If feasible, visit the room where the session will be delivered to see the size, number, and type of (white or black) boards available for the session |
| Reserve a section of the map for the session's learning objectives and take-home points |
| Ensure that each board's content is large enough for the audience to see but not too cluttered with material |
| Plan the order in which you will fill out the board over the course of the session |
| Identify figures that are best drawn in real time versus those that are better to draw before the session starts |
| Plan which figures you will leave on the board for the duration of the session versus material you will erase as you go to create more space |
| Plan where you will seek input from learners and other interactive elements |
| Plan where you will use different color markers or chalk to emphasize key concepts |

When feasible, it is helpful to practice a chalk talk ahead of time. This allows an opportunity to evaluate issues such as the clarity and legibility of the boards from different parts of the room, how well the written material conveyed the key concepts and the amount of time necessary to draw the figures and other material. It also provides a sense of the time necessary to cover the core content, an important variable given the increased potential for questions and interaction with the learners in chalk talks that may occupy a lot of time in the session. If not feasible to practice ahead of time in the actual room, it is useful to reflect upon these issues once the session is completed with an eye toward improving future iterations of the session.

## 5.7 Delivery

Even the best planned and developed sessions may still not enhance learning if there are problems in the delivery of the material. Below are pointers for presenting the session in a way that not only engages but also avoids disengaging the learners.

### *5.7.1 Practice*

Delivery of session content can be greatly enhanced by practicing ahead of time. An appropriate goal is to rehearse enough to remove the need to refer to notes or read from a script or the slides as they are displayed on the screen. As an extreme example, TED Talk speakers, generally known for their exemplary delivery, start rehearsing 4 months out, typically practicing the session up to 15 times before the talk is given [25]. This degree of preparation is neither necessary nor feasible for most education sessions, but the example demonstrates the value of practicing in advance. In general, the higher the stakes of the session (e.g., a presentation at a national meeting), the higher the importance of practicing ahead of time.

### *5.7.2 Working with Technology*

Technology such as videos, Internet links, and audience response systems can greatly enhance a presentation but should be tested ahead of the session to ensure they work properly. Allow sufficient time (at least 30 minutes) prior to a session to set up and test the technology and troubleshoot any problems. Unfortunately, despite seemingly adequate preparation, malfunctions are still possible and cannot be fixed on the spot. For this reason, always have a contingency plan to ensure the content can be covered without significant loss of time or audience engagement.

Related to this problem is the issue of interoperability: slide presentations created on a Mac platform do not consistently display properly when presented on PC platforms and vice versa. Images can be lost, and formatting is often disturbed due to cross platform incompatibility. Such problems can be avoided by testing the presentation on the alternative platform ahead of time or, when feasible, using one's own laptop computer. The latter option may require the session leader to have the appropriate adapter for connecting the computer to the LCD projector.

### 5.7.3 Stage Presence

Being an engaging teacher does not require a specific personality (i.e., charming extroverts with a widely appealing sense of humor), but rather, a person that can actively engage with the material and with their audience. Being engaging requires paying attention to the learners during the large group learning session by continuously monitoring their attention to and understanding of the material and responding accordingly. Are they looking at the session leader, taking notes, and nodding along? Or is a wave of smartphones surfacing? When the latter situation occurs, the effective session leader has plans to respond and reengage.

An important aspect of stage presence is body positioning. Rather than turning away from the audience and looking at the screen, face the learners. Have a conversation with the learners rather than reading the slides to them – something they are capable of doing themselves. Wireless slide advancers and lavalier microphones provide an opportunity to move away from the podium, allowing the speaker to move from one section of the stage to another and subsequently interact with different sections of the audience. Movement can also be used to mark the outline of the session. For example, move to another part of the stage when transitioning to a new section of the presentation. Or, move closer to the audience when explaining a difficult concept, priming them for an activity, or answering questions. In other words, use one's physical position on stage strategically and with purpose.

An instructor's voice can also be an important tool for engaging the audience. Pause to highlight important concepts; slow down to explain difficult ones. This allows learners to absorb and frame what they just heard. Change tone to emphasize points, lightening it when correcting wrong assumptions or incorrect answers to maintain an open learning environment.

Useful tools for improving stage presence include watching a video of one's own lecture or obtaining peer feedback. Both methods can provide insight that is not readily apparent to the speaker as the session is proceeding. Stage presence should be considered a work in progress which can improve over time with feedback.

### 5.7.4 Promoting Interaction

While students are steadily becoming used to more interactive large group sessions, not all learners are comfortable with this approach. Prime students for their role as active learners by explaining how the session will proceed. Let them know there will be pauses for questions and opportunities to apply concepts. Explain the rationale for doing this and give them permission, encouragement, and motivation to actively engage.

Facilitate learner engagement by using a conversational tone when interaction is sought or moving toward and looking at the learners when they speak. When learners volunteer an answer or opinion, show appreciation for their participation. Challenges arise when a learner offers a wrong answer, as curt or dismissive

**Table 5.7** Responding to a wrong answer from a learner

| | |
|---|---|
| Incorrect learner statement | "The patient must have a neuromuscular disease because they have a low total lung capacity" |
| Identify the incorrect assumption | Restrictive physiology only develops as a result of neuromuscular disease |
| Appropriate response | "You are certainly correct that restrictive processes cause a low total lung capacity. However, there are a lot of processes besides neuromuscular disease, which can cause this. Why don't we consider them as a class?" |

responses from an instructor may negatively impact learners' participation later in the session. To minimize this risk, lower the stakes by finding the "kernel of goodness" in what was said (Table 5.7). Consider their incorrect answers as incorrect assumptions, and address them accordingly, as well as remind students that mistakes are simply part of the learning process.

### 5.7.5 Dealing with Questions

Handling questions is a key part of leading large group learning sessions. How questions affect speaker dynamics varies based on the setting. In more formal sessions such as at a national meeting, questions tend to be reserved for the end of the session, whereas in less formal settings such as a medical student classroom, questions may come at any point in the session with varying degrees of frequency. When addressing questions, wait for the learner to finish posing the question before responding, and repeat the question to the audience before answering. The latter ensures all audience members hear the question and provides time to formulate a coherent response. This is often important when lectures are being recorded for use at a later time by the learners, as some recording systems only record the speaker's voice and will not record questions or comments from the audience.

The fact that questions can come at varying frequencies and quantities in less formal settings creates challenges for staying within the session's time limit. It is important to pay attention to the time as the session proceeds. If the session is behind schedule due to a large number of questions, it may be necessary to politely inform the learners that you need to move on to ensure the learning objectives are covered and welcome them to ask their questions at the end of the session. Building discrete pauses for questions into the session may also limit the number of random questions from the audience, as the learners understand that time has been allotted for their questions.

Session leaders may not be able to answer every question from the learners. Rather than obfuscating or "hand-waving" in response to a challenging question, session leaders may actually gain credibility by offering that they do not know the answer, looking into the issue after the session is over, then either following up with the learners at the next session or via some form of communication to the class.

### 5.7.6 Laser Pointers

Session leaders commonly point to information on the screen using either a dedicated laser pointer or the computer's cursor. While useful for highlighting key points in a figure or pathway, excessive use, such as repeatedly swirling the pointer around an object or word on the screen or pointing to every word being read to the audience, can be distracting. The device is a laser *pointer* rather than a laser *doodler*. Use it strategically and in limited amounts to point to discrete items for short periods of time and, otherwise, keep it off the screen.

### 5.7.7 Flexibility

Highly interactive sessions carry a fair amount of unpredictability regarding the timing of the session or the types of questions that may come from the learners. While rehearsing provides an estimate of the time needed to cover the learning objectives, issues outside of the session leader's control may still arise that derail the intended session schedule. Being flexible in one's approach and having contingency plans helps with this unpredictability. For example, rather than insisting on thoroughly covering the remaining slides in a presentation, abbreviate their coverage and deal only with core messages. When timing issues are anticipated during the preparation of the session, conscious decisions can be made about what material to skip or include. Within PowerPoint, it is possible to use hyperlinks or Presenter View to seamlessly jump over sections of the presentation.

## 5.8 Reflection and Assessment

Many large group learning sessions are delivered on a repeated basis, and subsequent iterations can be improved through thoughtful reflection on the prior iterations. The best time to do this is often immediately following the completion of a session, when the session dynamics are fresh in one's mind. Consider and write down issues such as the timing of the session, concepts that confused the learners, or difficult or unanticipated questions. Seek further feedback by reading student evaluations, asking a peer in the session for detailed feedback, or by watching a video of the session. Writing notes on an extra slide at the end of a presentation is one useful way to save this information and obviates the need to keep track of paper notes over time.

Peer assessment, in which a colleague observes the session and takes detailed notes on content, structure, learning resources, and delivery, is a particularly useful, low-stake method to gain another point of view of positive behaviors and potential corrections. Among its many benefits, peer assessment has been shown to create enthusiasm for revisiting the substance and performance aspect of the lecture and stimulating change [26]. There is also the broader effect of prompting reflection on one's teaching style by hearing someone else's thoughts and perspectives. Such a review can be completed using a formal Peer Lecture Assessment Tool (Table 5.8). While there are many such evaluation instruments, this particular tool was associated with high rates of perceived feedback on structure, content, and quality of visual materials [27].

## 5.9 Making It Happen

Here we apply the steps in creating a large group learning session on oxygen delivery for preclinical medical students.

**Table 5.8** Peer lecture assessment tool [25]

| | Observed | Not observed | Exemplary | Comments (give specific examples of any "Exemplary" ratings) |
|---|---|---|---|---|
| **Structure** | | | | |
| Identifies reasonable goals for session | | | | |
| Clear, organized flow of presentation | | | | |
| Appropriate pace of talk | | | | |
| Summarizes key points during conclusion | | | | |
| **Content** | | | | |
| Demonstrates relevance of subject to audience | | | | |
| Content is at appropriate level for audience | | | | |
| Demonstrates command of subject matter | | | | |
| Supports content with most recent literature | | | | |
| High-quality audiovisual aids | | | | |
| **Teacher dynamics** | | | | |
| Shows enthusiasm for subject | | | | |
| Engages the audience and elicits participation as appropriate | | | | |
| Responds to verbal and nonverbal cues from audience | | | | |
| Speech is easy to follow (e.g., volume, clarity) without distracting mannerisms | | | | |
| Additional feedback: how could this presentation be more effective? What would make it exemplary? | | | | |

The example in Table 5.9 highlights the principle stages of creating a large group learning session. Preparation is the key first step. Before any material is created, the instructor begins by considering who the learners are, as well as their background, objectives, and learning environment. This allows the instructor to construct a framework for the session, bolstered by interactive features chosen with the session parameters in mind. In creating the material, deliberate attention is paid to slide design, aiming for clean and varied visual aids. The content focuses on the transfer of knowledge with opportunities for manipulation of information and consolidation of concepts. After crafting the large group learning session, attention is now directed

**Table 5.9** An example of a large group learning session on the pathophysiology of oxygen exchange

| Creating a large group learning session | How we handle oxygen |
|---|---|
| Before you start | |
| Who are your learners and what do they already know? | First year medical students |
| | Third lecture in an introductory respiratory physiology and pathophysiology course |
| | To date, the class has covered the anatomy and histology of the respiratory system |
| | Most learners have limited prior experience with respiratory physiology principles |
| What are the learning objectives? | Identify the effect of changes in barometric pressure on the rate of diffusion of oxygen across the alveolar-capillary barrier |
| | Describe the relative changes in oxygen delivery following a red blood cell transfusion versus supplemental oxygen administration |
| | Predict the changes in hemoglobin-oxygen affinity in response to exercise and an anxiety attack |
| | Predict changes in arterial and venous oxygen content and hemoglobin saturation in patients with dyshemoglobinemias and cyanide poisoning |
| What is the setting? | Lecture hall of 100 students, stadium seating, shared tables for up to 3 students per table |
| | Equipped with a white board, projector and screen, computer built into the podium, microphones at every other student seat |
| Time allotment | 50 minutes, with 10 minutes available for setup |
| Building the talk | |
| Structure | Outline content |
| | Start with a case of a climber on Mount Everest |
| | Four sections, one built around each objective |
| | Summary |
| | Time for questions |
| Planning for interaction | Each section will have one interactive exercise to check for understanding |
| Allowing for questions | Slides incorporated at the end of each section as a flag to pause for questions |

**Table 5.9** (continued)

| Creating a large group learning session | How we handle oxygen |
|---|---|
| Elements of slide design | |
| Simple background and readable font | Solid white slide background |
| | Black text |
| | All slide titles in 40-point font |
| | All other text displayed at minimum of 24-point |
| | No red or green letters, lines, or arrows |
| Varied layout, uncluttered | Review all materials when complete to ensure high quality |
| Delivery | |
| Practice | Plan for 1–2 practice sessions if time allows |
| Working successfully with technology | Obtain contact information for AV support |
| | Inquire of course director as to who is responsible for loading the slides at the time of the session |
| | Test ARS technology ahead of time |
| | Test all videos on the lecture hall computer ahead of time |
| Stage presence | Use remote slide advancer |
| | Use lavalier microphone |
| | Move around front of the room |
| | Learn the names of the students in the class |
| Encouraging interaction | Pair-share exercises for interactive elements |
| | Pause and clarify at end of each section |
| Flexibility | Insert hyperlinks into slides to facilitate skipping material if time is running short |
| Reflection and assessment | |
| Peer assessment | Recruit a trusted peer to schedule this session into their calendar in order to provide feedback using the Peer Lecture Assessment Tool |

toward preparing for effective delivery by rehearsing, familiarizing with and testing technology, and ensuring flexibility within the session, whether seamlessly advancing through slides if time is short or the ability to step away from the podium and move around the room. Finally, reflective practice completes this process, priming the instructor for the next teaching opportunity.

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# Chapter 6
# Teaching in the Classroom: Small Groups

**Diana J. Kelm and Alexander S. Niven**

## 6.1 Introduction

The widely held perception that active engagement and facilitated discussion result in better learning has led to the rapid growth of small group sessions in undergraduate, graduate, and continuing medical education. The complexity present within the field of pulmonary, critical care, and sleep medicine makes this learning strategy particularly attractive, but how to use small group teaching strategies within existing curricula and clinical settings is less well defined. Although small group education is well supported by learning theory and expert opinion, objective evidence of superior educational outcomes is mixed. The reason for this likely reflects the challenge providing a high-quality, small group learning experience, which requires a unique and important set of teaching skills [1, 2]. The purpose of this chapter is to provide a summary of current literature, a practical guide to best practices for faculty engagement in small group education, and highlight opportunities for ongoing study.

## 6.2 Why Does This Matter?

The purpose of a small group is to facilitate learning by providing participants an opportunity to demonstrate their understanding of new material, to ask questions, and to learn from both faculty and peers as they apply content to solve conceptual and clinical problems. Small group learning can also help develop discussion skills, teamwork skills, critical thinking abilities, and the exploration of professional and

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_6

personal identity through sharing and reflecting on past experiences [3]. Facilitator presence is a key element to small group learning, but their role is to encourage rather than to control, to coordinate as much as communicate, and to inspire more than inform [4].

Providing a high-quality small group learning experience, however, is not easy. Although learners generally report that small group interactions are more enjoyable than large group didactic sessions, prior systematic reviews have raised concerns over gaps in knowledge, varied reasoning processes, and faculty and learner stress using this teaching method. The low facilitator-to-learner ratio also translates to higher costs and time demands of practicing physicians [5]. Systematic reviews of small group learning have uniformly underlined the heterogeneity of educational outcomes and varied design of curriculum interventions as major limitations to assessing the postulated benefits of this learning strategy [6, 7].

The literature is rife with examples of small group learning programs and workshops conducted in the context of residency and fellowship programs, most with an emphasis on curricular innovation and short-term improvements in learner knowledge and skills. In reality, a significant proportion of graduate medical education is delivered in an informal small group setting through rounds, bedside teaching, conference room presentations, and informal "chalk talks" [8–12]. How to effectively facilitate small group learning within the practice of Pulmonary and Critical Care Medicine (PCCM) is the focus of this chapter.

## 6.3 Who Cares?

### *6.3.1 Theory*

The management of the acute respiratory distress syndrome (ARDS) is a good example to illustrate how learning theory supports the small group setting. Constructivist theory suggests that the first key step to adult learning is the recognition of a gap between current knowledge and a new learning opportunity. The renewed interest in driving pressure in the medical literature is one such example [13]. Using driving pressure in the management of ARDS requires an integrated understanding of pulmonary physiology, mechanical ventilation, and patient-ventilator interactions. Reviewing these content areas and the current literature in this area is helpful, but small group discussion can lead to reflection and elaboration, which helps the learner to refine and organize this information into a schema that can be stored into long-term memory [14]. Learning is most effective when these schemas are periodically retrieved, rehearsed, and applied to new problems. These actions strengthen memory traces, increase their complexity, and enable the information to be more readily retrieved. In practical terms, these concepts can be applied by asking learners to read a concise ARDS review and a study focused on driving pressure, and then asking them to apply this information using facilitated small group discussion of ARDS cases during a chalk talk or bedside ICU rounds.

Unfortunately, individuals regularly overestimate the strength and accuracy of the memories they develop. Repeated retrieval and testing both maintain and strengthen key elements of new learning and help to identify areas for further improvement [15]. The Johari window (Fig. 6.1) is a popular tool in cognitive psychology which has been used to demonstrate the value of small group discussion. Small group interactions can help individuals to learn things about themselves (the blind area) and provide opportunities to share their knowledge with others (the hidden area). The amount and depth of practical knowledge gained through this process can be affected by the diversity and experience within the group. Using carefully chosen tasks, resources, and cases, facilitators can guide learners through these areas thoughtfully, and introduce and integrate new knowledge (the unknown area) into group discussions [16, 17]. Using our example, a facilitator may offer an esophageal balloon tracing in a spontaneously breathing patient and ask her group to discuss the pitfalls of transpulmonary pressure measurement using driving pressure in this setting.

A number of other adult learning theories support the process of small group learning. Social educational theories emphasize that learning and thinking are social activities, structured and influenced by the setting in which learning takes place [18, 19]. Self-determination theory argues that adults must have intrinsic motivation to learn, which is best sustained in learning climates that support autonomy, competence, and relatedness (a feeling of belonging) [20–22]. Kolb's experiential learning model also underlines the importance of deliberate practice, reflection, and feedback as tools that lead to action and change [23, 24].

The small group learning process must therefore begin with a foundation of common, newly developed knowledge. Small group discussions provide an opportunity for learners to recall, test, and apply these concepts through discussion with an ideally diverse group of individuals, facilitated by an instructor and subject matter expert. The result is a broader and deeper understanding of the topic in question through case-based application, feedback, reflection, and learning consolidation.

| | Known to Self | Not Known to Self |
|---|---|---|
| Known to Others | Known | Blind |
| Not Known to Others | Hidden | Unknown |

**Fig. 6.1** The Johari window. (Adapted from Luft and Ingham [17])

These opportunities can also build critical thinking skills and help develop a learner's personal and professional identity toward their work and the patients they serve [1].

### *6.3.2 Evidence*

Although small group learning has a strong foundation in educational theory, clear evidence of small group learning effectiveness is limited to reaction, the lowest level of the Kirkpatrick model of assessment [25]. A systematic review of published experience with case-based learning in medical education found that the majority of learner reactions were positive, with common responses including "a valuable learning experience," "real-life relevance," "increased confidence," "enhanced learning of material," and "an effective means to learn concepts" [7]. Learners have also commented on the degree of creativity, challenge, interest, and enjoyment afforded through the case study method and stated that it improved understanding [26, 27]. A qualitative undergraduate medical education study conducted at McGill University identified six major themes of effective small group teaching (Fig. 6.2) [3].

Within critical care, small group learning is often combined with simulation to provide skills training within a clinical context, such as central line training and communication workshops. This method of teaching has resulted in improved procedural performance [28], knowledge [29], and subjective skill assessment [30]. Peer-to-peer learning for basic life support has been shown to be as effective as clinical faculty instruction for practical skills, knowledge, and satisfaction [31]. For procedures, the use of small group teaching has been found to reduce anxiety and improve procedural competence [32, 33]. The addition of small group sessions within a PCCM fellowship curriculum has been found to be feasible, prompting trainee requests for increased use of these learning techniques [34].

For the past decade, the American College of CHEST Physicians (CHEST) has made considerable efforts to strengthen and expand active learning offerings within

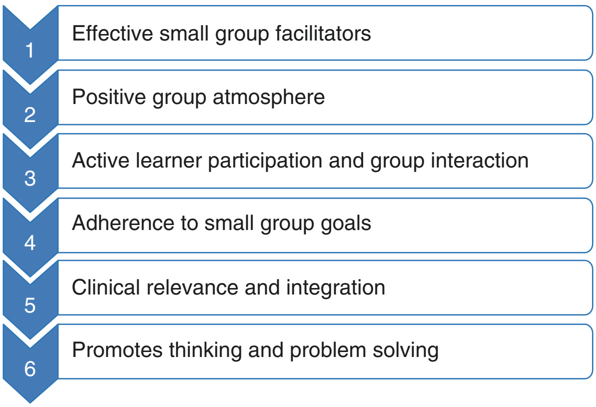



**Fig. 6.2** Effective small group teaching. (Adapted from Steinert [3])

its educational programs, including simulation-based, self-directed, and small group learning. At the CHEST international conference in 2012, a series of small, case-based interactive discussions were piloted with subject matter experts on a variety of topics ranging from asthma management to echocardiography. The response from the attendees was immediate and overwhelmingly positive. Subsequent demand for additional content in this format has successively increased the proportion of case-based learning to over 30% of the total offerings at the annual CHEST conference since that time, and small group sessions are now integrated into all CHEST simulation-based educational workshops [35].

Evidence that small group activities favorably impact learning, behavior, and patient outcomes is more limited and controversial. In 1999, Springer and colleagues published a meta-analysis that concluded that small group learning promoted greater academic achievement, more favorable attitudes toward learning, and increased persistence in undergraduate science, mathematics, engineering, and technology courses and programs [36]. This study garnered considerable attention in the medical education community and has led to widespread use of small group learning in undergraduate medical curricula. A later review by Colliver and colleagues, however, argued that these conclusions were overstated given the marked heterogeneity of the studies included in Springer's analysis. Published outcomes in PCCM are unfortunately even more limited [37]. A study of communication skills in the care of critically ill patients found that a 2-day small group simulation course changed provider behavior and increased early documentation and selection of patient-centered goals of care [38]. Small group teaching has been shown to improve family physicians' ability to teach inhaler use based on a certified respiratory educator assessment [39]. Lack of standardization and outcome assessment remains major impediments to assess the impact and potential benefit of small group dynamics during rounds, bedside teaching, and chalk talks in PCCM practice settings and offer important opportunities for future research.

Medical schools have developed a growing emphasis on case-based and problem-based learning (PBL) since the pioneering work in this area by Barrows and Tamblyn in the 1970s [40]. Hartling and colleagues performed a systematic review of 30 studies examining the impact of PBL in undergraduate and preclinical medical education on learning and on subsequent behavior in clerkship and residency performance [6]. Hartling's conclusions suggest that knowledge acquisition using PBL is similar to conventional medical school curricula, but PBL results in a high degree of learning satisfaction [5, 41]. PBL may also improve performance in social- and cognitive-based competencies, although data are limited due to challenges providing objective comparison of discussion skills, problem-solving, attitudes, and values in clinical practice [42]. Using PBL in a critical care course for nurses increased overall critical thinking skills (based on the California Critical Thinking Skills Test) and sub-scales of evaluation and deduction, as compared to a lecture [43]. A large international bronchoscopy training program also demonstrated improvements in knowledge, confidence, and interdisciplinary communication using a blended curriculum experience [44, 45].

## 6.4 Best Practices

Defining the role of small group learning in medical education is challenging, as this technique is used in many forms within various curricula and clinical settings. Common types of small group learning described in the medical literature are denoted in Table 6.1. The following sections summarize published best practices for small group learning and provide examples of how to employ these activities in a curriculum or training program.

### *6.4.1 Group Size and Dynamics*

A group is a collection of individuals who interact, but this simple definition fails to capture the many complex qualities present in each group (Table 6.2) [46, 47]. The ideal size of a small group is controversial, but many sources suggest that six to eight individuals constitute an effective and productive learning environment [4]. Although larger groups of participants offer greater diversity and experience, opportunities for interaction decrease and there is a greater likelihood that some learners will remain quiet [1]. Smaller numbers of participants (i.e., two to five) offer greater opportunity for interaction. One study demonstrated that a group of three to four was more effective for developing critical thinking and decision-making skills [48, 49]. In many learning environments, facilitators do not have control over group size and must recognize and actively manage the complex dynamics that are frequently present in larger groups of individuals [46].

### *6.4.2 Structure*

Preparation is one of the keys to successful navigation of small group dynamics and achievement of a small group session's goals. The facilitator must consider (1) what

**Table 6.1** Common types of small group learning

| Type of small group | PCCM examples |
|---|---|
| Tutorials | Medical student pulmonary physiology session |
| Problem-based learning | Systematic, structured learner-led discussion on the diagnosis and management of a clinical case of COPD |
| Seminars | PCCM fellowship journal club |
| Workshops | Simulation-based education (e.g., central line training, point-of-care ultrasound, patient communication) |
| Electronic discussion groups | Blog posts from PCCM fellows on current controversies in PCCM, fellowship Twitter feed, electronic curriculum site for pulmonary physiology course |
| Case-based discussion | Resident report, ICU bedside teaching |

**Table 6.2** Qualities necessary for a successful small group

| Quality | Definition of group members |
|---|---|
| Collective perception | Conscious of their existence as a group |
| Needs | Joined the group to satisfy a need or provide a reward |
| Shared aims | Hold common goals, ideals that connect them together |
| Interdependence | Each is affected by and responds to any event that affects other group members |
| Social organization | Social unit with norms, roles, statuses, power, emotional relationships |
| Interaction | Influence, respond to each other in person or apart |
| Cohesiveness | Want to remain within the group and contribute to its well-being |
| Membership | Durability of relationships – more than two people interacting for longer than a few minutes |

learners should gain from the session (learning objectives), (2) the best approach to help them learn it (curriculum methods and delivery), and (3) how learning will be measured (learning outcomes). Successful facilitators frequently start with the last question and work backward, carefully weighing what learners know and may say within the small group setting, to plan activities and questions [1]. One approach to session planning is to draw a concept or "mind" map to organize ideas and facilitate the thinking and learning process [50, 51]. Facilitators and/or learners start with the topic and most general concepts at the top of a page (e.g., "What is sepsis?") and next identify more specific subtopics and then the relationships between them (e.g., "How does our understanding of sepsis pathophysiology drive common principles of management?"). Clustering similar questions and subtopics together can help focus the conversation and serve as a discussion guide. Providing learners with specific materials to prepare before small group sessions on more complicated topics will facilitate this process.

One important consideration is that the direction of gaze strongly influences interaction [52, 53]. For a small group classroom discussion, arranging seats in a circle or horseshoe places all learners in an equal line of sight and creates a more open environment for discussion. During ICU rounds, key points can be illustrated using markers on the glass door or dry erase board in patient rooms, ensuring that all interprofessional team members can see the visual aids, hear the discussion, and are encouraged to share their perspectives and engage in collaborative discussion.

Facilitators must set an appropriate tone at the beginning of a small group session. They should explain the purpose of the small group session and use a systematic approach to guide the discussion (Fig. 6.3) [1, 52]. Starting off with a "short" lecture on pulmonary pathophysiology in ARDS, for example, can create a passive group dynamic and make learner participation more difficult in later discussions. Starting with a straightforward question or asking learners to discuss a topic in pairs (for example, using the think-pair-share technique) offers the opportunity for immediate engagement and creates a non-threatening atmosphere that will foster free discussion.

The role of the facilitator during small group interactions should be thoughtfully structured [1]. Lecturing is often overused in small groups; facilitators should gen-

**Fig. 6.3** An approach to small group sessions. (Adapted from Edmunds and Brown [1])

R Develop a *rapport* with the group

E Review mutual *expectations* of the leaners and the facilitator

S Discuss the *structure* of the small group session

T Create brief, but relevant *tasks* and provide feedback to the group

erally limit didactic comments to a brief introduction and/or to summarize key teaching points. The facilitator's primary aim is to encourage learner engagement and guide discussion with as few interruptions as possible. Common facilitation strategies to encourage learner participation, discovery, critical analysis, and problem-solving skills are summarized in Table 6.3 [47]. Many of these techniques focus on the principle of "making the small group smaller" to diffuse the natural hesitancy to speak out in new settings and reduce the power dynamics that a faculty presence creates.

At the end of a small group session, it is helpful if facilitators provide a summary of the key learning points, resolve unanswered questions, and thank learners for their participation. This technique helps ensure that the learning outcomes are achieved and provides learners with a sense of accomplishment.

### *6.4.3 Facilitation Skills*

Facilitation skills are a major determinant of the success of a small group. Experts recommend that an effective small group facilitator should be able to "question, probe, and encourage critical reflection, suggesting and challenging in helpful ways, but only when necessary" [54, 55]. Commonly defined personal attributes and facilitation skills of small group facilitators in comparison to learners are listed in Table 6.4 [3, 56–58]. Facilitators must interact with their learners on a more personal level, gently challenging their assumptions to facilitate reflection, justification, and collaboration to integrate and apply information appropriately to problems [59–62]. A recent review proposed five pragmatic strategies to stimulate critical thinking during the time-constrained activity of ICU rounds. Hayes and colleagues recommended starting with explicit demonstration of thought processes for early learners and ending with open-ended questioning to assess more advanced learner reasoning (Table 6.5) [63].

In settings that offer more time for discussion and reflection, discussion skills provide a foundation for developing collaborative learning and teamwork. The four core elements of discussion skills include questioning, listening, responding, and explaining. A good facilitator needs to understand when to use a specific discussion skill in a particular setting to facilitate thinking and the group process. When trying

**Table 6.3** Facilitation strategies for small group discussions

| Strategy | Description | PCCM example |
|---|---|---|
| Free association (brainstorming) | Encourages the generation of ideas without criticism; encourages quantity, not quality | Root cause analysis discussion during a quality improvement project to reduce central venous catheter infection rates |
| Inner/outer circle (fishbowl) | Creates an inner circle within a group; the inner circle discusses a specific topic while the members of the outer circle observe | Simulated mock code where one team performs the code and the others watch to provide feedback during the debrief |
| Thinking and reflective writing time | Dedicated time for learners to write down their thoughts | Facilitator allows time for the group to think of about the causes of hypoxemia and then asks for the group's response |
| Buzz groups | Brief discussion sessions in which smaller groups of learners talk with each other (think, pair, share) | Large group PCCM conference in which the speaker asks the audience to discuss with their neighbors about a specific topic or question |
| Snowball groups | Buzz groups in which learners first form into pairs, then group of 4 (then groups of 8, 16, etc.) to discuss a problem | In the same large group PCCM conference, the speaker asks audience member pairs to discuss the same question with the nearest pair in the next row before sharing with the larger group |
| Role-play | Participants enact common scenarios usually from the clinical setting | Communication workshop in which learners role-play challenging interactions (e.g., giving bad news, goals of care discussion) |
| Tutorless groups | Working through a problem or task independent of a faculty member (usually for smaller groups) | Medical students working on pre-assigned tasks for their respiratory physiology course without a facilitator or instructor present |
| Step-by-step discussion | Discussion using a planned series of questions, usually facilitated by a tutor | Bronchoscopy training of a group of novice learners in which the facilitator has the learners go through a standardized checklist |

**Table 6.4** Facilitator and learner roles

| Facilitator | Learner |
|---|---|
| Guide discussion, focus | Active discussion participant |
| Provide session structure | Support group process |
| Develop critical thinking | Analyze, thoughtfully challenge |
| Foster collaboration | Be nonjudgmental |
| Summarize key teaching points | Ask clarifying questions |

to assess understanding, the use of "why," "what do you mean," and "how do you know that's true" questions can help the facilitator [55]. At other times, explanation may be more important, and the facilitator can provide examples and metaphors to help the learners better remember the material discussed [62].

Questions are critical to assess learner knowledge, arouse curiosity and interest, and encourage critical thinking (Fig. 6.4). Broad questions often start with "why"

**Table 6.5** Strategies to teach critical thinking skills in a critical care environment

| |
|---|
| Make the "thinking process" explicit |
| Discuss cognitive biases and de-biasing strategies |
| Model and teach inductive reasoning |
| Use questions to stimulate critical thinking |
| Assess your learners' critical thinking skills |

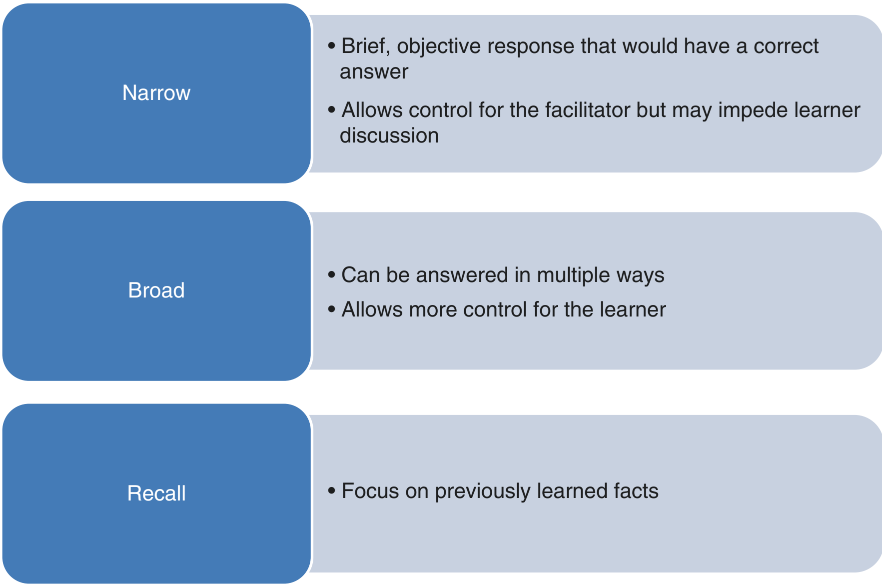



**Fig. 6.4** Classification of questions

and "how" and provoke attitudes, opinions, and feelings [64]. Questions that start with "what" should be avoided when soliciting in-depth responses, as "what" questions frequently yield closed-ended answers. Follow-up questions should be brief, direct, embedded within in the discussion context, and asked one at a time to avoid confusion. Narrow questions are helpful to make key learning points, and recall questions at the beginning of a discussion can allow the facilitator to assess learner level of knowledge and activate their thinking processes. Questions targeting a high level of cognitive function lead to greater achievement (i.e., "How would you apply these principles of sepsis resuscitation to a patient with mixed cardiogenic and septic shock?"), but are frequently underutilized [65, 66]. An encouraging questioning style (rather than a game of "guess what I am thinking") creates a safe space for learner discussion, and nonverbal cues including stance and tone of voice are important to achieve this goal.

Listening skills are essential to respond to and guide the learning process (Fig. 6.5), with one pragmatic approach and example offered in Fig. 6.6 [1]. Reflection occurs when the facilitator repeats back what the learner just said, to both

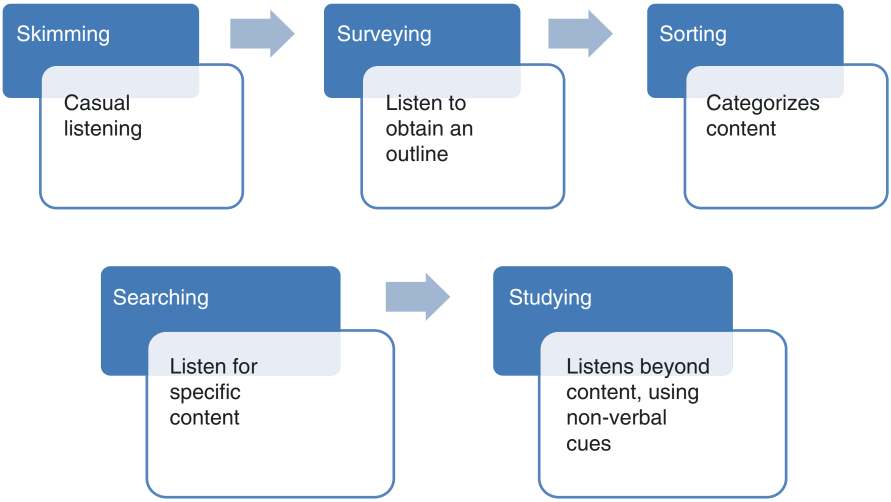
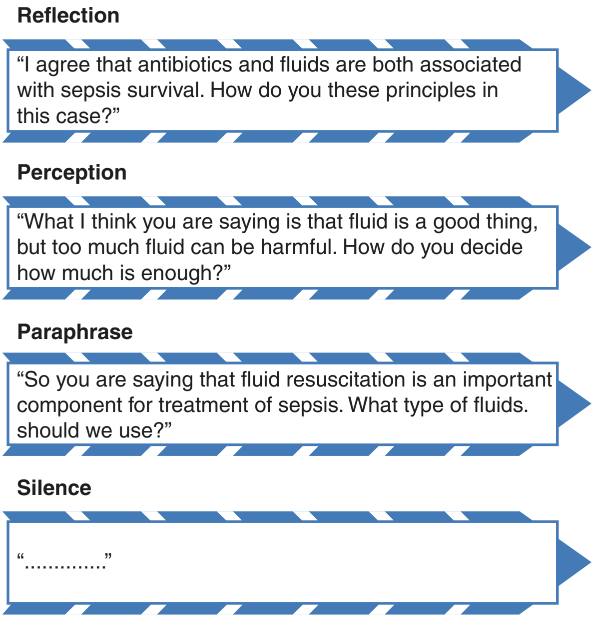



**Fig. 6.5** Levels of listening. (Adapted from Edmunds and Brown [1])

**Fig. 6.6** An example of the four-step process to creating a safe learning environment




encourage collaboration and show that she is listening. Perception is when a facilitator checks his understanding of the learner’s response. Paraphrasing can be helpful by making statements more precise and in summarizing key aspects of the discussion. Silence may make some facilitators uncomfortable, but 5–10 seconds pauses have been shown to increase learning by allowing students time to think [67].

## 6.5 Making It Happen

Effective small group teaching requires deliberate preparation, leaders who are both content experts and skilled in small group facilitation, and motivated and engaged learners willing to share their perspectives during small group discussions. Several hypothetical examples are provided based on the authors' experiences that demonstrate the application – and challenges – of implementing these small group teaching concepts.

### *6.5.1 In Situ Multidisciplinary Mock Codes*

Running an effective code is a complex task, requiring organization, medical knowledge, procedural proficiency, and effective communication. Maintaining these skills is challenging because codes are relatively uncommon and members of the code team change frequently. At one institution, all interprofessional code team members are required to participate in a half day code management course which includes online pre-course modules and a blended small group and simulation-based educational experience that emphasizes fundamental TeamSTEPPS principles and local code protocols to develop and practice this shared mental model.

In response to the need to strengthen the teamwork of the code team, a multidisciplinary mock code program was implemented within the medical ICU for small groups of internal medicine residents, ICU nurses, pharmacists, and respiratory therapists. Mock codes occur several times a month, unannounced and on random days, including two to three scenarios as time permits. After each mock code, the responsible faculty member begins a debrief with a broad question ("How did things go?") and probes for strengths and opportunities for improvement during the subsequent discussion. The goal is to facilitate reflection and feedback and further deliberate practice. Common topics include role assignment, closed loop communication, code cart medications, defibrillator functions, and effectiveness of chest compressions. Participant satisfaction has been high, especially with the interprofessional nature of this program. Medical knowledge and code leader skill assessment has consistently improved, suggesting the debriefing strategy described can be effective.

**Take-Home Points** Small group learning does not need to be done in isolation and can be very effective when used in a blended curriculum that employs multiple delivery methods. Although the group dynamics can be complex, interprofessional small groups offer a wealth of diversity and experience that can lead to rich discussion – especially in areas of teamwork and collaboration.

### *6.5.2 Refining Patient Communication Skills*

As part of a PCCM fellowship boot camp, all fellows are required to complete a course on patient communication skills and cultural diversity. The communication skills program includes a pre-course online module, small group discussion after viewing of video examples, simulated encounters using standardized patients, and video-based peer, facilitator, and “patient” feedback. Learning objectives emphasize best practices in the areas of breaking bad news, leading goals of care discussions, acknowledging mistakes or errors, and key cultural and communication considerations with patients with diverse socioeconomic and cultural backgrounds. The standardized patients have been trained to raise psychosocial issues that frequently complicate physician–patient relationships (e.g., mistrust of the medical system due to past experience, medication noncompliance because of a recent lapse in insurance). The resulting small group discussions offer a rich opportunity not only to discuss common communication strategies such as “ask-tell-ask” but also to share past challenging experiences. Fellows discuss the values- and ethics-based processes that our professional community follows in these situations. Course evaluations are consistently outstanding, and participants complete a commitment to change form that highlights key lessons that they plan to implement in their practice. This form is returned to each learner 90 days later.

**Take-Home Points** Small group learning can be particularly effective at developing personal and professional identity, drawing from shared experiences within the group to highlight best practices, common values, and methods to resolve conflict in complex areas such as the management of challenging patient interactions.

### *6.5.3 Providing a Small Group Learning Experience to Not-So-Small Groups*

In 2015, CHEST created interdisciplinary sessions at its international conference, many of which used a small group discussion or PBL model. The overwhelmingly positive response and demand for more offerings of this format created a challenge. To provide adequate capacity to meet learner demands for these offerings, faculty leaders in subsequent years have used creative small group learning solutions and blended workshops to provide the necessary milieu for interaction, reflection, and feedback. A recent interdisciplinary session at the CHEST 2018 international conference, for example, used a small-in-large group learning strategy on ICU leadership and management challenges for a group of 150 participants. Learners were divided into groups of ten, sitting at round tables with a single assigned faculty member. After viewing one of three assigned video-based case vignettes, each small group participated in a facilitated discussion of possible solutions for the clinical scenario. Each faculty member had received a concept outline with key learning objectives and summary points in advance of the session, which were discussed during faculty development preparations to ensure the learning experience was consistent across groups. At the end of the session, representatives from each table were invited to share the final lessons from their discussions with the larger group in a faculty-facilitated panel.

This format has also been very successful using a PBL-style discussion to work through challenging cases in lung cancer and interstitial lung disease. In these sessions, circulating pathologists and radiologists serve as consultants to answer questions from each small group as they work through their assigned cases, and randomly selected small groups are asked to present the results of their discussions as part of a multidisciplinary panel discussion to highlight key points and provide feedback at the end of the session.

**Take-Home Points** A small group learning experience can be successfully delivered in the large group setting, provided the key ingredients (i.e., a well-designed topic, a question outline with key learning points, skilled facilitators, and the opportunity for a limited number of diverse individuals to engage in rich discussion) are present.

## 6.6 Conclusion

Small group teaching is a well-established strategy in medical education, with a firm foundation in adult learning theory. The varied evidence supporting the efficacy of small group teaching in individual learning, behavior, and results reflects both the heterogeneous approach with which small group education has been integrated into medical education curricula at various levels and the complex set of skills and preparation that are necessary to maintain a high-quality, small group learning environment. Recognizing the considerable training, time, and resources required to conduct a small group session, future research must focus on the best methods to integrate small group teaching within a curriculum to produce superior learning, performance, and outcomes; best practices to facilitate faculty development in this area; and methods to integrate current and emerging technology to better facilitate current and future small group interactions.

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# Chapter 7
# Teaching at the Bedside

**John Bishara and Terese C. Hammond**

## 7.1 Why This Matters

Bedside teaching is an important teaching method in which the process of mentored medical history taking, physical examination, and differential diagnosis generation occurs in real time in the context of an actual patient encounter. Bedside teaching is a core component of a holistic approach to patient care and presents an opportunity to inform and engage learners at various levels of experience and expertise in the diagnostic process [1]. Bedside teaching can also enlist patients in creating an evidence-based therapeutic plan.

Teaching at the bedside was the central part of training from the mid-seventeenth century to the early twenty-first century [2]. Sir William Osler famously stated, "Medicine is learned by the bedside and not in the classroom" and "teaching away from the bedside is a bastard substitute" [3, 4]. Despite its initial acceptance, bedside teaching progressively fell out of favor with medical educators, occupying only 75% of rounding time by the mid-twentieth century and 15–20% of rounding time by the late 1970s [5–7]. More recently, it has lost more ground, with only 8–19% of modern academic rounding time allocated to bedside teaching [8, 9]. It is unclear how much time is dedicated to bedside, or "exam room," teaching in clinic, but the time devoted to such patient-centered teaching in the outpatient setting has likely also decreased over the past several decades.

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_7

The decline in bedside teaching is multifactorial. A major perceived obstacle cited by many attending physicians is the time constraints that have arisen from the high-throughput nature of contemporary healthcare. Utilization review has led to progressively shorter inpatient hospitalizations; however, shorter hospitalizations and higher patient volumes can reduce time for the attending physician to teach about patients' medical problems. Restricted intern and resident duty hours often mandate hard stops on rounding times, and high patient censuses and increased illness acuities can further overload a system that is inefficient by nature [10]. Decreasing visit times in the outpatient setting have similarly affected the time for teaching in clinic. Opportunity and time for bedside teaching are further cannibalized by mounting electronic record keeping responsibilities faced by clinical patient care teams.

Compared to bedside teaching, other teaching modalities such as clinical simulation and patient-actor encounters can be scheduled, planned, and created to encompass any clinical scenario, even rare pathologic conditions that may not be encountered during a clinical rotation [11]. Furthermore, there has been a paradigm shift in clinical diagnosis with an increasing reliance on technology, imaging, and laboratory tests, rather than clinical examination skills, which have been traditionally fostered at the bedside [11].

Despite these perceived obstacles and limitations, bedside teaching is strongly supported by both learners and educators [11]. Learners gain firsthand experience in fostering a doctor-patient relationship, and patient-centered care is directly observed by supervisors who can provide advice and corrective action in real time. Trainees can develop and improve communication skills with patients, from basic interviewing and establishing rapport to more challenging interactions such as discussing sensitive topics or delivering bad news. Additionally, trainees can hone structured history-taking skills in an environment that challenges them to avoid the extensive use of medical jargon [12]. Trainees experience not only how to assess disease processes but learn how to personally and professionally address and empathize with the human impacts of illness [12].

Concerns about the effectiveness of traditional Internal Medicine resident education in Pulmonary and Critical Care Medicine (PCCM) are apparent in national surveys from both Internal Medicine residents and Critical Care faculty members [13]. Program and ICU directors report that barriers for current teaching practices in the intensive care unit (ICU) include, but are not limited to, lack of resident availability, high clinical workload, lack of protected time for bedside teaching, lack of published standards of what to teach at the bedside, and faculty disagreement about what to teach [13]. Subspecialty physicians (i.e., pulmonary physicians) cite similar barriers to bedside education but also report lack of resident interest in engaging in bedside teaching in their areas of clinical practice [13].

A multisite survey of Internal Medicine residents demonstrated that the Accreditation Council for Graduate Medical Education (ACGME) work hour changes decreased continuity of care and opportunities for educational experiences [14]. Duty hour regulations from the ACGME have the potential to impose constraints on critical care education for residents [15].

## 7.2 Who Cares?

### *7.2.1 Theory*

The comfort of the conference room has many benefits. The educator is able to guide the direction of the discussion without potential interruptions from a concerned patient or family member [1]. Also, results from diagnostic procedures can be easily viewed and reviewed, often in the format of an electronic medical record. Moreover, larger numbers of learners can be taught at the same time as compared to bedside teaching, where physical space or sensitivities of the patient's condition may limit the number of participants. Clinicians have become increasingly dependent on technology and electronic resources, and this may lead more educators to transition away from the bedside to the more comfortable environments, such as conference rooms. The decrease in comfort with teaching at the bedside leads to a further separation and alienation from patients [15].

Clerkships, residencies, and fellowships allow trainees to learn the importance of the doctor-patient relationship. Students gain firsthand knowledge and perspective from these experiences. Residents and fellows strengthen their connections with patients and best practices in clinical care [11]. Bedside rounding is important as it demystifies the process of building a rapport with patients, through modeling and practicing communication, listening, touch, and being present in the moment. The balance of being efficient with time, yet establishing a rapport with patients, can be learned and help strengthen trainees and prepare them to their next step in their career [11].

Physical diagnostic skills in trainees have been declining, and this decline is significantly associated with the decrease in curricular time allocated for bedside teaching [11, 16, 17]. This deterioration in bedside teaching has raised concerns by medical education councils and medical educators about the acquisition of clinical skills by trainees, prompting recommendations that residency training programs develop strategies to dedicatedly reincorporate bedside teaching into clinical curricula [18].

In the ICU and on the Pulmonary Consult service, time constraints, distractions and interruptions, and patient complexity are myriad. In addition to the severity and variability of patients' illnesses, factors such as residents' duty hour restrictions, multidisciplinary care team dynamics, system-based practice challenges, and patient safety and quality concerns can complicate resident education in this environment [19]. In clinic, compressed visit times, increasing patient volume, and patient complexity conspire to decrease the time for teaching and learning, shifting the focus on clinical efficiency and service. As such, regardless of the clinical setting, these pressures can create conflict between providing optimal patient care and insuring adequate resident education. Therefore, an efficient, effective, and standardized systems of medical education must be designed and implemented that addresses both clinical care and educational priorities.

### 7.2.2 Evidence

The development of proper interviewing and physical examination skills is inextricably linked to the need for hands-on experience. The nature of medicine is such that there are many derivations of "normal," and only repetitive practice with concurrent feedback and reeducation and/or redirection is necessary to progressively gain competency and progress to independent practice. However, certain pathological disorders are impossible to mimic in teaching or simulation scenarios, which leaves real-world patient encounters as the only viable learning method [20]. For example, one study found that structured sessions in bedside teaching by expert faculty greatly improved resident interpretation of cardiac murmurs [21]. Additionally, when 4th-year medical students were proctored at bedside for history and physical examination skills on patients with gastroenterology conditions, there was a trend toward better scores on objective structured clinical examinations (OSCE) [22].

Other evidence of the value of bedside teaching comes from a study involving students on a Neurology rotation [23]. Students were randomized to either a control group, in which they received the normal lecture curriculum, or to an intervention group, where didactic teaching was superseded by daily bedside teaching, case presentations, and emphasis on history and physical examination and other methods to diagnose neurological diseases. Those who were randomized to the intervention group significantly increased posttest knowledge acquisition scores by 16% over their pretest performance. In comparison, the control group posttest scores only increased by 6%. These results are relevant for PCCM educators in clinic, on the wards, or in the ICU.

Discrepancies are observed in how bedside teaching is viewed by medical teachers and patients. The majority of patients appear to appreciate and are very satisfied with bedside teaching because of the perception of extra time and insight given to their medical situations [1]. Additionally, patients generally enjoy the shared teaching and learning experience and even report a better understanding of their diseases with bedside teaching [1]. However, physicians, especially younger physicians, seem to favor this teaching method far less than patients, as they often fear that patients may interpret bedside teaching as demeaning or burdensome [1].

One study evaluated conference room presentations versus bedside teaching in a pediatric ICU. In general, parents reported significantly more satisfaction with bedside teaching than when teaching occurred away from the bedside [24]. When residents performed presentations at the bedside, parents rated residents' competency higher as compared to when presentations were performed in the conference room [24]. Residents, however, felt more uncomfortable when asked questions at the bedside as compared to inquiries made by the teaching physician in other learning environments [24].

### 7.2.3 Best Practices

Effective bedside teaching must be customized to the specific clinical practice setting. Both time constraints and the ability of patients to participate in the process vary based on disease acuity and site of care. The overriding mandate for bedside teaching is established in part by the Institute of Medicine's definition of quality healthcare [25]. Bedside teaching should be safe, timely, effective, efficient, equitable, and patient-centered. Developing a best practice approach for bedside teaching in different practice settings (i.e., ICU, step-down unit, general medicine wards, and outpatient settings) requires a systematic evaluation and framework that is attentive to best practices. Each teaching setting presents site-specific advantages and challenges. In the following section, we review specific educational strategies and best practices for teaching effectively at the bedside for different learners in different practice settings, with an emphasis on teaching the physical exam, learner perspectives, and curricular design.

### *7.2.4 Physical Examination*

Regardless of the clinical site of care, physical examination is one of the mainstays of clinical education at the bedside [26]. Specifically with regard to the ICU, the presence of technology, including point of care ultrasound and the availability of sophisticated laboratory tests, increasingly usurps physical exam, but the value of a thoughtful physical exam should not be underestimated [27]. Model of a rational approach to the physical exam, as well as proper physical exam techniques, is an important component of bedside teaching.

Before conducting a physical exam, trainees should be encouraged to review the patient's chart, and obtain a history, and/or gather information from the patient or relatives and the medical staff [27]. Whether in clinic, on a Pulmonary Consult rotation, or in the ICU, the scope of the physical exam can be modified to the patient's circumstances. While a "head to toe" approach may be indicated in some settings (e.g., the first time meeting a new patient in clinic), a focused, targeted exam is frequently more appropriate. Learners should be encouraged to adopt a "hypothesis-driven" approach to the physical exam, such that physical exam maneuvers are informed by their clinical reasoning and different diagnosis, rather than simply performing physical exam maneuvers for the sake of performing physical exam maneuvers. For example, if a resident on the Pulmonary Consult service is concerned about acute systolic congestive heart failure as an etiology of a patient's shortness of breath, a focused physical exam should target manifestations of heart failure (i.e., lower extremity edema, jugular venous distension, and pulmonary crackles) and not simply consist of ceremonial cardiac auscultation.

Regardless of the clinical setting, the pulmonary exam is obviously a foundational component of the physical exam for PCCM. Proper pulmonary examination must include more than just lung auscultation, although this is an important tool for a preliminary pulmonary assessment, as effusions, pneumonias, or pneumothoraces can be appreciated through auscultation. Careful inspection of the patient's overall appearance (labored versus comfortable) and work of breathing, including chest excursion and chest symmetry, is important and may provide information regarding the patient's risk for respiratory pathology. In the ICU specifically, other physical findings such as chest wall or neck crepitus, asymmetric chest rise, or abdominal distension can have specific relevance in ventilated patients.

Cardiovascular assessment includes palpation over the left chest to feel for ventricular heaves, palpable pulmonary arteries, or any displacement of the point of maximal impulse (PMI). Auscultation of the heart over specified landmarks allows for valvular assessment. The strength and symmetry of carotid and peripheral pulses should be assessed, capillary refill should be measured, and dependent and extremity edema should be assessed and quantitated.

The abdominal exam includes checking for distention, bowel sounds, and tenderness. Careful attention to any surgical sites or wounds for signs of infection is vital. For patients in the ICU or on the Pulmonary Consult service, examining tubes, lines, drains, and/or other extrinsic devices should also be monitored and considered for early removal as clinically indicated.

Finally, careful skin inspection is an essential component of the "head to toe" examination. Skin color, turgor, temperature, rashes, infections, and skin breakdown should be observed and documented as these findings may have important implications and can help generate and refine differentials either in the inpatient or outpatient setting.

## 7.3 Curriculum Design and Implementation

Addition of a formalized critical care curriculum to augment bedside rounds is also associated with increased trainee satisfaction [29]. Using an objective performance assessment tool such as an OSCE can also benefit learners. When available, medical simulation can significantly improve student training and education. Adopting explicit, identifiable, and attainable goals for learners in any clinical setting, from the outpatient clinic to the ICU or Pulmonary Consult rotation, increases the likelihood that all learners extract the most from these clinical experiences.

Discussing learning objectives prior to the start of the rotation can help improve trainees' and interprofessional learners' expectations and learning experience [28]. When supervising physicians inform trainees of expectations and demonstrate willingness to directly supervise activities such as physical exam or clinical history, it may motivate learners to seek out and accept direct feedback during the rotation [28]. It is helpful to reassure learners that these teaching practices are not intended to embarrass them in front of their patient or peers [28]. This concern may limit their participation or jeopardize their relationship with the patient.

### *7.3.1 Teaching to Teach*

The mandate for medical educators is not solely to train learners to become competent physicians but also to mentor them to become effective educators. Modeling effective clinical teaching and involving learners in the educational process are identified as important by a broad range of learners [29].

Uncertainty and insecurity about their own medical knowledge may dissuade supervising residents from conducting formal bedside rounds. Moreover, attending physicians' willingness to allow residents or fellows to lead rounds is a barrier to their doing so. Nevertheless, senior house staff play a critical role in near-peer teaching of medical students and junior residents. As such, they should be encouraged to actively develop their bedside teaching skills. Training residents to become better clinical teachers offers many advantages. In one study of clinical teaching during an Internal Medicine clerkship, teaching provided by resident teachers had a more beneficial effect on medical student standardized test scores than teaching from the supervising attending [30].

#### 7.3.1.1 Framework for Developing Bedside Teaching

Teachers must possess both medical knowledge and clinical practice to be effective teachers; the framework of both knowledge and experience forms the bedrock of clinical teaching [31]. Trainees typically develop teaching skills through apprenticeship and observation, as they learn by observing positive and negative examples of teaching. Commonly used bedside teaching pedagogical strategies include the use of questions, case discussions, observation, feedback, and specific clinical teaching methods [31]. Examples of specific clinical teaching methods are delineated in Table 7.1.

These general teaching strategies are used in clinical teaching and supervision to support active learner engagement in clinical work and to create a positive learning climate [31]. Depending on the clinical site of practice (i.e., outpatient clinic, inpatient ward, or the emergency department or ICU), a specific teaching strategy can be used to effectively teach learners. Such methods use questioning and observation strategies to determine how far a specific learner deviates from general expectations and offer the opportunity for guidance, support, and challenge for the learners' levels of development [31].

The more frequency with which a trainee teaches a particular topic or skill, the more routine and automated the interchange becomes. One of the most difficult aspects of teaching is deciding what content to leave out [31]. Faculty development guidance recommends focusing on foundational concepts [31]. Being able to reduce countless details to essential, high-yield concepts is part of the process of learning to teach effectively. Additionally, less experienced teachers benefit from observing more experienced and effective teachers in practice. Furthermore, new strategies need to be imparted to improve teachers, and this can be accomplished by having a creative and supportive climate for clinical teaching [31].

In addition to becoming a clinical teacher, professionalism is also reinforced in bedside teaching. This is done through modeling by senior trainees during actual patient encounters. The majority of medical students surveyed perceived interns and residents as important facilitators of professionalism training and education [35]. Additionally, pediatric residents who gave lectures performed far better on a knowledge assessment posttest than did those who passively listened to a lecture on a specific topic [36]. Fostering the development of strong teaching residents enhances

**Table 7.1** Educational frameworks for bedside teaching

| Teaching methods | Description/explanation | Example |
|---|---|---|
| Aunt Minnie [32]/pattern recognition | A lady walking across the street walks like your Aunt Minnie and dresses like your Aunt Minnie | When reviewing a chest x-ray in clinic, the attending physician looks at the film and states "That's a great case of lipoid pneumonia" |
| | She probably is your Aunt Minnie | |
| | Even if you cannot identify her face | The student asks how the attending knows the film depicts lipoid pneumonia, and the attending states "After you've seen enough x-rays of lipoid pneumonia, you just know it when you see it!" |
| | | The attending then reviews the specific features of the x-ray that suggest lipoid pneumonia with the student |
| One-minute preceptor [33] | Get a commitment | What do you think is going on? |
| | Probe for supporting evidence | Why do you think this? |
| | Teach general rules | Tell them what they did right and the effect that it had |
| | Reinforce what was right | |
| | Correct mistakes | Tell them what they did right |
| | | Tell them what they did not do right |
| | | Tell them how to improve for the next time |
| SNAPPS [34] | Summarize history and findings | S – 40-year-old man with hypertensive urgency with a blood pressure of 185/115 and normal physical exam |
| | Narrow the differential | |
| | Analyze the differential | |
| | Probe preceptor about uncertainties | N – Differential diagnoses are the following… |
| | Plan management | A – I don't believe this diagnosis fits because… |
| | Select case-related issues for self-study | P – The patient should have the following… |
| | | S – When you leave today, you should read on hypertensive urgency |

the scholarly spirit of a program and better prepares graduates for careers in academic medicine and clinical practice.

## Specific Strategies

Communication is key for the doctor-patient relationship. Too often learners are uncomfortable speaking to patients, especially in front of a group. However, trainees' growth and development occurs as they are increasingly able to engage in active listening and to converse with patients in any situation.

Preparation is a critical element to conducting effective rounds and increasing educator comfort at the bedside [37]. Familiarization with patients and their clinical conditions prior to engaging in teaching can be very reassuring and allows the instructor to prioritize teaching points prior to beginning rounds. Prior assessment of learners' pertinent medical knowledge base and clinical skill level can also improve teacher confidence and comfort [37]. In addition, teachers should be encouraged to self-reflect on ways to improve their own history taking, physician exam skills, and clinical problem-solving abilities by soliciting feedback from peers and senior expert clinicians [12].

Instructors should consider formulating a road map of what they plan to achieve at the bedside for each teaching encounter [37]. Developing such a road map requires planning and preparation. The road map does not need to be followed strictly, especially during bedside encounters. However, this structure enables an instructor to walk into an encounter with increased confidence [37], which is valuable since bedside encounters can be filled with uncertainty. Digressions occur often at the bedside, and unexpected questions arise from both learners and patients. The response to questions outside the team's knowledge or comfort level can cause embarrassment or discord if not handled carefully. This disharmony can affect clinical teachers to the point where they avoid going to the bedside altogether. Table 7.2 describes strategies which can help raise teacher confidence levels.

Stepping out of the limelight as a teacher is a necessary component of learner-centered bedside teaching [12, 37]. It is very important to present opportunities for other team members to lead, based on their knowledge, experience, and comfort level. Observing trainees' interactions with patients at the bedside can be illuminating and provides a chance for additional feedback. While communication, history taking, and exam skills of the learners are often the focus of observation, other abilities such as problem-solving skills, knowledge, and attitudes can also be evaluated. This evaluation can influence future teaching rounds and help instructors better assess their learners. Additionally, the instructor can actively expand learners' knowledge and skills through immediate feedback and gentle correction as necessary [37]. After bedside teaching is completed, the instructor should debrief and

**Table 7.2** Communication strategies for use in bedside teaching

| Communication strategies | Examples |
|---|---|
| Topic of discussion decided in advance | Asthma |
| | Congestive heart failure |
| | Hypertension |
| What specific aspects are to be emphasized? | History taking |
| | Physical examination |
| | Patient counseling |
| | Delivering bad news |
| Plan activities to keep everyone engaged and involved in the teaching and learning | Assign topics for discussion the next day |
| | Allow trainees to facilitate or lead rounds |
| Select patients who would make for good bedside teaching | Preferably with the input of the learners, have them select a patient that they can lead discussion |
| Decide how much time is to be spent with a given patient | 5–10 minutes of discussion after presentation |

summarize the encounter with learners and encourage further personal reflection and analysis in order to guide and enhance the next encounter [37].

#### 7.3.1.2 Making It Happen

Trainee educators (i.e., residents and fellows) who participate in teaching may seek credibility and feel compelled to craft overly detailed presentations that emphasize exhaustive knowledge rather than carefully selected learning objectives that can enhance patient encounters. Overly detailed, instructor-centric presentations can overload learners and shut down effective learning. Shorter, well-conceived presentations done at the bedside, highlighting two or three important teaching points, can be extremely effective and may actually improve retention of information [33].

A variety of techniques are commonly used to facilitate learning at the bedside and merit consideration. Mini-chalk talks are brief (1–3 minutes) teaching opportunities using a writing utensil and a writing surface. They are easy to implement and can be extremely effective [38, 39]. This approach creates a dynamic, interactive, and relevant learning environment that can be used when rounding with large teams or in outpatient clinical settings with a heterogeneous group of learners. Additionally, this teaching method has the advantage of allowing for presentation of multiple short topics during rounds. Examples of visuals which work well in mini-talk format include [22]:

- Venn diagrams for comparison of diseases
  - (e.g., COPD and asthma, Fig. 7.1)
- Simple tables for grouping features of diseases
  - (e.g., lab findings in different types of pleural effusions, Fig. 7.2)
- Drawn pictures of clinical findings
  - (e.g., ventilator waveforms, Figs. 7.3 and 7.4)
- Treatment flowcharts
  - (e.g., asthma action plan, approach to diabetic ketoacidosis)
- Timelines
  - (e.g., disease progression, Fig. 7.5)
- Simple graphs of physiological or pathophysiological concepts
  - (e.g., oxyhemoglobin dissociation curve)
- Two by two tables for providing a paradigm of comparison
  - (e.g., modes of ventilation)
- Concept maps
  - (e.g., CHF, Fig. 7.6)

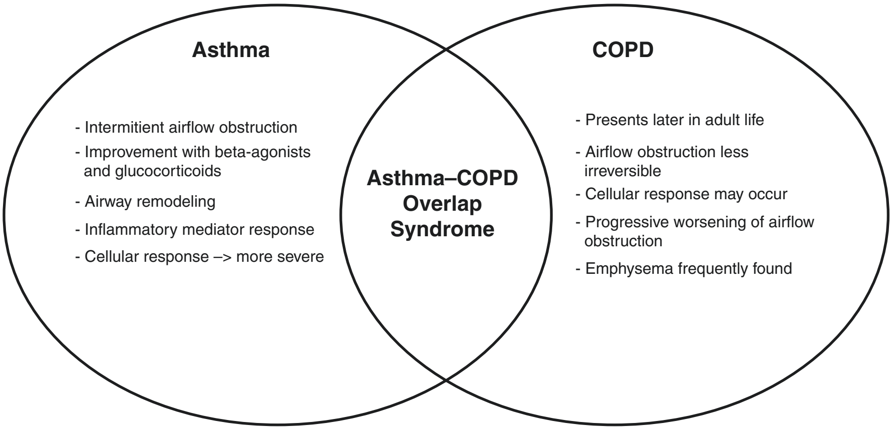
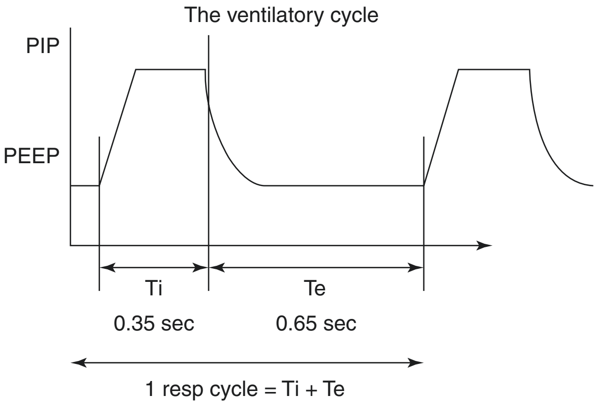



**Fig. 7.1** COPD and asthma

| Criteria | Exudate | Transudate |
|---|---|---|
| 1. Appearance | • Straw,<br>• Purulent,<br>• Chylous<br>• Bloody | • Clear<br>• Serous |
| 2. Protein | > 3 grams | ≤ 3 grams |
| 3. Glucose | Low | Normal |
| 4. Cholesterol | > 60 mg/dL | ≤ 60 mg/dL |
| 5. Pleural LDH | > 2/3 of upper limit of normal serum LDH | ≤ 2/3 of upper limit of normal serum LDH |
| 6. Pleural LDH : serum LDH | > 0.6 | ≤ 0.6 |
| 7. Pleural protein : serum protein | > 0.5 | ≤ 0.5 |
| 8. Δ Serum to effusion albumin | < 1.2 g/dL | ≥ 1.2 g/dL |

**Fig. 7.2** Simple table for outlining pleural effusion

**Fig. 7.3** Picture of respiratory cycle from a ventilator



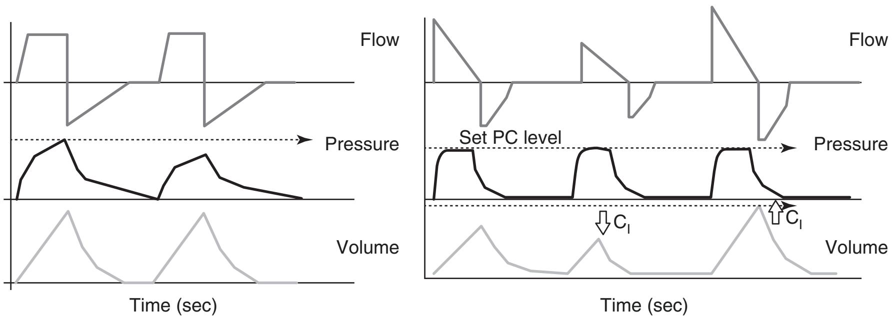



**Fig. 7.4** Picture of ventilator waveform showing volume and pressure control modes

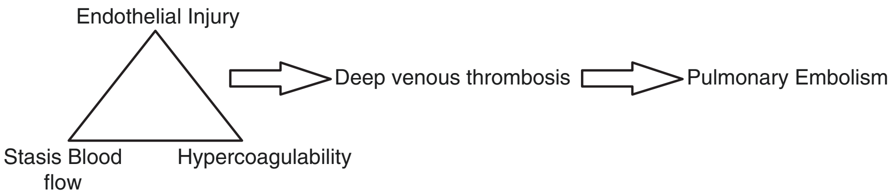
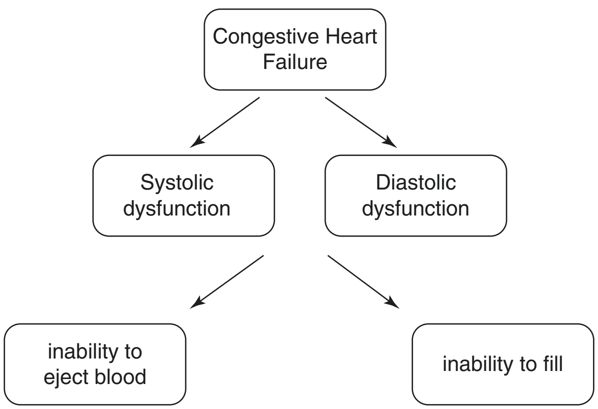



**Fig. 7.5** Pulmonary embolism progression

**Fig. 7.6** Simple concept map defining congestive heart failure




A highly effective approach is to assign 1–2 “chalk talks” to each learner which draws from a topic relevant to one of their patients. A valuable learning strategy involves asking the learner to demonstrate how they might convey disease-specific information directly to the patient. For example, a resident might be asked to explain the concept of “hypoxemia” to his or her patient with advanced lung disease. To do this effectively, the resident must not only understand the concept but also translate that medical knowledge into a framework accessible to the patient. The visuals that are used can then be directed toward specific details of the patient's case. As another example, for a patient with overt ventilator asynchrony, ventilator waveforms can be shown to trainees at bedside, and the instructor can demonstrate how to adjust settings in real time to improve synchrony. The use of visuals in conjunction with actual bedside examples reinforces learning. Finally, the ultimate goals are for learners to assemble their own repertoire of "chalk talks" that they can then use to teach others.

#### 7.3.1.3 Specific Framework for Implementing Bedside Teaching Session

Another unique approach to bedside teaching is the climate, attention, reasoning, and evaluation (CARE) paradigm [28]. The first element for optimizing bedside teaching is *climate*. Setting the appropriate tone and creating a safe and comfortable learning environment are key to a successful teaching session for patients and learners. As noted above, advanced planning can help avoid difficult bedside situations. Encouraging patients to interrupt, ask questions, and express fears or concerns is an effective strategy for developing rapport and partnership. Informing patients beforehand that a teaching discussion will take place that may not be directly applicable to their disease or plan of care is also imperative for a positive encounter and to diminish unnecessary stress or anxiety [28]. The CARE framework can be implemented in any clinical setting, from the outpatient clinic to the ICU.

Teaching before entering the room helps maintain *attention* of your learners. Prior to a patient encounter, developing a plan helps all team members, including the educator, focus and attend to specific objectives for the bedside teaching session. Examples of focused encounters include motivational interviewing, performing a detailed history and physical for a specific complaint, and reviewing the plan of care for the day. Keeping the content relevant for all learners is crucial, especially when dealing with patients with several complex, chronic health issues. The learning value of such situations can be increased, by posing theoretical situations (i.e., what if the patient's ventilator is reading high pressure?). Such theoretical situations can add educational benefit to an otherwise routine clinical encounter. Finally, the educator can set a democratic tone at the bedside so that learners feel liberated to add their input through a group rather than individual mechanism. A large, unsculpted group of learners at bedside can induce anxiety when an individual feels singled out to participate. One strategy to address this is for the educator to employ open-ended questions to encourage consensus participation [28].

Teaching clinical *reasoning* is well suited to bedside patient encounters. Probing, open-ended questions can encourage targeted physical examination that tests diagnostic hypotheses through direct intervention and observation [28]. The principal aim of the educator is to ascertain whether the trainee understands the rationale behind the diagnosis or treatment course. A further gauge of clinical reasoning can be made when the educator poses questions to the learner on behalf of the patient (i.e., what would you recommend to the patient if after this clinic appointment she were to develop increased wheezing?). This technique creates multiple opportunities for the educator to assess trainee knowledge, reasoning, and communication.

One final, but essential, element of bedside teaching is *evaluation*. Educators should alert learners to the process for providing formative feedback in advance [28]. If the educator plans to redirect or critique at the bedside in the presence of the patient, the learner should be alerted to this intention. By clearly establishing "ground rules" for the encounter, the educator prepares the learner for the receiving formative feedback and frames the experience in a positive way so that the feedback offered is not perceived as punitive but rather interpreted as an exercise for fine-tuning, modeling, or polishing bedside techniques and behaviors. Evaluators should avoid pointed criticism and encourage reflection after the encounter [28]. The ultimate goal of this input is to help to constructively modify learner behaviors in subsequent interactions.

#### Time Management

One of the biggest perceived barriers to bedside teaching is the lack of time. Given the significant interest from learners for bedside teaching and the significant demands on physicians' time, some specific strategies can be employed to improve teaching skills and maximize bedside efficiency. At the start of clinical service in the inpatient setting or at the beginning of an outpatient clinic session, setting ground rules with learners and informing them of expectations are vital [28]. Informing patients and family members about bedside rounds prior and encouraging them to participate and to ask questions during the encounter further the model of a strong physician-patient interaction.

As stated above, the teacher should prepare teaching points prior to rounds or prior to clinic and decide which patients would provide the best learning opportunities for the trainees. Encouraging hands-on skills demonstration and targeted observation allows learners to remain engaged [37]. If the educator does wish to engage in "what-if" types of scenarios, it is essential to clarify to the patient that these discussions are theoretical and may not be directly applicable to his/her case [28]. In general, lecturing should be avoided, and the emphasis should be placed on creating or capturing teachable moments. The clinical teacher should summarize teaching and learning points in front of the patient before leaving the room, although more detailed patient education may need to be deferred or delegated to a future encounter or another team member outside of the context of the bedside teaching session [28].

## 7.4 Summary

Once a mainstay of medical education, bedside teaching has been relegated to a supporting role on most inpatient services. This trend is in large part due to the misperception that bedside teaching must always be time and effort intensive and inefficient and that bedside teaching is perceived as a threat to the objectives and demands of busy clinical obligations. However, with forethought and preparation, bedside teaching can be an effective and efficient means of cultivating a rich, robust learning environment among educators, trainees, and patients. When planned carefully, bedside teaching can serve as a highly effective technique for multidisciplinary patient-centered care and increase both patient and provider satisfaction. Medical educators may find that re-embracing the tradition of bedside teaching can enhance the training of new physicians by re-emphasizing communication, patient connection, and compassion.

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# Chapter 8
# Teaching in Clinic

**Nirav G. Shah and Nikita Leiter**

## 8.1 Why This Matters

The majority of healthcare in the United States takes place in outpatient settings, and ambulatory care will continue to expand as emphasis shifts toward decreasing healthcare costs, reducing hospitalizations, and shortening lengths of stay [1–3]. As such, the Accreditation Council for Graduate Medical Education (ACGME) Program Requirements for Graduate Medical Education in Pulmonary Disease and Critical Care Medicine stipulate that trainees must be well-equipped to practice independently in managing a wide range of diseases in the ambulatory setting [4].

The ambulatory setting has advantages for learners given that patients are often easier to interact with and less acutely ill. It offers unique learning opportunities not present in the inpatient setting, such as time and opportunity for preventative health counseling, and the chance to view illnesses in both the early and late stages of presentation, ideally fostering an understanding of the longitudinal impact of diseases on patients and their families [5, 6]. Additionally, in the ambulatory setting, there is the opportunity to see several patients with the same problem over the course of a day, providing a natural reinforcement of concepts learned.

While spending time in clinic is an important asset to trainee education, teaching effectively in the ambulatory setting has its unique challenges. The foremost challenge is time constraints. The preceptor has to find time to assess and address the patient's needs, which can be variable and unpredictable with each visit and also provide both the trainee and the patient with relevant education [6]. The outpatient

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_8

clinic visit is primarily driven by the patient's agenda, which is often not known until the time of the visit. This relative lack of control can make it difficult to simultaneously meet the needs of patient and the learner [5]. Cases can be surprisingly complicated, and comprehensive clinical information is not always available before medical decisions are required. Additionally, there are pressures to see a sufficient number of patients to generate revenue and to complete clinic sessions on time to avoid staff overtime and job dissatisfaction.

Patient satisfaction is also an important concern. The presence of a medical student can add 32 minutes to a clinic session [7], and in a trial randomizing patients to be seen by an attending only versus an attending with a medical student, patient satisfaction with the overall visit tended to be higher when they were seen by the attending only [8]. Patients may be frustrated by the delays imposed by teaching, or confused about who is responsible for their care [9].

Given these multiple challenges, it can be difficult to find time to observe and teach trainees and provide feedback in the ambulatory setting [5]. In a survey of 4th-year medical students at multiple medical schools, 35% of students reported that no faculty member had ever observed them performing a history and physical [6]. For higher-level learners with more autonomy, few outpatient cases (based on observational studies, about one-third of cases seen by residents) end up being discussed with the attending physician, and even fewer patients (2%) are examined by them [6, 7]. This may also be dependent on the ratio of attending physicians to trainees, and this often decreases in advanced training. As a result, whereas in the inpatient setting trainees have the opportunity to discuss and confirm their findings with multiple other physicians, the outpatient setting has the potential to make students, residents, and fellows feel isolated and vulnerable if they are practicing alone in an exam room [1].

Finally, residents and fellows may have ongoing inpatient duties that distract their focus from clinic [10], and they may not have adequate administrative support to help them balance these duties. Exposing trainees to a suboptimal clinic setting may have the unintended consequences of discouraging outpatient care in their future careers [11].

This chapter discusses methods and suggestions for leveraging the opportunities of teaching in clinic as well as addressing the challenges to providing effective teaching in the ambulatory setting. To create an environment conducive to optimized teaching and learning without negatively impacting patient care, this chapter begins with suggestions for modifying the clinic environment and scheduling process. Specific teaching techniques for the ambulatory setting are also outlined, including empowering and equipping trainees to take ownership over their learning. Finally, methods to supplement direct patient care in providing ambulatory education are reviewed.

## 8.2 Adjusting the Clinic Environment to Facilitate Learning

As mentioned above, while the outpatient clinic is a rich and valuable learning environment, part of the challenge of teaching effectively in the ambulatory setting is related to a relative lack of control over workflow and time when compared to the inpatient setting. However, there are certain elements of the clinic environment that *can* be controlled. Specifically, there are ways that a clinic's structure, procedures, and processes can be modified to achieve an ideal setting for learning.

### *8.2.1 Integrating Trainees into Clinic*

As much as possible, trainees should be made to feel that they are a part of the clinic. A thorough orientation for learners led by clinic staff and preceptors should become routine and protocolized. Table 8.1 outlines various topics that should be addressed in such an orientation. An inadequate orientation can lead to confusion among learners and diminished use of learning opportunities and resources [5]. Prior to starting any rotation or new clinic, learners should be encouraged to seek out such an orientation from the staff, if it is not provided, and to determine what their personal goals are for the time that they spend in clinic. For trainees who will be in the same clinic throughout their training, consider providing them with mailboxes and adding their names to the list of physicians on the office wall to help integrate them into the practice [7]. Providing long-term trainees with printed business cards will also help them feel more a part of the clinic team and may even improve patient satisfaction [12].

### *8.2.2 Engaging the Patients and Clinic Staff*

Fully integrating trainees into the office will require cooperation and buy-in from patients, clinic staff, and preceptors. One could consider placing signs or brochures

**Table 8.1** Responsibilities for orientation to clinic

| | |
|---|---|
| Staff | 1. Introduce staff (names and roles) to the trainees |
| | 2. Show trainees where to store belongings, food, etc. |
| | 3. Explain the patient flow through the clinic (i.e., check-in, vitals, rooming, checkout process) |
| | 4. Instruct trainees on what clinic resources are available (i.e., medication samples, PFTs, radiology, phlebotomy lab) and where to locate these services |
| | 5. Provide a list of commonly used phone numbers |
| Preceptors | 1. Outline expectations for the learner |
| | 2. Provide an overview on how to effectively and properly use the electronic medical record in the outpatient setting (e.g., note templates, where to find PFTs, how to document a visit, how to provide patient instructions, etc.) |
| | 3. Educate the trainee on what to consider in billing for an outpatient visit. Provide brief overview of common billing codes used |
| Learners | 1. Seek out orientation from staff and preceptor if it is not provided |
| | 2. Determine personal goals for the time spent in clinic – come with a list of learning objectives |

in the waiting room to let patients know that the clinic participates in training doctors. Such signage could prepare patients for the possibility that they may be seen by a trainee and encourage their cooperation with the medical education component of the clinic [7].

An introductory meeting for staff is also needed to explain the importance of ambulatory teaching in Pulmonary Medicine, the various levels of trainees that will be in the office, and the roles that these trainees will play. Soliciting the staff's input on how to best incorporate trainees into the office may also provide some useful insight and may empower the staff to take some ownership over educating trainees. Staff should be instructed to direct phone calls from patients to the trainee who saw the patient, as learning how to address these calls is an important component to students', residents', and fellows' education. Nurses and respiratory therapists can be encouraged to instruct trainees on standard office procedures, such as obtaining an ECG, performing spirometry, and drawing blood for laboratory analyses [7]. If there is a pharmacist in the office, trainees would benefit from learning how to administer inhaled medications properly, so that they can then directly instruct their own patients.

### *8.2.3 Scheduling Patients*

A teaching clinic will not, and arguably should not, function exactly the same way as a nonteaching clinic; adjustments will need to be made given that effective teaching takes planning and time, and trainees will take longer than experienced practitioners to complete a patient encounter. To improve the experience of not only the trainee but also the preceptor and the patients, there may be a role for altering the number of patients scheduled, the timing and length of appointment slots, and even the types of patients scheduled.

Although clinics may aim to minimize inefficiency by overbooking appointments, under-booking by approximately 5–10% will achieve minimal physician idle time and minimal patient wait time [13], whereas overbooking will result in minimal reduction in physician idle time with significant increases in patient wait time [14]. Additionally, in a teaching practice model, physician "idle time" is not idle, as this is time that preceptors can spend teaching. Therefore, block scheduling in a "rolling wave"-type model, leading to a pattern in which physicians work continuously while seeing a block of patients and then have a continuous block of free time between waves of patients [15, 16], or creating a schedule in which gaps are purposefully incorporated may be most conducive to teaching. Two sample schedules are shown in Figs. 8.1 and 8.2, one outlining a block schedule or modified rolling wave pattern and the other outlining a sequential schedule with gaps purposefully incorporated [15–17]. The sample schedules could be modified to reflect the number of rooms available and the number and level of trainees present in a clinic.

With regard to scheduling patients, another consideration may be to solicit volunteer patients who are interested in being "teachers." Attending physicians could

| A Sample Block Schedule | | | |
|---|---|---|---|
| | **Room 1** | **Room 2** | **Room 3** |
| 8:00 AM | Patient 1-Initial Resident | Patient 2–Initial Fellow | Patient 3 Attending |
| 8:30 AM | *Teaching time with resident and fellow on Patients 1 and 2* | | |
| 9:00 AM | Patient 4 Resident | Patient 5 Fellow | Patient 6 Attending |
| 9:30 AM | *Teaching time with resident and fellow on Patients 4 and 5* | | |
| 10:00 AM | Patient 7–Initial Resident | Patient 8–Initial Fellow | Patient 9 Attending |
| 10:30 AM | *Teaching time with resident and fellow on Patients 7 and 8* | | |
| 11:00 AM | Patient 10 Resident | Patient 11 Fellow | Patient 12 Attending |
| 11:30 AM | *Teaching time with resident and fellow on Patients 10 and 11* | | |

**Fig. 8.1** An example of block scheduling, in which patients are scheduled on the hour, as a group. Assuming the availability of three rooms and at least two advanced trainees, as patients arrive they can be placed into a room. This approach has been shown to result in longer continuous blocks of free time, which would be conducive to teaching. A slight modification to this would be a rolling wave pattern, in which patients are scheduled, for example, on the hour, 5 minutes after the hour, and 20 minutes after the hour. Both approaches help ensure that the next patient is ready to be seen as they are already in an exam room and give patients time to arrive for their appointments [15, 16]

| A Sample Sequential Schedule with Gaps Incorporated –2 Learners | | |
|---|---|---|
| | **Room 1** | **Room 2** |
| 8:00 | Patient 1 (Initial) LearnerA | Patient 2 (Follow-up) Learner B and Attending Patient 3 (Follow-up) Learner B and Attending |
| 8:30 | | |
| 9:00 | Teaching about Patient 1 Learners A & B, and Attending | |
| 9:30 | | |
| 10:00 | Patient 4 (Follow-up) Learner A and Attending Patient 6 (Follow-up) Learner A and Attending | Patient 5 (Initial) Learner B |
| 10:30 | | |
| 11:00 | | Teaching about Patient 5 (Initial) Learner A & B, and Attending |
| 11:30 | | |
| 12:00 | Lunch | |

**Fig. 8.2** A sample schedule with purposeful gaps incorporated for teaching time [17]

ask select patients, whose cases would be particularly educational to trainees, if they wanted to participate. Alternatively, the clinic could advertise in the waiting room, or query patients' interest during the check-in or checkout process. A volunteer patient registry could be used to schedule longer appointment slots with medical students and clinical teachers [7, 18]. This approach would allow attendings to directly observe students and give real-time feedback and for students to learn from motivated and engaged patients. Other models schedule certain patients in a teaching clinic and certain patients in a nonteaching clinic, depending on their preference [17].

### *8.2.4 Optimizing the Work Environment*

The physical work environment should be consciously designed to facilitate ideal learning conditions. There should be a centrally located "teaching room," with enough chairs and computers, where trainees can easily access an experienced clinician preceptor [19]. This requires adequate staffing so that learning is not hampered by lack of availability of a teaching physician to address learners' questions. Having a sense of how many clinic rooms are available at what times will help to determine how many trainees can be accommodated. There should be enough patient rooms for higher-level trainees to see patients independently and for the teaching physician to continue seeing patients, while medical students, who take longer with their clinical encounters, are seeing patients [7].

### *8.2.5 Scheduling Preceptors and Trainees*

There are no clear data on the optimal faculty member-to-trainee ratio in the ambulatory setting, nor on whether faculty members should see their own patients while teaching [9]; however, different organizational approaches might have variable effects on learning. One study employing computer simulation optimization analysis suggests that trainee-to-preceptor ratios between three and seven to one minimize flow and wait times and maximize revenue [20]. In this study, based on discrete-event simulation, flow time and wait time for patients in the base case (with four trainees and one preceptor) were 148 minutes and 20.6 minutes, respectively. The average time spent waiting for a preceptor by trainees was 6.2 minutes. Patient flow time and wait time remained relatively constant for trainee-to-preceptor ratios below 4:1 but increased steadily thereafter, regardless of the number of preceptors. With one or two preceptors, the waiting time for precepting increased steadily as the number of trainees increased [20].

Future studies may focus on evaluating the benefit of having one preceptor for a small group of learners versus having one learner paired with one preceptor for a given period of time to allow for a longitudinal educational experience. Another method that could be investigated would involve the learner identifying a specific preceptor for each unique encounter based on the clinical scenario and the individual faculty member's expertise.

### *8.2.6 Adjuncts to Outpatient Curriculum*

The outpatient curriculum should also afford trainees the opportunity to experience other important aspects of community care specific to the clinic's specialty, such as hospice care, teaching patients how to use inhalers, oxygen supply, and pulmonary function testing [7]. Additionally, advanced learners should be educated in billing and coding in the ambulatory setting and may even benefit from spending time with administrative staff to learn these skills. These additional learning opportunities should be built into a trainee's schedule, using days when the work environment may not be conducive to effective teaching (i.e., insufficient availability of exam rooms, patients, or faculty preceptors).

### *8.2.7 Inpatient Versus Outpatient Balance*

A final consideration in creating trainees' schedules is the balance of their inpatient and outpatient duties. Although there is evidence within Internal Medicine residency programs that conflict between inpatient and outpatient responsibilities is associated with an inability to focus on clinic and with lower resident and patient satisfaction [10], it is unclear if separating these duties is beneficial at the subspecialty training level. Most Pulmonary practice models still require practitioners to juggle outpatient and inpatient responsibilities. Fellowship training should ideally prepare trainees for what their ultimate practice model will be; however, one could argue that as trainees are still learning the management of pulmonary disease processes in the ambulatory setting, their learning may be enhanced by lightening these conflicting duties. Another consideration is that fellows often may not have the same administrative support available to them as faculty members, such that balancing outpatient duties while on being on inpatient services is particularly challenging.

Several potential approaches exist to help trainees achieve this balance, such as block scheduling, the use of advanced practice providers or "day floats" for inpatient coverage on clinic days, or designating a "fellow of the day" to manage outpatient messages and phone calls [10, 21, 32]. Block scheduling models using an "X + Y" approach, alternating inpatient rotations with dedicated ambulatory blocks, have been extensively studied and adopted within many Internal Medicine residency programs to help minimize conflicting inpatient and outpatient responsibilities.

Implementing such a schedule in a Pulmonary fellowship program would require an assessment of the program's size, educational and service priorities, clinic capacities, and number of trainees that could be relieved from inpatient duties at a given time [33]. Alternatively, to reduce strain on fellows rotating on intensive care unit services, a "Fellow of the Day" role could be assigned on a rotating basis to a fellow not actively on an inpatient service. In this model, rather than sending patient calls and messages to the fellow who saw the patient, the clinic staff would forward these calls and messages to the "Fellow of the Day," particularly if the fellow who saw the patient was on an inpatient rotation or away on vacation or leave. When this approach was piloted within the Pulmonary and Critical Care program at the Mayo Clinic, fellows reported spending less of their personal time or time away from critically ill patients to focus on patient care-related messages and paperwork, and there was no significant effect on faculty workflow [32]. Additionally, patients reported receiving responses to their messages more quickly [32]. Finally, coverage could be provided by an advance practice provider for fellows on the Pulmonary consultation service or other such inpatient services, on half-days while they are in clinic. Alternatively, two fellows could be assigned to services such as these, with different clinic days, so that they could cover one another while their counterpart is focusing on outpatient duties.

## 8.3 Teaching Techniques

As part of the effort to improve education in the ambulatory setting, a structured approach to teaching should be developed. This includes delineating the learner's responsibilities, identifying the learner's needs, and determining teaching techniques that are familiar and comfortable for the teaching attending. Different techniques may be more or less appropriate depending on the learner, the work environment, or time constraints.

### *8.3.1 The Learner's Responsibilities*

Sprake and colleagues outline three suggestions to create an effective and efficient outpatient learning environment: (1) orient the learners, (2) manage time, and (3) encourage learners to take more responsibility for their own learning [5]. Adult learners will best be served by taking ownership of their education and identifying and communicating their learning needs. Depending on the trainee, this approach to learning may need to be taught and encouraged, as education leading up to graduate medical training often relies on pedagogic instruction, and some trainees may be accustomed to information simply being provided [7].

In preparing for clinic, the expectation should be that learners review the charts of scheduled patients, extract pertinent data, and independently address some relevant knowledge deficits before clinic starts [5]. This will allow learners to come to clinic with a list of learning needs. Establishing a formal "learning contract" is one way to facilitate trainees' participation in defining their own learning objectives and taking ownership of their education – by sitting down together to define objectives, a focus for teaching points can be developed. This process can also serve to equip trainees with skills that they will use throughout their career to enhance their medical knowledge, learn to identify weaknesses or knowledge deficits, set learning objectives, and develop appropriate learning strategies [7, 23].

Another potentially useful suggestion to learners is to create a system for capturing and revisiting experiences after clinic [5]. A sample template is shown in Fig. 8.3. By keeping track of patients seen in this manner, the trainee maintains responsibility for following up on pending diagnostic tests. In addition, this approach provides a mechanism for trainees to record knowledge gaps to guide future study and inquiry. Finally, by linking topics to particular cases, deeper learning of disease processes and management approaches is achieved and may be more likely to affect future critical thinking and clinical behaviors [31].

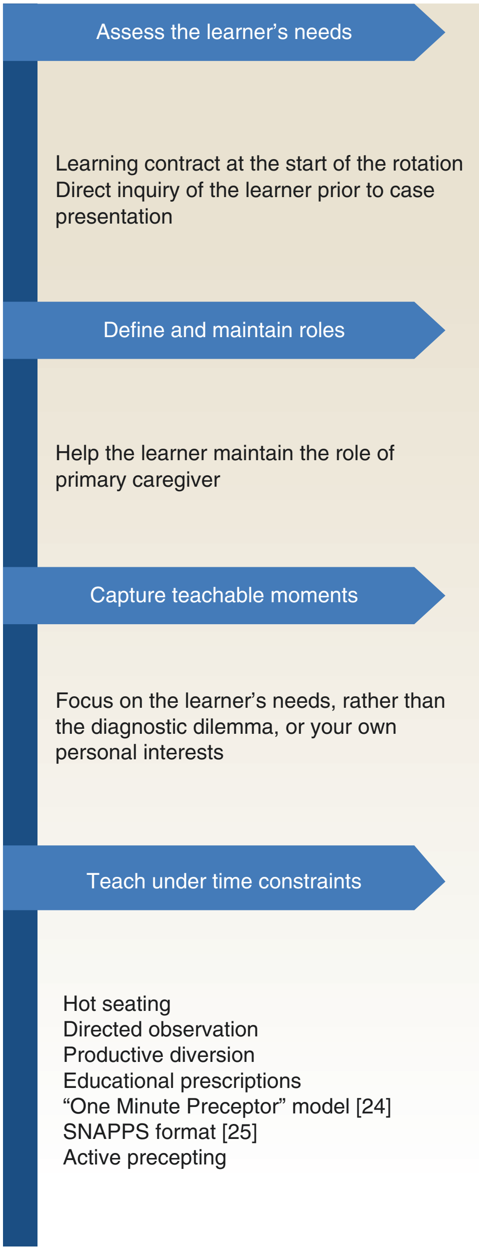
### 8.3.2 *Identifying the Learner's Needs*

The learner's needs should also be assessed on a case-by-case basis, after first identifying the patient's immediate needs for care. Assessing the learner's needs requires active, direct inquiry of the learner after the case presentation. For this reason, assessing the learner's needs is often omitted from teaching agendas. When teaching begins with direct clarification of the learner's needs, it identifies a learner-centered approach as a priority for the educator while simultaneously "forcing the learner to synthesize information and commit to a direction of analysis" [9]. Traditionally, synthesis and processing of information rested on faculty members, not the learners. As highlighted by Lesky and Borkan, attending physicians must focus on the learner, rather than the case, in order to capture teachable moments and move trainees closer to the goal of independence. Delineation of learning objectives and up-front discussions about the roles of the attending physician and trainee improve the chances that these objectives will be realized. This can then be followed by a traditional model of asking learners questions, making observations, and demonstrating exam findings while focusing on the clinical task of taking care of a patient. It may be best if bursts of clinical activity are followed by review periods to revisit teaching themes, address misconceptions, and direct further independent learning.

### 8.3.3 *Teaching Under Time Constraints*

Specific techniques need to be implemented in order to teach effectively under the time constraints encountered in the ambulatory setting. One method used in primary care outpatient clinics is "hot seating," where the attending physician hands over

**Fig. 8.3** Four suggestions for how to make teaching in the ambulatory setting effective and efficient [24, 25]



part of the consultation to the learner – literally changing seats with the learner. Important advantages of this method include the ability of the attending to observe and provide feedback while still managing the timetable of the ambulatory visit [22]. Directed observation can be a valuable tool to keep learners engaged during the encounter (e.g., "note how I explain idiopathic pulmonary fibrosis to the patient", or "write down your differential diagnosis").

Alternatively, "productive diversion" can be beneficial in a busy clinical practice where the learner is asked to see a patient further down the list and then present the history to the attending physician within a certain amount of time. Another popular technique that can broadly be applied in time-limited outpatient and inpatient situations is the use of "educational prescriptions" – the attending asks the learner specific questions that require more research and sets a specific time and place for follow-up [23]. Importance should be placed on discussing topics when they are fresh in the mind of the learner. The "hot review" method can occur at the end of a clinic session or after a burst of clinical encounters in order to be cognizant of the patient's time, the provider's time, and the need for dedicated teaching time.

Finally, using a "thinking out loud" technique will likely not add on significant time to the patient encounter, but can be invaluable for trainees. This technique requires faculty members to communicate their thought process out loud regarding how they think about and approach clinical scenarios. Listening to an experienced physician explain their thought process may help trainees gain confidence in approaching these scenarios independently [34].

The misconception that education takes a significant amount of time was addressed by Neher and colleagues with the One-Minute Preceptor model, where they identify five microskills of clinical teaching (Table 8.2) [24]. This approach requires that the attending have knowledge about the case and that the learner needs and wants to know what the attending knows, tying together the concepts of identifying individual needs of a particular learner and capturing teachable moments.

**Table 8.2** Five microskills for clinical teaching [24]

| Clinical teaching microskill | Description |
|---|---|
| Get a commitment | Encourage a learner to identify the most likely cause of a patient's symptoms |
| Probe for supporting evidence | Ensure that the learner identifies and contextualizes pertinent positives and negatives with regard to his or her differential diagnosis |
| Teach general rules | Emphasize mechanistic concepts, evidence-based practice, and/or clinical practice guidelines that can be applied broadly in clinical practice |
| Reinforce what was right | Highlighting accurate clinical reasoning and correct clinical decision-making helps learners understand what they did well |
| Correct mistakes | Empathetically identifying and describing how to avoid clinical reasoning mistakes in future encounters is important for mastery learning |

Another teaching technique that has similar features to the One-Minute Preceptor, but is more learner-driven rather than teacher-driven, is the SNAPPS format – **s**ummarize the case, **n**arrow the differential, **a**nalyze the differential, **p**robe the preceptor, **p**lan management, and **s**elect an issue or topic for self-directed learning [25]. Having the learner present a case in this way is meant to redirect but not lengthen the learning encounter, condensing the reporting of facts and emphasizing the expression of reasoning and uncertainties by the learner.

In one study [25], 3rd-year medical students who used SNAPPS to present cases during their family medicine rotation were compared to students who used a standard presentation style. Students in SNAPPS group offered more than twice as many diagnoses, compared and contrasted diagnostic possibilities more often, justified their diagnostic possibilities five times more often, and formulated significantly more questions and uncertainties [25]. Additionally, students using SNAPPS identified case-related reading in more than 50% of their presentations, and the identification of either student-initiated or preceptor-initiated reading selections actually occurred *only* among students using SNAPPS. Of note, there was no significant difference in presentation time between students in the SNAPPS group and students in the usual presentation group [25].

Educating patients is also an instructional experience for trainees in clinic. Using role modeling and directed observation, preceptors can instruct trainees how to provide counseling on important topics such as smoking cessation, inhaler use, and descriptions of disease processes. Observing and actively listening to advanced care planning discussions is also instructional for trainees. Preceptors can use time in a patient's room to educate both the patient and the trainee by simultaneously talking about a disease process at a level the patient will understand, with intervening pearls or teaching points for the trainee. When doing this, it is important to explain this process to the patient, specifically broadcasting that the preceptor may intermittently "speak in medical terms" during the discussion.

There may be topics relevant to patient education that trainees would be best served learning from other specialized providers, such as how to troubleshoot positive airway pressure and oxygen delivery devices or how to explain pulmonary rehabilitation. These may be opportunities for trainees to spend time away from clinic working with these other services.

### *8.3.4 Active Precepting*

Active precepting is another tool that can help accomplish the goals of identifying learners' needs, establishing a teaching agenda, and running an efficient clinic. The POwER model of active precepting in residencies was outlined by Lillich and colleagues and included roles to **p**repare, **o**rchestrate, **e**ducate, and **r**eview. Preceptors arrive prior to the start of the clinic session to informally huddle with trainees and staff to organize the session for efficiency and to empower everyone involved to share the care of the patients and anticipate needs. Translating this model to a

Pulmonary and Critical Care Medicine training program may involve identifying specific patients that the fellows should plan to see, or reviewing relevant imaging before clinic starts. It also may be helpful to alert the clinic staff ahead of time about patients who will likely need ancillary testing such as spirometry or EKGs during their visit.

The preceptor then orchestrates care during the clinic session by circulating into the patient care area and providing timely assistance and mini-huddles throughout the session to fellows or staff, as well as being available in the staffing room [26]. To educate efficiently and meet learners' needs during consultative sessions, preceptors can use teaching microskills (see Table 8.2) [24] or encourage use of the SNAPPS presentation format [25]. Finally, after clinic, the preceptor, fellow, and clinic team review what could be been done to enhance patient flow, whether patient needs and expectations were met, whether clinical guidelines were followed, what they learned from their patients, and what learning issues they will pursue after the clinic session.

Interestingly, when the POwER model has been used in residency programs, preceptors reported reviewing residents' clinic schedules more often prior to clinic sessions, and clinic staff reported that residents and faculty were more willing to help solve problems [26]. Concurrent flow studies showed that patient time in clinic decreased from 110 minutes before using the POwER model, to less than 70 minutes after introducing the POwER model. Furthermore, resident time with patients, including precepting time, decreased from 44 minutes to less than 30 minutes [26]. Active precepting using the POwER model can be translated to all levels of learners, including medical students, residents, and fellows, with likely beneficial effects at all levels. Figure 8.4 summarizes the techniques discussed here to help make teaching in the ambulatory setting effective and efficient.

**MRN**: 1234567

**Diagnosis/complaint:**
Dyspnea, restriction on prior PFT's

**Therapies initiated or changed:**

**Interesting aspects/Things I learned:**
Dental lab tech = risk factor for beryllium exposure
Pathology for berylliosis = non necrotizing granulomas

**Studies for follow up:**
[ ] labs
[ ] PFT's
[ ] CT chest

**Questions to look up/ask:**
Blood BeLPT
Treatment?

**Fig. 8.4** Encourage fellows to develop a method for capturing and revisiting experiences after clinic. A sample template that could be suggested or provided to learners is shown here

### 8.3.5 Teaching Techniques to Avoid in the Outpatient Setting

While some teaching techniques are particularly suited to enhance education in ambulatory settings, some techniques should be avoided. For instance, when an attending physician enters a room after a learner and asks questions or performs parts of the physical exam that may have been omitted, it can undermine the ability of the learner to achieve the goals outlined above. It has been shown that adult learners are most effective when given primary responsibility to solve problems and/or communicate with patients [1]. A more effective strategy may be to discuss these omissions with the learner prior to seeing the patient together and then have the learner return to the room to ask additional questions or perform omitted portions of the exam. This allows the learner to maintain the role of primary healthcare provider and allows the preceptor to observe the learner performing components of the history and/or physical exam.

In addition, when preceptors repeat or rephrase questions too quickly, this can hinder active thinking and does not allow the learner sufficient time to formulate well-thought-out answers. Increasing wait time for a response can address this issue [35, 36]. Leaving some of the learner's questions unanswered can stimulate independent inquiry and foster self-directed learning, particularly if the preceptor encourages and provides time for the learner to present the answers to such questions at future clinical sessions [1]. Lastly, focusing on the diagnostic dilemma rather than the learner can be enticing given the complexity of some cases; however, this will result in missing teachable moments and inhibit the learner developing independent thought and action.

## 8.4 Supplementing Ambulatory Education

Although the majority of patient care is provided in the outpatient setting, trainees spend most of their time in the inpatient setting. ACGME requirements for 3-year Pulmonary and Critical Care Medicine fellowship programs only require one half-day of clinic weekly for 30 months [4], which amounts to only 6% of total training time. Residents and students assigned to ambulatory rotations are also frequently on "back-up" or "sick" call, potentially resulting in abbreviated and/or fragmented outpatient experiences. Trainees therefore cannot rely solely on direct engagement in patient care to acquire sufficient ambulatory education. Additionally, learners' education during clinic sessions is limited to interactions between themselves, patients, and attending physicians, and due to time constraints, they may not have the opportunity to fully discuss all important points of cases with experienced clinicians. To overcome this limitation, ambulatory education needs to be supplemented, preferably with collaborative learning opportunities. Various options to help provide supplemental ambulatory education in a training program include implementing a formal ambulatory curriculum, holding a case review prior to or after clinic sessions, and encouraging faculty and fellows to present interesting outpatient cases in teaching conferences.

### 8.4.1 An Ambulatory Curriculum

A case-based curriculum focused on evidence-based management of basic Pulmonary and Sleep Medicine disease processes has been designed by Kassutto and colleagues [27]. This curriculum uses case-based teaching scripts which incorporate relevant literature to teach practical clinical management and decision-making for 20 core outpatient Pulmonary topics. The Kassutto curriculum is similar to the "Yale Office-based Medicine Curriculum" [28] that is used in many Internal Medicine residency training programs. Implementation of this curriculum within the University of Pennsylvania's Pulmonary and Critical Care Medicine fellowship program via twice-monthly 30-min conferences improved fellows' opinion of their ambulatory education and their perceived competency in ambulatory management of Pulmonary issues [27].

Without a control group of fellows who did not participate in the curriculum, it is unclear if this improvement in perceived competence was simply related to the natural progression of the fellows through their training or directly related to the implementation of the curriculum. However, these limited preliminary data suggest that there is feasibility, and potential value, in implementing a structured outpatient pulmonary ambulatory curriculum, and this is a worthwhile area for further study.

### 8.4.2 Case Review of Clinic Sessions

Another option for supplementing ambulatory education is to hold a case review for experienced learners, either prior to or after clinic sessions. A case review would be useful for trainees who are expected to have more autonomy, such that each patient would not need to be seen by the attending physician [6]. One model for conducting such a review after a clinic session was first described in 1989 in the Primary Care Program at the Montefiore Medical Center and has since been updated and adapted for use in other residency programs [29, 37]. In the initial study, residents spent 2–3 minutes completing a standardized "Clinical Encounter Form" after each visit, which outlined the reason and specific details of the visit, any therapies initiated or modified, diagnostic tests ordered, and any other psychosocial or other special considerations. All forms were submitted to the attending after the clinic session, and the attending then reviewed them and chose a few cases to focus on during a morning conference the following day to highlight certain teaching points. Residents rated this educational intervention highly in follow-up evaluations [29].

Alternatively, having residents or fellows review charts and extract relevant information before the session and then conducting a case review with an attending prior to clinic may help streamline the clinic session. A prospective quality improvement project conducted in the Johns Hopkins Pain Clinic revealed that by having attending physicians invest 25–42 minutes ahead of the clinic session reviewing cases with trainees, total patient wait time was reduced by 175 minutes, and overall duration of the entire clinic session was reduced. Residents reported feeling more confident during the patient encounter. The time that patients spent interacting with physicians (either the trainee or the attending) was not changed [30].

There are multiple other potential benefits to reviewing cases prior to clinic in a conference-type setting. Trainees could get guidance in how to manage difficult cases ahead of time, rather than when the patient is waiting, allowing them to discuss more aspects of the case in greater detail. Additionally, if a resident or fellow does not have to leave the room in the middle of the encounter to talk to an attending, or bring an attending in, they may be able to more easily maintain their role as the primary caregiver role for the patient, and this may help minimize patient confusion and contribute to improved patient satisfaction. Finally, a significant benefit of creating such a conference would be that other trainees could learn from the cases presented and could even contribute to providing education [6].

One prominent downside to ambulatory practice is that trainees often end up isolated in an exam room, and they do not have the opportunity to discuss the case with multiple physicians and compare viewpoints, as they may be able to do in the inpatient setting. A case review conference conducted prior to a clinic session would thus serve multiple purposes, including helping to streamline the clinic session for the patients, trainees, attending physicians, and staff and enhancing trainees' education via team learning.

### *8.4.3 Presenting Ambulatory Cases in Conference*

Finally, fellows and faculty should be encouraged to present complicated or interesting outpatient cases in a conference setting as a case report from beginning to end, if and when a definitive diagnosis is achieved. This serves several purposes for learners. They are able to see how an experienced physician approaches the outpatient workup of various complex disease processes and along the way speculate on the various diagnoses that should be considered. Seeing cases presented from beginning to end would help address lack of continuity present in residents' and fellows' fragmented ambulatory training. Conducting such case presentations in a social learning atmosphere will foster reflection on prior experience, and discussion among different providers regarding how a particular problem might be approached.

For any one particular case, while some providers may take a more conservative observational approach, others may opt for medical therapies, and others may choose to pursue bronchoscopic or surgical procedures. Trainees have the opportunity to consider all these perspectives and learn from the different viewpoints and arguments. Additionally, by presenting a case with a known diagnosis, trainees will be able to learn from the actual outcome of the particular approach(es) taken. Seeing workups for different pulmonary diseases unfold in the case presentation can be invaluable in guiding future practice. This approach would likely also help trainees feel more comfortable dealing with uncertainty in their own practice, which can be a difficult concept to accept and to communicate to patients [19].

## 8.5 Conclusion

While teaching effectively in the outpatient setting can be challenging, the experience is extremely valuable for trainees and rich in learning opportunities. Thus, improving the quality of ambulatory medical education should be a focus of teaching physicians and requires a multifaceted, thoughtfully executed approach. Potential suggestions discussed in this chapter include modifying the clinic environment and scheduling processes, using specific teaching techniques tailored for use in time-constrained settings, and incorporating collaborative learning opportunities. An important goal must also be to empower trainees to take ownership of their learning. Mindful reflection on how the experience of teaching in clinic can be improved for learners, teachers, and patients will prove invaluable to all parties, and we anticipate that implementing some of these suggestions will result in better training for future Pulmonary physicians.

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# Chapter 9
# Teaching on the Inpatient Pulmonary Consult Service

**Samuel P. Wiles and Rendell W. Ashton**

## 9.1 Experiential Learning

By combining education with specialized clinical care, the pulmonary consult service provides an environment of progressive experiential learning that addresses the needs of learners and patients alike. Each patient encounter provides an opportunity for the learner to build both deeper understanding of pathophysiologic mechanisms contributing to pulmonary signs and symptoms, as well as illness scripts by matching clinical clues to principles of medical knowledge, a process essential to the recognition, diagnosis, and treatment of specific pulmonary conditions. Furthermore, the juxtaposition of different pulmonary diseases with similar presentations afforded by rotating on the pulmonary consult service allows the learner to appreciate clinical subtleties that may not be obvious otherwise. The ability to provide a longitudinal service also allows for repeated cycles of planning, intervening, assessing, and modifying care that encourages the learner to challenge pre-existing cognitive biases when expected outcomes do not match results and reinforce knowledge across a continuum of pulmonary disease. With multiple cycles across varied patient encounters, the learner becomes better able to recognize slight differences in presentation and disease course unique to individual patients, thereby improving his or her ability to provide the highest level of patient-centered, individualized care.

## 9.2 Clinical Focus

Determining the "reason for consult" and addressing a focused question appropriate to the expertise of the consultant is essential to the process of effective consultation

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_9

[1, 2]. The types of questions asked of the consulting service will largely depend on the institution and the comfort of the primary provider with managing different pulmonary conditions. The process by which consults are vetted through a primary team nonetheless allows for selection of a breadth of potentially rare and interesting cases for the consultant that may not be routinely encountered on a primary service. This in turn provides the opportunity to tailor teaching focused on unique pulmonary physiology and pathology. Topics may range from management of an uncomplicated asthma exacerbation to acute respiratory failure in an immunocompromised host – each case presenting an opportunity to teach from pathophysiologic principles to clinical assessment and diagnostic confirmation to management in a comprehensive and longitudinal fashion.

## 9.3 Recognizing Learners in the Consult Environment

Learners in the consult environment can be divided into several groups: the consulting team; the primary service; other consulting services; and the patient and/or family. The type and extent of teaching will vary based on the grouping of the learner(s). Members of the consulting team may also differ substantially in training (i.e., physician, nurse practitioner, physician assistant) as well as experience (i.e., medical student, internal medicine [IM] resident, pulmonary fellow). Appreciating such differences is essential to the process of appropriately tailoring teaching content and maximizing learning [3].

### *9.3.1 Primary Team*

While the majority of time may be devoted to teaching the members of the pulmonary consulting team, communication with the primary team, other consultants, and the patient and/or family are all integral parts of effective consultation, and present opportunities for valuable teaching. Providing rationales for clinical decision making offers necessary insight into the disease process for the primary team and better enables them to comprehensively care for the patient. Establishing open lines of communication with the primary team can also help the consultant team identify potentially missing or confounding information that may not have been evident from the history. This can in turn help to better characterize the disease process and improve the overall consultative recommendations and the care plan [1, 2]. Short and succinct teaching points are best when teaching medical knowledge to the primary team, as clinical volume for both services and competing responsibilities typically limits the potential for formal didactics. Face-to-face communication between teams is most effective and efficient, since it provides opportunity for questions to clarify conclusions and recommendations. Sometimes inter-team communication is limited to notes placed in the medical record. This is not ideal for teaching but still affords opportunities to provide relevant learning through provision of published guidelines or clinical studies pertinent to the clinical question being addressed [4].

### 9.3.2 Other Consulting Teams

Communication and coordination with other consulting services – particularly when dealing with a medically complex patient – can be paramount to providing consistent and comprehensive patient care. Conflicting opinions from members of various teams can lead to confusion and frustration on the part of both the patient and the primary team [1, 2]. For this reason, it is best to establish similar lines of information transmission with other consultants as with the primary team. Exchange of impressions from different perspectives will serve not only as a means of getting everyone "on the same page" but may also be an opportunity to reflect and appreciate the role other organ systems may be playing in the disease process. As with interactions with the primary team, education in this setting should focus on succinct teaching points and resources for independent learning given the time constraints associated with differing responsibilities and degrees of clinical volume.

### 9.3.3 Patients and Families

Consultants play an important role in patient education in the inpatient setting. That being said, the pulmonary consultant must be aware of the potential for conflicting messages being provided to the patient by different services (Fig. 9.1). For this reason, it is always best to communicate with the primary team and other consulting services before educating a patient and his or her family about the disease process and clinical plan. Keeping the comprehensive care of the patient in mind when addressing the pulmonary contributions to illness, and getting a sense of both the short- and long-term goals of care before explaining the rationale for treatment are extremely important. While the pulmonary process may be reversible, other components of the patient's health may limit the utility of providing treatment. When educating the patient and his or her family, one should always assess the patient and family's level of health literacy, as well as the amount of information they would like to be provided and how it is best delivered. Teaching in this setting differs significantly from educating those with a medical background - simple, patient-centered language is mandatory [5]. Use of analogy is often helpful, specifically when the patient has an educational or vocational background amenable to its use. In counseling patients, the pulmonary consultant also has the opportunity to teach the team on best practices for communication. Sitting down for the discussion and maintaining eye contact while providing support both in the form of empathetic language and physical gestures can be demonstrated and taught at the bedside, and are valuable skills for those at all levels of training [6].

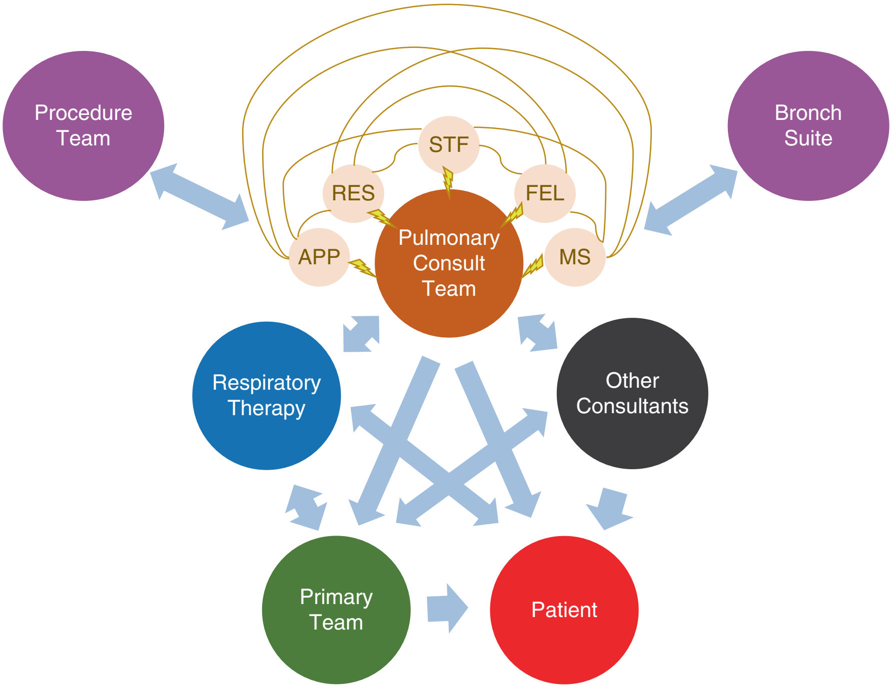


**Fig. 9.1** Complexities of education and communication while on the pulmonary consult team. APP advanced practice provider, RES resident, STF staff, FEL fellow, MS medical student

### *9.3.4 Pulmonary Consult Team*

Prior to initiating a teaching session for the pulmonary consult team, it is extremely important to assess and appreciate the learners' levels of training and to tailor the content appropriately. For example, basic pathophysiology and clinical presentations of various pulmonary diseases would be more appropriate content for a medical student in the early stages of his or her medical career than for a pulmonary fellow, who would generally be better served by topics involving management of more complex disease states. Using a variety of techniques and resources is important, as adult learners differ in their preferred methods of education and will vary with regard to the amount of information retained by active versus passive learning [7]. Empowering the learner to become a teacher can also be extremely effective in promoting self-directed learning and independent knowledge acquisition, and ultimately can benefit all team members. Content and techniques to maximize learning for those with varying degrees of medical knowledge will be further addressed in the next section.

## 9.4 Unique Teaching Opportunities: Content and Delivery

As previously alluded to in Sect. 9.2 *Clinical Focus*, teaching on the pulmonary consult service has the distinct advantage of providing a breadth of diverse clinical cases from which to educate. Because cases are "screened" by the primary service with a specific question being asked, the clinical encounters tend to be focused and based in the area of expertise of the consultant, which for many clinical educators raises the value of the cases for teaching. Furthermore, because the reason for consult is not known in advance, teaching on the pulmonary consult service has the advantage of being *ad hoc*, which provides spontaneity and flexibility to the learning environment [3, 7]. A given teaching session that stems from a consult can have a narrow focus (i.e., diagnosis of pulmonary sarcoidosis) but can also be extrapolated to incorporate more generalized themes (i.e., the differential diagnosis for acute hypoxemic respiratory failure). By focusing more or less broadly in this way, often the same clinical case can provide useful and engaging pearls for learners of widely different experience levels.

### *9.4.1 Standard Curriculum*

Because the types of cases encountered during a rotation are not known in advance, it can be very useful to establish a standard curriculum addressing the conditions most commonly seen on the consult service. Having such a curriculum also has the advantage of providing a baseline expectation for medical knowledge that can bring learners at different levels up to speed (Table 9.1). Though pre-scheduled didactic sessions led by attending physicians, fellows, residents, or medical students can be used as a means of delivering this content, clinical demands may limit the amount of time available for didactic discussion. In such situations, the use of asynchronous teaching interventions such as online modules, video libraries, and podcasts can be extremely helpful in providing

**Table 9.1** Standard curriculum for the pulmonary consult service

| Topic | Sub-topics | Teaching modalities |
|---|---|---|
| Asthma | *Beginner*: Triggers, diagnosis and management | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate*: Severity assessment and management of asthma exacerbations | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: ABPA, pulmonary eosinophilia, bronchiectasis, ventilator management | *Advanced*: Literature review, bedside teaching |
| COPD | *Beginner*: Diagnosis and management, smoking cessation | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate*: Management of exacerbations | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: End-stage COPD, preventing readmissions | *Advanced*: Literature review, bedside teaching |

(continued)

**Table 9.1** (continued)

| Topic | Sub-topics | Teaching modalities |
|---|---|---|
| Pneumonia | *Beginner*: CAP/HAP/viral pneumonia | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate*: Opportunistic infections in the immunosuppressed, parapneumonic effusions and empyema | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: Mimics (i.e., ILD), chest tube placement | *Advanced*: Literature review, bedside teaching, procedural training/ simulation lab |
| Pulmonary edema | *Beginner*: Cardiogenic | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate/advanced*: Non-cardiogenic (ARDS) | *Intermediate/advanced*: Case-based discussion, literature review, bedside teaching, ARDSnet |
| Venous thromboembolism | *Beginner*: DVT/PE, anticoagulation | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate*: Moderate-/high-risk PE | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: CTEPH, thrombophilias | *Advanced*: Literature review, bedside teaching |
| Preoperative pulmonary risk assessment | *Beginner*: Risk assessment tools | *Beginner*: Online calculators, formal didactics, bedside teaching |
| | *Intermediate*: Assessment in advanced disease | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: Lung reduction therapies, lung transplant | *Advanced*: Literature review, bedside teaching, procedural workshops |
| Diagnostic testing | *Beginner*: Chest radiograph, PFTs | *Beginner*: Online learning modules, formal didactics, bedside teaching |
| | *Intermediate*: Chest CT, V/Q scan | *Intermediate*: Case-based discussion, bedside teaching |
| | *Advanced*: CPET, bronchoscopy | *Advanced*: Simulation lab, procedural training |

*ABPA* allergic bronchopulmonary aspergillosis, *ARDS* acute respiratory distress syndrome, *CAP* community-acquired pneumonia, *COPD* chronic obstructive pulmonary disease, *CPET* cardiopulmonary exercise test, *CTEPH* chronic thromboembolic pulmonary hypertension, *DVT* deep venous thrombosis, *HAP* hospital-acquired pneumonia, *ILD* interstitial lung disease, *PE* pulmonary embolism, *V/Q* ventilation/perfusion

baseline understanding and allowing reinforcement through application of that knowledge to individual cases (Table 9.2) [8]. This requires active participation on behalf of the team members outside of clinical hours, however, and thus will vary with the level of motivation of the team members. It also requires that the curriculum be calibrated to the right volume, so the time expected to be dedicated to independent learning does not overburden learners with already heavy clinical responsibilities [9].

**Table 9.2** Online resources for the pulmonary inpatient consulting team

| Publishing organization | URL | Description of content |
|---|---|---|
| Association of Pulmonary and Critical Care Medicine Program Directors | www.apccmpdscholars.org | Medical educators' toolbox published by the program directors' association specifically for educators in pulmonary and critical care. Some content is restricted to members, but the vast majority of US training programs have a membership, which gives program directors as well as faculty access to these resources |
| American Thoracic Society | http://www.thoracic.org/professionals/clinical-resources/video-lecture-series/ | Best of ATS video lecture series: A collection of videos focused on various aspects of pulmonary and critical care content; suitable for learners at different levels of experience |
| | http://www.thoracic.org/professionals/all-ats-podcasts.php | ATS podcasts: a collection of podcasts sponsored by the ATS covering principles and advances in the field |
| | http://www.thoracic.org/professionals/career-development/residents-medical-students/ats-reading-list/ | ATS adult and pediatric reading lists: updated lists of classic and seminal publications organized by topic |
| American college of Chest physicians | http://www.chestnet.org/Guidelines-and-Resources | CHEST Journal's published guidelines and other reference material |
| | http://www.chestnet.org/Education/Advanced-Clinical-Training/Video-Resources | CHEST video resources, providing video presentations and overviews of a number of core pulmonary topics |
| Society of Thoracic Radiology | http://thoracicrad.org/?page_id=1141 | Online courses in thoracic radiology produced by the American Board of Radiology with lectures that cover different radiologic patterns with an emphasis on differential diagnosis |
| Pneumotox | http://www.pneumotox.com/ | An online reference of all reported pulmonary effects of medications – a well-known and well-used reference by pulmonary consult teams looking for medications to implicate in lung disease or complaints |
| New England Journal of Medicine Procedural Videos | https://www.nejm.org/multimedia/medical-videos | Step-by-step description of various medical procedures along with indications, contraindications, precautions, and technique demonstration |

### *9.4.2 "Flipped Classroom"*

If utilizing asynchronous learning methods to deliver core content, team teaching sessions should be reserved for manipulation of the subject matter in the context of clinical encounters. These sessions should encourage interaction among team members as they discuss issues and principles related to the content and their patients. These pearls are often among the best retained because they are linked to a specific real patient for whom the team cared [10–12]. The "flipped classroom" educational model is often underutilized in academic settings and can be modified to specially cater to the unique advantages of the pulmonary consultant service [12].

Referring diagnoses are almost always provided with the consult request and can be used as a starting point for providing on-the-fly teaching prior to patient evaluation. For example, if the reason for consult is for assistance with management of a COPD exacerbation, the learner can be provided with a summary of published guidelines prior to patient assessment. She can then be asked to assess how the guidelines apply to the specific patient and, using the knowledge gained from the guidelines, what the next steps in management should be. This active learning technique engages the individual team member by encouraging independent learning and reinforces teaching points by applying them to a distinct, real-world patient encounter. Other members of the team can be incorporated into the educational process by having everyone review the guidelines and provide input with regard to disease classification and management. These sessions can be led by the attending physician (running the risk of less effective, passive learning) or delivered by members of the team (which usually increases engagement and the overall value of the teaching). The balance here may depend on the judgment of the attending physician, again keeping in the mind clinical volume and titrating the amount of expected preparation so as to not overwhelm a particular learner or group of learners.

### *9.4.3 Formal, Scheduled Teaching*

In situations where fellows play a more supervisory role, it may be appropriate to give the team fellow primary responsibility for the formal, scheduled teaching that occurs on the consult service. This role may be appropriate for the fellow, as one of the common goals of fellowship is to cultivate the teaching skills essential to becoming an academic pulmonologist. Sessions should aim to be as interactive as possible, incorporating the input of team members and stimulating in-depth discussion. Use of technology to review imaging from patient encounters as well as to search for typical imaging findings for a specific disease allows for correlation and comparison.

Whenever a trainee is given responsibility for teaching, it is an important opportunity for feedback. Without feedback on the fellow's teaching preparation, techniques, and effectiveness, the opportunity to improve will be lost. As a fellow matures in clinical knowledge and skill, there is a parallel opportunity to focus on development as a teacher. As a fellow leads the consult team discussion about a patient's condition, for example, there is an opportunity for the attending physician to observe and later provide specific feedback on the fellow's teaching. In some cases, this can be standardized using simulation techniques similar to clinical learning (see Box 9.1).

**Box 9.1**

The concept of the observed standardized clinical encounter (OSCE) has taken hold in training programs and in fact is now viewed as a pillar of clinical training. The same approach has been adapted for teaching skills, sometimes called the observed standardized teaching encounter (OSTE). A "standardized learner" takes the place of a standardized patient, giving the developing teacher a scenario that can be shaped to evolving needs, and them observed by more experienced educator who then provides feedback on the developing teacher's performance [11]. Some examples of "standardized learners" could include, among others:

1. The "struggling learners," whose primary deficit is in medical knowledge and/or organizational skills
2. The "challenging learner," characterized by either overconfidence, apathy, or general lack of professional demeanor
3. The "excelling learner," who is far above his or her peers but seeks constant growth and desires continual, constructive feedback

Whether the observed teaching encounter is standardized or in real time on the hospital consult service, the quality of the feedback given is critical. Successful lifelong learners know that feedback is always a gift, even when poorly packaged. However, feedback that is thoughtful, accurate, objective, detailed, and sensitive to the needs of the developing teacher will most likely lead to the greatest improvement. Many educators have used the acronym SMARTi to both develop objectives for educational sessions as well as teach effective feedback (adapted here from the business literature): Specific, Measurable, Attainable, Relevant, and Time-bound [12]. Areas of targeted feedback for the developing educator are further described in Table 9.3, and a more thorough discussion is available in the chapter dedicated to feedback (Chap. 15).

### *9.4.4 "Reverse" Journal Club*

Journal clubs with assigned pre-readings can be employed and serve the dual purpose of teaching the skills needed for critical assessment of the literature as well as highlighting evidence-based disease management [13, 14]. The standard journal club format is often ineffective as a teaching and learning modality, so alternative methods and organization can be explored. One such method is employing a "reverse" journal club, in which a question that arises as a result of a clinical encounter is posed to a group of learners who are then responsible for developing a study proposal to answer this question. This interactive model allows the facilitator to highlight biases inherent to different study designs, assess external validity based on patient inclusion and exclusion criteria, and teach appraisal of endpoints as surrogates for disease states. The learners can then apply what is discussed during the study design session to critically review an article from the literature addressing their specific question. They should be able to answer questions such as, "Is this result significant?" and "Does this apply to my individual patient?" Performing such sessions has the potential to enhance the learner's ability to understand and employ evidence-based medicine in individual clinical scenarios [15].

### 9.4.5 Bedside Teaching

Bedside teaching is an essential component of education in all clinical settings, including on the pulmonary consult service. Teaching the physical exam and correlating findings with the disease presentation is a core component of bedside teaching and is particularly important when interacting with learners at the novice level. Reinforcing those findings that were correctly identified and correcting those that are not, serves to shape developing clinical skills while also instilling confidence in the learner's ability to assess patients. Aside from teaching the physical exam, the "one minute preceptor" model can be employed to impart succinct teaching points in a setting where clinical volume is prohibitive to longer teaching sessions. The five steps for the one-minute preceptor (get a commitment, probe for supporting evidence, teach general rules, reinforce what was done well, correct errors) have been validated in improving resident teaching skills and are an effective means of learner assessment on a case-to-case basis [16]. When employing any form of bedside teaching, it is important to remember not to compromise the patient's trust in a

**Table 9.3** Targeted areas of feedback for teaching in the consultant role

| Area of feedback | Example |
|---|---|
| Medical content | Accuracy of medical principles including patient presentation, physical exam findings, diagnostic testing, and treatment modalities |
| | Ability to focus a small group session on a defined and limited set of teaching points |
| Teaching technique and style | Utilization of impromptu visual aids versus prepared content |
| | Device teaching (e.g., invasive and noninvasive ventilators) |
| | Case-based teaching |
| | Use of simulation technology |
| Engagement and interaction | How to tailor teaching to the needs and wants of learners with different concentrations and levels of interest |
| Understanding the consultant role | Capacity to focus the consultant team's role within the context of a clinical question and communicate with various consulting teams (e.g., medical vs surgical) |
| Feedback on feedback | Ability to provide constructive feedback to learners at various stages on multiple aspects of learning (e.g., medical content, communication, professionalism) |

member of the consulting team by overly focusing on weaknesses in the team member's assessment. Formative feedback may be best reserved for after completion of the clinical teaching encounter.

### *9.4.6 Procedural Training*

Depending on the institution, procedural training may or may not be an important component of the pulmonary consult service. Larger institutions may have distinct consultative services dedicated to assessing and managing pleural effusions, such that thoracenteses and pleural catheter placement may be requested of the specific procedural consulting service. The opportunity to perform consultative procedural services presents a unique opportunity for teaching to those at various levels of training. Prior to performing any procedure, including thoracentesis or pleural catheter placement, procedural indications and contraindications should be reviewed and understood fully. Reasons for conducting various studies on a collected sample should be examined, and interpretation of such studies should be mastered. Etiologies of transudative versus exudative effusions should be taught, and application of this knowledge to individual patients can help to reinforce this information.

Though not performed on the wards, bronchoscopy is an inherent component of the pulmonary consult service and should be taught with content stratification based on stage of training. Again, indications and contraindications should be explored and reasons for ordering additional studies examined. Findings specific to a given disease state (i.e., progressively hemorrhagic alveolar lavage in diffuse alveolar hemorrhage) should be reviewed, in addition to pulmonary anatomy, bronchoscopic imaging, and intervention.

Establishing clear expectations regarding who should perform which procedures is important given the diverse nature of the consulting team and the potentially limited number of available procedures. Though traditionally procedural competence has been thought of as completing five (or some other arbitrary number) of a given procedure, true competence requires much more repetition and feedback than can likely be acquired during a single rotation, and clearly setting the expectation that this level of competence may not be achieved is important in modulating the beliefs and attitudes of individual team members (see the Procedural Teaching chapter) [17].

### *9.4.7 Portable Technology*

Given that consulting teams service the entire hospital and are not usually working in a defined or limited geographical area, portable electronics can play a major role in facilitating teaching on rounds. The use of portable computers and mobile electronic devices allows for inter-team communication, rapid acquisition of clinical information, interpretation of imaging, and review of the medical literature, all of which facilitates the *ad hoc* teaching characteristic of the pulmonary consult service. Portable devices can also be used to show patients their imaging findings and better facilitate their understanding of the underlying pulmonary disease process. The use of applications dedicated to pulmonary risk scoring (i.e., preoperative respiratory failure risk assessment, Wells' criteria) is also extremely helpful for real-time patient stratification and management [8].

## 9.5 Challenges Encountered While Teaching on the Pulmonary Consult Service

Teaching on the pulmonary consult service is not without its challenges, some of which have been mentioned already. The most prominent of the difficulties is often clinical volume. While it is the volume that ultimately provides the breadth and diversity of cases seen on service, clinical responsibilities also limit the amount of time that can be devoted specifically to teaching and learning as well as the format in which content is delivered. Furthermore, cases may not be of optimal educational value, and/or the question being asked may not be entirely clear, which could skew the balance of service versus education toward service. When members of the team are dispersed to complete the work at hand, volume can also make it difficult to deliver unified teaching to all members of the team. If teaching cannot be done in formal or informal settings during the work day, it puts more onus on the learner to read independently, and can create additional stress in an already potentially pressure-filled environment. It is therefore essential to continually assess and try to balance service and education on the consult service, creatively weaving teaching into clinical work (as described earlier in this chapter).

Catering to the specific needs of individual learners from different backgrounds and at different stages of their careers is not unique to the pulmonary consult service but is a daunting task nonetheless. Assessing learners' baseline knowledge can be difficult, and the skills to do so are often ones overlooked in training of academic physicians [3]. Methods such as the one-minute preceptor are relatively easy to learn and can help triage team members based on their medical knowledge. Developing standard curricula to ensure exposure to baseline content for all team members can make interactive didactic sessions more fruitful for the group as a whole. It is important to note that this also requires investment on the part of individual team members, especially when delivered via asynchronous teaching methods.

While engaging the learner in the educational process by assigning the role of teacher can be a very effective strategy, one must also recognize the potential for poor execution due to misunderstanding of disease processes or inadequate preparation on the part of the trainee-teacher. Along similar lines, the spontaneity and flexibility provided by patient-focused case-based education can also be a challenge to the provision of a complete and consistent body of content [9, 10, 13]. Ultimately, individual learners have different preferred methods of content delivery and by incorporating different teaching styles and employing different resources over the course of a rotation, one can maximize the chances that everyone derives educational benefit while on the consult service.

Effective communication with the members of other services is difficult and often neglected due to time constraints and varying clinical responsibilities. Ineffective communication can lead to frustration on the part of the primary service, other consultants, and patients and/or families. While the narrow clinical focus that accompanies consultation requests affords unique teaching opportunities, it can also limit the consultant's ability to synthesize a comprehensive assessment of patient complexity and develop treatment plans appropriate to the goals of care for the patient. Furthermore, dissenting opinions regarding the etiology of a disease process can put specialist and primary teams at odds, leading to management plans that are potentially haphazard and without clear direction. Despite the associated difficulties, establishing effective lines of information transmission is paramount to patient care and optimizes inter-specialty and interdisciplinary education [1, 2]. It allows for open exchange of ideas and better assessment of the overall clinical picture. Effective communication at the onset and continuing throughout the entire consultative process can prevent conflict and may also save time by minimizing the need for prolonged damage control discussions due to confusion over the plan of care. In establishing healthy communication practices, one can also cultivate these skills in the members of the consult team, thereby enhancing their ability to practice as effective consulting physicians in their future careers.

## 9.6 "Making It Happen"

Because of the dynamic and unpredictable nature inherent to the pulmonary consult service, it is difficult to provide a concrete example of the ideal integration of the various teaching techniques and means by which to conquer the unique challenges encountered while working in the consultant role in a given week. Nonetheless, a general approach that can be utilized across a variety of clinical/teaching scenarios in a given week is shown in Fig. 9.2, with an application of such an approach in a specific clinical context in Fig. 9.3.

## 9.7 Conclusion

In summary, the pulmonary consult service presents unique opportunities and challenges for teaching that are not encountered on other rotations. It provides the opportunity for specialty learning with a narrowed scope of responsibility across a wide variety of cases that allows for both depth and breadth of education in pulmonary diseases. The pulmonary consult service interfaces with a large number of

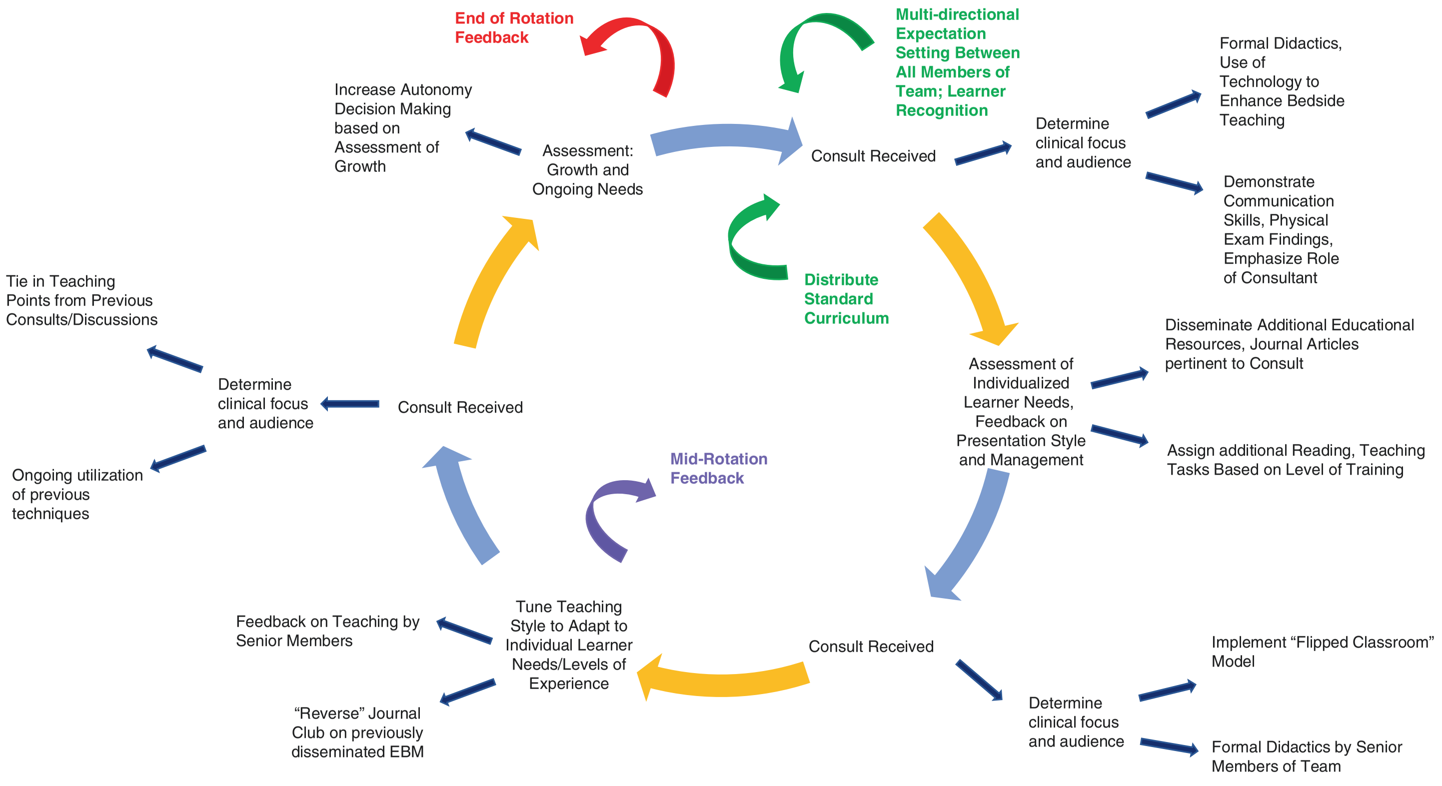


**Fig. 9.2** General approach to a week on the pulmonary consult service

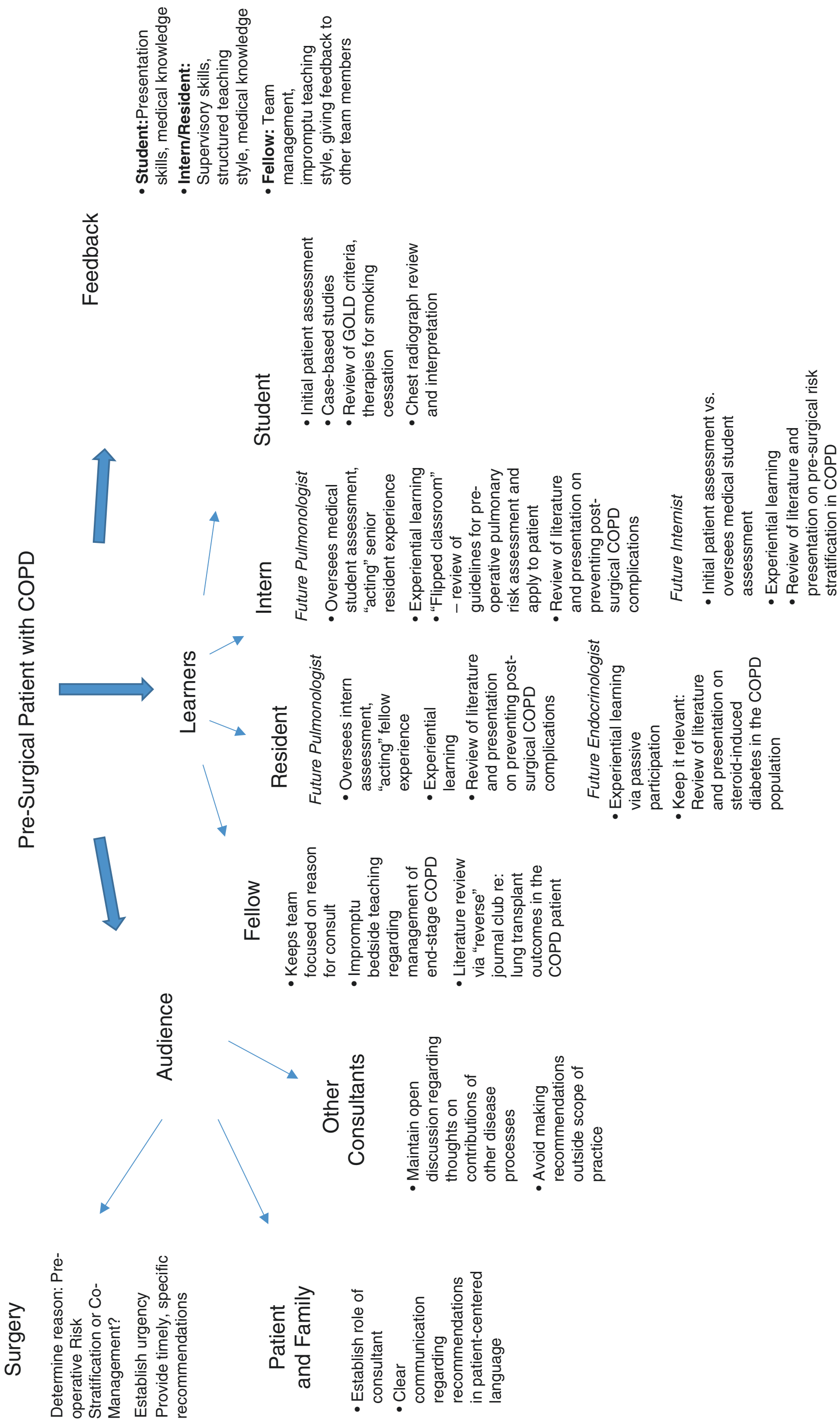


**Fig. 9.3** "Making it Happen" in a particular clinical context

other groups, providing opportunity to enhance learning and communication on multiple platforms while at the same time providing an invaluable service to learners and patients alike. The operational and educational dynamics of the consult service lend itself to a variety of educational techniques: bedside teaching, flipped classroom, reverse journal club, and procedural training can all be implemented and further enhanced with appropriate use of technology. Through diversification of medical content, modification of delivery techniques, and utilization of a variety of different resources, one can capitalize on the unique opportunities available to educators on the pulmonary consult service and provide an excellent educational experience for individuals from a variety of backgrounds at varying stages of their careers.

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# Chapter 10
# Teaching in the ICU

**William Graham Carlos III and Emily Cochard**

## 10.1 Introduction

The intensive care unit (ICU) is an incredibly rich environment for teaching the pathophysiology behind many diseases. The pace, acuity, and complexity provide unique challenges for teachers and learners alike. Faculty are challenged to practice quality critical care in an academic environment where learners require varying levels of guidance and autonomy to grow and develop independently. Teaching in the ICU requires the faculty to give a timely orientation, to have multiple bedside and classroom teaching modalities, to stress critical thinking and reasoning, to focus on multidisciplinary team training, and to debrief with formative feedback. This chapter will orient the reader to best practices of ICU teaching.

First, it is important to understand that the ICU "team" has different levels of physician trainees that interact with providers from multiple disciplines. These disciplines may include medical and surgical subspecialists, nurse practitioners, physician assistants, pharmacists, nurses, respiratory therapists, physical therapists, occupational therapists, speech therapists, dieticians, case managers, and social workers. To function properly, there is constant multidirectional communication. Lessons in communication have been learned from the airline industry [1]. The aviation Crew Resource Management Curriculum (CRM) promotes cooperation, coordination, and sharing and parallels relationship-centered healthcare models. Those models place value on collaborative provider-patient, provider-provider, and provider-multidisciplinary team relationships. Applying CRM concepts to the ICU can improve teamwork and patient care.

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_10

## 10.2 Orientation

Step one for teaching an ICU team is providing an orientation that addresses roles, introduces the environment, manages expectations, and sets the stage for teaching.

### *10.2.1 Establish Roles*

Given the diversity of providers, roles should be established at the start of each rotation, particularly for learners. The "chain of command" may vary depending on the institution but generally consists of faculty, fellows, residents, interns, and subinterns. Examples of specific expectations for each learner level are shown in Table 10.1.

### *10.2.2 Set Expectations*

After addressing roles, establishing expectations will help the rotation run smoothly. Essential components to discuss include:

- Process and flow of rounds
- Rounding roles – presenting, entering orders, answering pages/phone, communicating plan with ancillary staff
- Preferred presentation details – system-based vs. problem-based
- Expected timing of order and note completion
- Required note content
- Procedural supervision requirements
- Code participation – who goes? who stays?
- Guidelines on transitions of care
- When to notify resident and faculty
- Cross-cover expectations
- Teaching and learning expectations
- Anticipated feedback

**Table 10.1** ICU physician trainee learner roles

| | |
|---|---|
| Fellow | Guide the team's coordination of care, dialogue with residents about evaluation and treatment decisions, and function as a liaison for the faculty |
| Resident | Direct patients' ICU care from start to finish including orders, notes, and procedures, while supervising and coaching interns and subinterns |
| Intern/ subintern | Serve as the primary communicator for their assigned patients formulating broad differential diagnoses and thorough treatment plans under a resident's direct guidance |

Teaching faculty should also reiterate how timeliness is of the upmost importance in the ICU and provide guidance for how to be most efficient. There is not a moment to lose when evaluating a patient on admission, placing orders, following up on ordered studies, assessing response to therapies, and evaluating any rapidly changing conditions throughout the day or night. In addition, learners are often juggling multiple patients requiring attention at the same time. They must know whom to call when help is needed and understand they will be supported at all times.

### *10.2.3 Open Communication*

In the face of critical illness, it is understandable if providers become overwhelmed [2]. Learners should know it is common to experience trepidation and feel intimidated by the high-stakes nature of care and unfamiliar life-supportive modalities. Parallels between the ICU and airline environments can again be drawn: high risk, complex technologies, changing workloads, uncertainty, fatigue, and stress [3]. Teaching faculty should aim to create a learning environment where questions and areas of uncertainty are welcomed and addressed. Open dialogue surrounding knowledge and performance gaps should occur often and in a timely manner so learners can quickly adapt to their roles. The sooner these deficits are addressed, the more quickly the team will reach peak efficiency. This cannot be accomplished if learners feel the environment is threatening or unsafe.

Not only is it common to be overwhelmed by the pace, the ICU is also an emotionally stressful environment for all involved with a high rate of provider burnout [4, 5]. Dating as far back as the 1980s, prolonged care of patients with multisystem organ failure and a poor prognosis were frequently reported sources of stress by trainees [6]. A study of pediatric residents before and after their ICU rotation demonstrated significantly increased incidence of depression, depersonalization, and emotional exhaustion [7]. While it is difficult to be prepared for this, teaching faculty should address these challenges preemptively. It is helpful to normalize the wide array of emotions experienced in the face of critical illness, death, and dying as well as emphasize the importance of adequate self-care such as rest, hobbies, and exercise [8, 9]. Once again, teaching faculty should assure their learners that they are supported.

### *10.2.4 Family-Centered Rounding*

Learners should be aware of the possibility of families being present during rounds. In many institutions, families are encouraged to be present for and participate during rounds. While the prevalence is higher in neonatal and pediatric ICUs, no survey has reported the prevalence in adult ICUs. Most data regarding outcomes of family presence on rounds are extrapolated from pediatric studies, well-summarized by

Judy Davidson [10]. She reports that families perceive they receive more information, understand the plan of care better, develop better relationships with the providers, and have reduced incidence of stress and anxiety. An adult ICU pilot study [11] found including families on rounds increased satisfaction regarding frequency of communication and support during decision-making. Given family presence can challenge the bedside climate due to learner anxiety, teaching faculty should set clear guidelines on how to communicate effectively. Some best practices for teaching at the bedside with families include [10]:

- Daily introductions; update provider communication board
- Assess privacy concerns
- Remain focused while presenting
- Avoid medical jargon
- Allow time for family input and questions
- Summarize before moving on to the next patient

If not immediately present on rounds, it should be clear who is updating the family afterwards and when is the preferred time to do so.

## 10.3 Teaching

Teaching methods vary from one institution to the next and from one faculty member to another with teachers tailoring their methods to the strength, knowledge base, and experience of their teams. As there is no "one-size-fits-all" approach, this section will cover best practice teaching methods and provide examples for optimal ICU teaching.

Understanding that time is precious in the ICU and teaching time can be difficult to carve out, the "CARE – climate, attention, reasoning, evaluation" framework [12] can be utilized for effective and efficient teaching (Table 10.2). *Climate* prepares the learner and potentially patient or family for the teaching interaction by setting the tone. "I'm going to teach about ARDS ventilation today. Please feel free to interrupt me with questions." *Attention* focuses the learners on a few key points and reduces distractions. "Based on ARDSNet guidelines, low tidal volume ventilation is essential for improved ARDS outcomes – that is 6 ml/kg ideal body weight. Higher PEEP may be required to improve oxygenation. Plateau pressures must be kept below 30 cm$H_2O$." *Reasoning* challenges the learner to think critically and out loud. "What clinical findings would suggest an alternative diagnosis to ARDS?" Finally, *evaluation* promotes immediate, formative feedback for continued improvement. "Your understanding of the ARDS Berlin Criteria is excellent. A next step for you would be to focus your reading on evidence-based ventilator management techniques." The CARE framework will be woven throughout the chapter.

The first aspect of the CARE framework is setting the climate, which is hopefully first addressed during orientation. Based on an observational study of acute care bedside interactions, Piquette and colleagues describe three graduated

**Table 10.2** Features of CARE [12]

| | |
|---|---|
| Climate | |
| | Set learner expectations |
| | Avoid medical jargon |
| | Avoid "one-upmanship" |
| | Be explicit about what you will be observing |
| | Set patient expectations |
| | Ask permission |
| | Explain purpose and plan for the encounter |
| | Encourage questions and participation |
| Attention | |
| | Plan the encounter |
| | Remain focused |
| | Keep content relevant for all learners |
| | Maintain democratic leadership style |
| Reasoning | |
| | Encourage hypothesis-driven examination |
| | Ask probing questions |
| | Avoid "read my mind" questions |
| Evaluation | |
| | Give formative feedback |
| | Focus on specific behaviors |
| | Avoid pointed public criticism |
| | Encourage reflection after the encounter |
| | Compile observations for summative feedback |

approaches to interactive clinical supervision that illustrate how learning opportunities can be created in the ICU: engaging without enactment, sharing care with support, and caring independently [13].

*Engaging without enactment* implies that while the learners may be solely observers, the teacher includes him or her in patient care by creating a dialogue and hypothetically discussing aspects of care. Questions directed at learners force them to evaluate the clinical scenario and make decisions while allowing the teacher to assess their knowledge base.

*Examples: Describing procedural steps, discussing rationales for decision-making, or asking for proposed treatment plans.*

> *This patient has septic shock. I placed a central line and have started a single vasopressor. What would be your threshold to start another vasopressor or to consider stress dose steroids?*

*Sharing care with support* describes situations where the learner makes clinical decisions under direct supervision or performs procedures under direct guidance – "support-in-action." The teacher could provide clinical cues, make explicit suggestions, or offer specific care options to guide the learner.

*Examples: Using the video-laryngoscope for visualization of a learner intubation, allowing a learner to lead ACLS or negotiating treatment plans during staffing.*

*Let's get ready to intubate this patient. What medications do you want to use and which ones should we avoid? We can talk through your decision.*

*Caring independently with feedback* defines settings in which learners provide care without direct observation – "feedback-on-action." This provides opportunities for teachers to challenge management decisions or actions, and give feedback on opportunities for improvement.

*Examples: Providing feedback on overnight admissions, challenging therapeutic decisions, or assessing quality of care given to unstable patients.*

*Last night, you admitted someone with cirrhosis and an acute gastrointestinal bleed. You correctly started them on a proton pump inhibitor and consulted Gastroenterology for an endoscopic evaluation. There are a couple other medications that are critical in this setting of a patient with known cirrhosis: octreotide to improve splanchnic vasoconstriction and antibiotics to reduce bacterial translocation and incidence of spontaneous bacterial peritonitis.*

### *10.3.1 Bedside Teaching*

Regardless of the approach to the teaching climate, bedside teaching is fundamental to ICU learning. The patient is the focus at the bedside, but the ICU environment inherently also provides multiple opportunities to connect the mental-visual dots – monitors, medications, oxygen devices, dialysis, ultrasound, and other interventions. Attention is the next step in the CARE framework [12], and one key aspect to maintaining attention is to limit distractions. Breaking the room down into its components by focusing teaching on a single element will help simplify the complexity and keep the learners' attention. Ideally, the learners will be able to see the patient and room as a whole after learning about each component individually.

Having set the climate and focused the learners' attention, clinical reasoning [12] and critical thinking should be encouraged to promote concept learning rather than rote memorization. Hayes and colleagues [14] provide five strategies to promote clinical reasoning and critical thinking in the ICU (Table 10.3). These strategies stress the importance of metacognition, addressing biases, inductive reasoning, stimulating questions, and learner assessment. Using these strategies, teachers reveal to their learners how they think through ICU problems and concepts and unveil biases that lead to flawed reasoning. The ultimate goal is to transform learners from ones who make quick decisions often resulting in premature closure to advanced critical thinkers who can develop and use broad differentials, recognize their limits, have thorough thought processes, and appropriately ask for feedback.

In the next section, specific examples of how to focus attention on the individual elements in the room and integrate critical thought processes while addressing pathophysiologic concepts will be discussed.

**Table 10.3** Five steps for teaching critical thinking in critical care

| | |
|---|---|
| Strategy 1 | *Make the "Thinking Process" explicit* |
| | Challenge learners to understand, apply, analyze, and evaluate using probing questions. Engage in metacognition |
| | "*Why do you think the patient has respiratory failure?*" |
| Strategy 2 | *Discuss the cognitive biases and de-biasing strategies* |
| | Address common biases and overcoming them by encouraging alternative diagnoses and broad differentials. Discuss inconsistencies |
| | *"The lack of chest pain does not fit with the diagnosis of ACS. Can we rethink the case?"* |
| Strategy 3 | *Model and teach inductive reasoning* |
| | Reason facts into hypotheses that model pathophysiology. Concept mapping |
| | *"We have a patient with hypotension, anemia, and an elevated BUN-to-creatinine ratio. This suggests which diagnosis?"* |
| Strategy 4 | *Use questions to stimulate critical thinking* |
| | Pose questions that engage and inspire critical thinking. Avoid pimping |
| | *"How would DKA affect a patient's electrolytes?"* |
| Strategy 5 | *Assess your learner's critical thinking* |
| | Provide feedback and assess the learner's critical thinking milestones. Create a safe space |
| | *"How are you doing with this admission? Do you want to walk through it together?"* |

Adapted from Hayes et al. [14]

#### 10.3.1.1 Patient

The patient is the most central focus at the bedside. The bedside examination is a ritual that develops an essential skill set for all learners [15]. While the importance of this cannot be overemphasized, the era of duty hours, competing demands, and electronic health records has been taken away from the thorough history and physical exam [16, 17]. Chi and colleagues describe the "five-minute bedside moment" which supports the role of the physical exam in bedside teaching [18]. It consists of (1) a narrative to explain the context and usefulness of a physical exam maneuver and (2) the demonstration of the physical exam maneuver and findings, including interpretation and common technique errors. The bedside physical exam of a patient is a prime time to assess critical thinking [14]. Attention is focused on the patient and the specific maneuver [12] as described in the CARE framework. Teaching faculty can describe and model an examination technique and associated finding and then probe the learner about its significance. Critical thinking can be simulated with "how" and "why" questions and thinking processes can be made explicit.

Teaching faculty: Mr. Perez has a systolic ejection murmur at the left sternal border. What might that imply and how would that affect our management?
Resident: It could be aortic stenosis. In that case, we would want to maintain preload, as he is dependent on it for cardiac output. He should be monitored closely if we diurese him. Also, we want to treat his hypertension, but vasodilators like hydralazine may adversely affect his coronary perfusion so should be avoided.
Teaching faculty: I agree. What questions might we want to ask Mr. Perez to assess the severity of his aortic stenosis?
Resident: We should ask about dyspnea, dizziness, syncope, and exertional angina as those suggest severe stenosis.

#### 10.3.1.2 Monitors

Hemodynamic monitoring systems spanning from basic vitals monitor to noninvasive cardiac output monitors, provide ample opportunities for teaching. Simple bedside maneuvers to alter the monitor outputs allow learners to understand basic cardiopulmonary physiology. For example, a passive leg raise can be done to assess for the presence of a response in blood pressure indicating volume responsiveness. The learner must use inductive reasoning to figure out that the increase in venous return resulted in an increased stroke volume and subsequent improvement in blood pressure. Manipulating the more advanced noninvasive cardiac output monitors and interpreting stroke volume variation or pulse pressure variation also provide an opportunity for the learner to understand the relevant physiology and interpret results. The teaching physician can pose stimulating questions that engage the learner in critical thinking.

Teaching faculty: If we do a passive leg raise test and the SVI improves by more than 10%, what might that imply?
Learner: It could imply that the patient is fluid responsive since the ~300 ml "bolus" improved their SVI.
Teaching faculty: What other indices might suggest that the patient is fluid responsive?
Learner: The CO would also increase with a PLR or fluid bolus.

#### 10.3.1.3 Medications

The multitude of intravenous medications, particularly vasoactive medications, lend themselves to the review of hemodynamics. The rather rapid vital sign response to titration of the medications enables leaners to solidify these concepts as they watch them take effect. The discussion can span from why certain medications are selected to how they are titrated. The different receptors and functions of each vasopressor can be compared to provide a knowledge base for future clinical decisions. As the learners become more independent, teaching faculty can ask them to explain their decision process.

Teaching faculty: Mr. A was admitted overnight in shock. Can you explain your reasoning for ordering dobutamine as your first-line agent?
Learner: Mr. A has a history of systolic heart failure. He came in with increasing dyspnea, orthopnea, and lower extremity edema. His BNP of 2000, bilateral opacities with pleural effusions, and cool extremities were all consistent with cardiogenic shock. I chose dobutamine for inotropic support.

#### 10.3.1.4 Oxygen Devices

The expanding options for oxygen delivery have inherent indications, risks, and benefits that are fundamental in the ICU. Learners must understand when to advance from a nasal cannula to higher $FiO_2$ delivery modalities. Heated humidified high-flow nasal cannula (HFNC) and noninvasive positive pressure (NIPPV) devices have important indications and contraindications that are essential for learners to understand. Each device has specific settings and variables to monitor to ensure proper function and patient response. For example, a patient with obstructive lung disease who requires NIPPV for hypercapnic respiratory failure must be evaluated for adequate respiratory rate, tidal volumes, and minute ventilation, as well as changes in degree of respiratory acidosis. Teaching faculty can assess the learners' understanding of those parameters and when to proceed with intubation.

Teaching faculty: Mr. C was placed on NIPPV last night for hypercapnic respiratory failure. This morning his arterial blood gas is 7.25/70/90. What would you like to do with this information?
Learner: That is only a slight improvement from his initial ABG. I would make sure his mask is sealed tightly and that he is getting adequate tidal volumes on the current settings of 12/5.
Teaching faculty: Great. He has no leak and his tidal volumes are ~400 cc with each breath.
Learner: I would then adjust his settings to create a larger tidal volume by increasing his IPAP to 15 and then ask the RN to get an ABG in 1 hour.
Teaching faculty: Correct, by increasing his IPAP, you would likely increase his tidal volume and as such his minute ventilation. Unfortunately, despite making these change to his NIPPV settings, his next ABG is unchanged. What would you do next?
Learner: Well Mr. C has been on NIPPV for 4 hours with minimal improvement despite assessing for mask fit and adjusting his settings. At this point, I would proceed with intubation.

In this scenario, the teaching faculty is able to evaluate [12] the learner's understanding and critical thinking and promote self-reflection as part of the CARE framework. After intubation, teaching faculty can use the opportunity to explain how to choose the settings, describe the different ventilator waveforms, and review possible ventilator alarms.

#### 10.3.1.5 Dialysis

Dialysis is frequently co-managed with the Nephrology service and troubleshooting complications are frequently the ICU team's responsibility. Learners must be able to differentiate between the types of dialysis frequently used in the ICU, understand their indications and contraindications, and recognize their potential complications. Having even a basic understanding can help alleviate simple issues. For example, when the pressure alarm continuously goes off and flows stop, the learner should be able to think about the circuit and consider evaluating the patient's neck positioning or the tubing for kinking and consider repositioning.

Teaching faculty: Mrs. C is in septic shock with progressive ATN. She is now anuric. What type of dialysis might be indicated?

Learner: Well eventually, she will get volume overloaded and have electrolyte imbalances. Given she is requiring two vasopressors, she is not a candidate for conventional hemodialysis and as such will require continuous veno-venous hemodialysis for blood pressure stability.

Teaching faculty: Good thought process. What are the indications to starting dialysis?

Learner: I remember the mnemonic AEIOU – intractable acidosis, electrolyte disturbances like hyperkalemia, intoxicants like methanol, ethylene glycol, or aspirin, fluid overload compromising oxygenation, and uremic symptoms like nausea, pericarditis, or bleeding.

Teaching faculty: It is also important to remember the contraindications. As you stated, one contraindication of conventional hemodialysis is hypotension due to expected blood pressure shifts during intermittent hemodialysis. Why don't we cover this in more detail after rounds.

#### 10.3.1.6 Ultrasound

Bedside ultrasound (US) is complementary to the ICU physical exam [19–21]. Used in conjunction with the clinical picture, bedside US can assist in ascertaining volume status, assessing cardiac function, and evaluating for ascites or pleural effusions. Direct visualization of a collapsible IVC or a reduced ejection fraction can assist in formulating an understanding of management decisions. For example, if a patient with sepsis secondary to pneumonia remains febrile despite therapy, US can be used to evaluate for a parapneumonic effusion or empyema. The demonstration of an effusion with numerous loculations would suggest a complicated effusion and need for immediate drainage. The learners' ability to process the information and apply it rapidly to a management decision makes US a key teaching tool. Due to its utility in diagnosis, assessment, and interventional procedures, it is currently being incorporated into medical school curriculums across the country [22–24] and as such, an increase in knowledge and use will be expected with future trainees.

*Patient Y* is admitted from the ED billed as "septic shock." To help avoid bias and diagnostic momentum [14], bedside cardiac ultrasound is used to evaluate left ventricular function, right ventricular size, and IVC diameter. The teaching faculty may describe the four cardiac views and demonstrate how to orient the probe for each, after which the learner can emulate the same technique. A reduced ejection fraction is visualized with decreased contractility of the myocardium and a mitral valve leaflet >1 cm from the septum. The IVC is dilated and not collapsible. This is more consistent with cardiogenic shock (as opposed to a hyperdynamic left ventricle and small, collapsible IVC), and these findings will help guide the treatment plan more appropriately and effectively. The learner will recognize the importance of approaching each patient with an open mind and can apply the knowledge to future patients eventually leading to independent use of the ultrasound when the teaching faculty is not readily available.

### *10.3.2 Away from the Bedside*

Outside of the patient room, the teaching environment is flexible and offers multiple methods for teaching. Mini-didactic lectures, either at the whiteboard or impromptu, can allow the teacher to delve more deeply into a topic or question brought up at the bedside. In one study, 3rd-year medical students perceived mini-lectures on relevant inpatient topics as high-quality teaching [25]. For example, "we discussed severe metabolic acidosis in the setting of DKA, but let's discuss more specifically why bicarbonate is not necessary for resuscitation." Or "the patient with COPD on the ventilator had high peak pressures, so let's discuss the differential for high peak and/or plateau pressures and how to distinguish them by a few simple ventilator manipulations."

Simulation sessions help teach ICU skills for situations that either happen infrequently, are high-risk/high-stakes, or do not allow for adequate teaching moments (e.g., cardiac arrests [26–28], procedures [29, 30], and emergent intubations [31, 32]). Using simulated patient cases with or without mannequins allows the teacher to slow the situation down and discuss the decision-making and mental processes involved. During simulation sessions, feedback can be immediately given and applied. Scripted debriefing after simulation has also been shown to improve cognitive and behavioral learning outcomes as well as performance in future simulations [33]. Once back in the ICU, the learner can employ those learned skills having performed and debriefed them previously. Simulations have been shown to not only improve learner performance but also reduce complications [34].

An example of the start of a cardiac arrest simulation is below:

> Resident – "My name is Dr. Jones. I am in Internal Medicine resident and I will be running the code today. Please direct all attention and questions to me. Please continue compressions while I talk. Let's begin by identifying roles. Who is administering medications?"
> RN – "Hi, I am Veronica, I am giving medications."
> Resident – "Ok. Who is doing CPR?"
> Student – "I am Anand and I will take over for Javier."
> Resident – "Great. Who is recording and keeping time?"

This simulated scenario demonstrates direct communication where roles are easily and quickly defined. Timing of activities, selection of medications, and speed of transitions are prime targets for feedback.

Simulation can not only be applied to individual skills but also to general medical ICU care. Schroedl and colleagues [35] employed a simulation training where residents were asked to manage a rapidly decompensating patient who required resuscitation, intubation and mechanical ventilation, invasive monitoring with arterial and central venous catheters, administration of pharmacotherapy, and interpretation of laboratory data and chest imaging. This start-to-finish simulated care improved the residents' performance on a bedside skills assessment checklist compared to the traditionally "on-the-job" trained residents. Whether for individual skills or complete patient care, simulation sessions are an effective means of teaching learners. A more detailed discussion of the use of simulation in pulmonary/critical care teaching is available in Chap. 12.

Web-based resource links or self-made teaching videos are quick and easy ways to send additional resources to solidify a teaching point that may require more details or images/graphs easily displayed on a computer screen. Kleinpell and colleagues [36] compiled a list of web-based resources for critical care education consisting of various formats: tutorials, self-directed learning modules, interactive case studies, webcasts, podcasts, and video-enhanced programs. Other examples of quick and easy reads include PulmCCM at www.pulmccm.org which has short reviews on current literature, the IU Critical Care Survival Guide video series available on YouTube [37] (Fig. 10.1), and the critical care section of Louisville Lectures at www.lousivillelectures.org.

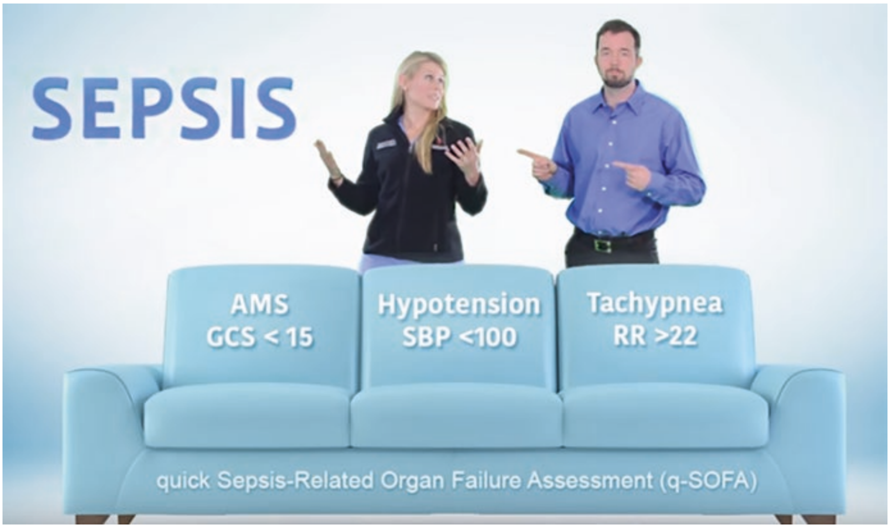


**Fig. 10.1** IU critical care YouTube video survival guide [37]

Finally, primary research articles that explain diagnosis or management decisions help guide the learners toward evidence-based medicine. The learner can read the article on his/her own time and reinforce concepts discussed earlier. "Today we discussed why ticagrelor is more widely used after acute coronary syndrome rather than clopidogrel. A good next step would be to read the PLATO study to help understand why." Another effective means of promoting evidence-based medicine is asking the learner to do the legwork and find research articles related to a patient case. Placing the onus on the learners is beneficial given they must read, summarize, and teach the material as a brief "journal club."

#### 10.3.2.1 Team Training

Training together as a multidisciplinary team is imperative in the ICU. TeamSTEPPS is an evidence-based teamwork system designed by the U.S. Department of Defense's Patient Safety Program in collaboration with the Agency for Healthcare and Research and Quality for healthcare professionals to improve patient safety and quality of care via teamwork skills and communication [38]. The program involves three steps: (1) needs assessment; (2) planning, training, and implementation; and (3) sustainment. Incorporating medical students, residents, and fellows as well as nurses, therapists, pharmacists, and other healthcare providers into the training will create an efficient and effective environment of patient care. Horsely and colleagues used TeamSTEPPS to formulate an interprofessional nursing and medical school curricula and found improved collaboration by removing the silos of education and patient care [39]. The program has also been shown to be successful in pediatric and surgical ICUs [40] where a 2.5 hours version of TeamSTEPPS was implemented and demonstrated improved communication, leadership, mutual support, overall teamwork, and overall leadership at 12 months. To date, no studies have been done to assess the value of TeamSTEPPS in medical ICUs.

Assessment and evaluation [12] of team members ensures continued performance improvement and completes the CARE framework. Individual and team feedback should address team member performance as compared to standards of high-quality, evidence-based patient care. Clay and colleagues developed debriefing checklists to assess bedside encounters and promote frequent feedback in the ICU [41]. The five “best practice” checklists evaluated residents on central catheter placement, consultation, family discussions, resuscitation of hemorrhagic shock, and resuscitation of septic shock. The checklists allowed for cheap, formative, self-reflective, timely, and critical care-specific feedback in comparison to Objective Structured Clinical Exams (OSCE), mini-clinical exams (mini-CEX), and simulation labs.

Even without checklists, feedback can be easily given on a daily basis. For example, after an intubation, the scenario can be replayed outside the room. Probe the learner with what they thought went well or what did not and focus on a few points. “Your choice of intubation drugs was appropriate. Why would X not be an appropriate choice for this patient?” or “Your technique was excellent. Using your right hand to reposition the head is a skill that many do not learn immediately. You could also use blankets/pillows to elevate the back and neck to align your axes which may alleviate the need to lift their head.” This direct, real-time feedback promotes progressive improvement throughout the rotation.

While the checklists addressed individual learner performance, the Individual Teamwork Observation and Feedback Tool (iTOFT), described by Thistlethwaite and colleagues addresses learners as part of an interprofessional team [42]. The “Advanced iTOFT” version for senior students and junior health professionals has ten observable behaviors under four headings: shared decision-making, working in a team, leadership, and patient safety. While not validated, this tool could be applied as a means to assess learners in their roles on an interdisciplinary ICU team. Teamwork is integral in the ICU, and as such processes to evaluate, discuss, and progress must be incorporated.

## 10.4 Bring It All Together

The ICU offers a challenging teaching environment and can often be physically and emotionally overwhelming for learners. By setting the stage early, breaking down the room to create a whole, promoting critical thinking, using available resources, simulating as a team, and giving feedback on a regular basis, learning can occur effectively and efficiently in the ICU.

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# Chapter 11
# Teaching Communication Skills

**Jennifer D. Possick and Kathleen M. Akgün**

## 11.1 Introduction

High-quality patient- and family-centered communication has been prioritized among clinicians in Pulmonary and Critical Care Medicine (PCCM) for more than a decade [1]. The American Thoracic Society (ATS) End-of-Life Task Force has identified core competencies in communication and relationship-building in the intensive care unit (ICU). Empathic communication that explores patients' preferences and values to guide clinical decision-making between PCCM clinicians, patients, and family members was among the key domains identified and defined in these competencies. Subsequently, a multi-society Task Force of PCCM education experts proposed comprehensive competencies and proficiencies for PCCM trainees, modeled after the Accreditation Council for Graduate Medical Education (ACGME) core competencies, that included interpersonal and communication skills (ICS) [2]. These educational milestones address both physician-patient/family communication and physician-team communication, emphasizing the importance of effective communication both as a consultant and primary clinician (Table 11.1) [3].

However, the importance of ICS competency among PCCM clinicians is greater than simply a regulatory imperative. ICS competency is an essential feature of practicing PCCM in a humanistic, patient-centered manner. And while ICS may not

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_11

**Table 11.1** Interpersonal and communication skills (ICS) milestones proposed by ACGME [3]

| ICS milestone | Example of demonstrated competency |
|---|---|
| Effective communication with patients and families across a broad range of socioeconomic and cultural backgrounds | An American-born trainee of Middle Eastern descent demonstrates cultural curiosity and respect by exploring rituals and beliefs of a Native American family planning to withdraw life-sustaining treatment for a family member with anoxic brain injury |
| Effective communication in interdisciplinary teams | A trainee checks in with nursing staff during ICU rounds, incorporates nursing input into the day's care plan, and clearly communicates questions to any consultants before presenting a unified plan for patient with multi-organ failure |
| Effective consultative services provided | After a nondiagnostic bronchoscopy for a patient with significant hemoptysis and cavitary lung nodule, a trainee engages additional consulting services (interventional radiology and cardiothoracic surgery) to discuss next best steps for diagnosis and management and communicates the consensus multidisciplinary decisions to the primary team, patient, and family members |
| Maintenance of comprehensive and legible medical records | A trainee clearly presents her clinical reasoning, differential diagnosis, and diagnostic plan in consult notes for a patient with leukemia and diffuse ground glass opacities on CT scan |

come naturally to all PCCM clinicians, these skills can and should be taught during medical training, from medical school to post-graduate subspecialty training and beyond. In fact, ICS should continue to be practiced and refined as part of ongoing professional development throughout our careers [4].

In this chapter, we detail the specific considerations for developing ICS training curricula in PCCM, consider examples from the existing literature, and identify ongoing challenges in implementing and evaluating ICS training programs.

### 11.1.1 Why Are Communication Skills Training Programs Needed in PCCM?

Effective ICS are critical to honoring patient autonomy, one of the guiding ethical obligations to our patients and a central concept to humanistic medicine. Effective ICS is more than information-sharing regarding a patient's clinical condition. Empathic communication shapes how the information is received and may inform subsequent decision-making for our patients.

As PCCM physicians charged with relaying information regarding diagnosis, prognosis, and therapeutic options, we increasingly recognize that *what* we say is indelibly shaped by *how* we say it to patients. High-quality ICS is crucial in both the outpatient management of patients with serious lung diseases and the high-stakes, high-intensity environment of the ICU, where critically ill patients and their families rely upon physicians to help them navigate challenging situations frequently fraught with a series of difficult decisions. PCCM physicians routinely exercise their ICS to hone in on the most important aspects of medical decision-making for their patients in inpatient and outpatient settings [5]. Effective communication requires that physicians distill complex medical situations into manageable information, elicit patient-centered values, react with empathy, and effectively integrate such discussions into a personalized care plan.

Patients, families, and providers each recognize the importance of effective communication for patients living with serious medical conditions, particularly toward the end of life [6]. Emphasis on the ICU team's commitment to avoid patients' suffering and to support decisions made by family members can influence families' reflections on their ICU interactions [7]. Empathic communication in the ICU can facilitate effective shared decision-making, improve patient/family satisfaction, and lessen the psychosocial burden on caregivers during critical illness [8, 9]. Ideally, discussions of symptom burden management, quality of life, and goals of care begin long before an ICU admission. Exploration of goals and values before a crisis may help set the stage for shared decision-making that reflects those priorities during critical illness. Patient- and family-centered communication during end-of-life (EOL) decision-making also decreases potentially non-beneficial or futile care, improves the mental health of caregivers, and may be viewed as a source of solace for grieving families [5, 10].

Unfortunately, patients and families frequently encounter suboptimal communication from medical providers and, just as positive encounters contribute to favorable family-centered outcomes, negative interactions can have a lasting, and potentially harmful, impact on their experience [7, 11–14]. Physicians frequently fail to recognize that patients with serious medical conditions want to have realistic, personalized conversations with their physicians regarding expectations, disease trajectories, and preferences for life-sustaining treatments. Inadequate communication around difficult topics can contribute to the emotional and spiritual suffering patients experience during the course of chronic and critical illnesses [11, 15].

Since many ICU patients are unable to make their own medical decisions due to critical illness, family members are placed in the role of surrogate decision-maker (SDM). SDMs rarely feel adequately prepared for their role [16]. As a result, SDMs look to the attending physician as the source of important information in the ICU [5]. Trainees, who usually have less experience in discussing serious medical news, may also find themselves representing the ICU team during crises in a patient's course. In fact, trainees report that they often undertake discussions about resuscitation status ("code status") after having observed four or fewer such discussions by more senior physicians [17]. Most trainees lead these discussions with sparse (or no) observation and feedback about their communication skills, and thus have little guidance about strategies or areas for potential improvement for future such conversations [17–19]. This may contribute to SDMs' perceptions of inadequate time with insufficient sharing of useful information during their meetings with ICU teams [14]. Conflict is also created when SDMs perceive that ICU physicians are not listening to and acknowledging the SDM's preferences and decisions [5].

High-quality ICS also impacts providers. Physicians frequently find these conversations to be stressful, and may worry that they are ill-equipped to respond to emotions appropriately or effectively. Ineffective communication can be a source of stress for physicians. Perceived ethical and EOL decision-making conflicts are significant risk factors for PCCM provider burnout and decreased provider retention in the field [20]. Evidence-based, real-world simulation training programs focusing on interpersonal communication skills may be a critical component to counteract these clinical communication challenges and to enhance resilience in PCCM physicians.

### *11.1.2 What Is the State of the Art in ICS Training?*

ICS education requires that learners recognize, process, and simultaneously manage both cognitive and emotional data [21]. By ultimately integrating these two data streams, learners should be able to understand and employ a larger range of ICS in conversations with patients and families. However, as with all practical skills, exploration of theory must ultimately be implemented in structured practice to become effective.

The Oncotalk program provides the foundation for development, deployment, and assessment of many future ICS studies and curricula [22]. This program is crafted around a 4-day intensive communication retreat for post-doctoral fellows in oncology, but the methodology and content are applicable to and have been used in a variety of subspecialties and disciplines, including PCCM. The curriculum includes didactic discussions of communication theory and cognitive roadmaps, but emphasizes active ICS practice and guided reflective discussion. Each Oncotalk session focuses on discrete ICS tasks framed by individual events that might occur at different timepoints in the care of simulated oncology patients (Table 11.2). For each task, learners are provided examples of cognitive roadmaps that emphasize recognition of and engagement with patient agendas, perception of empathetic opportunities, and formulation of appropriate verbal responses (discussed in more

**Table 11.2** Oncotalk ICS tasks and hypothetical clinical scenarios

| Communication task | Example |
|---|---|
| Delivering serious news | Sharing a new diagnosis of lung cancer after a biopsy |
| Discussion of diagnostic and prognostic uncertainty | Discussing the implications of a nondiagnostic biopsy of a new right upper lobe lung nodule in a breast cancer survivor |
| Transitioning from therapeutic to palliative care | Presenting palliative care options to a patient with refractory metastatic melanoma who can no longer tolerate traditional or experimental disease-modifying treatments due to frailty |
| Making recommendations surrounding do-not-resuscitate ("code status") orders | Making code status recommendations for a patient with end-stage multiple myeloma who declines renal replacement therapy in the face of worsening renal failure |

detail below). Sessions include formal and informal feedback as well as periods of self-reflection.

In a study of the Oncotalk curriculum, simulated patient sessions with 115 participants were audio-recorded and assessed in a blinded fashion using a previously validated methodology, with individual learners serving as their own controls. There were measurable improvements in participants' observed ICS behaviors, particularly with regard to delivering serious news and facilitating care transitions [23]. Participants also demonstrated more effective use of loaded language terms such as "dying." This study had the unexpected benefit of engendering substantive discussions among participants, and motivating early career physicians to commit to ICS as a meaningful facet of their work as clinicians, educators, and investigators [24].

Variations on the Oncotalk model have demonstrated that communication training is effective in improving ICS abilities across multiple subspecialties and levels of learning [25–28]. The Oncotalk model has also been associated with improved ICS in diverse care team models [29, 30] and even in different cultures [31].

The Oncotalk group also created the Critical Care Communication Project, modeled on the same principles and structure as Oncotalk [32]. The Critical Care Communication Project is a 3-day curriculum that includes brief didactics, skill-modeling by ICS faculty leaders, faculty-led small group practice with simulated family members, coupled with real-time feedback, and learner-centered role playing in small groups using real-world scenarios. Eighty percent of the content is small group learning based, and groups are designed to have a 1-to-5 faculty-to-learner ratio.

Cases are structured around the course of critically ill patients with a series of conversations occurring at different time points sequentially during their critical illnesses. Typical cases represent the spectrum of scenarios encountered in the ICU (Table 11.3). A linear timeline structure is used to mimic the typical relationship

**Table 11.3** Examples of typical cases used by the Critical Care Communication Project, paired with discrete ICS simulation task goals for trainees [32]

| Example case | Practice tasks |
|---|---|
| 28-year-old man with an unexpected critical illness following a traumatic fall | Provide clear, jargon-free information |
| | Talk comfortably about uncertainty |
| | Recognize and manage one's own emotions |
| 74-year-old lung cancer survivor with persistent physical disability and chronic dyspnea since surgery, now newly diagnosed with metastatic cholangiocarcinoma | Deliver serious news frankly |
| | Elicit and understand patient and family values |
| 81-year-old woman with advanced dementia, now admitted from skilled nursing facility to the ICU with recurrent aspiration pneumonia for the fourth time in 6 months | Effectively conduct a family meeting with multiple members |
| | Help families reach joint decisions and negotiate conflicts |

between PCCM physicians and family members, and to emphasize that ICS are applicable to more than EOL conversations.

Each individual simulated patient conversation tackles an ICS theme relevant to critical illness, such as delivering serious news, achieving consensus on goals of care, or discussing limitations on life-sustaining treatments. Additionally, the curriculum orients learners towards practicing discrete tasks (Table 11.3).

Importantly, this course is designed to be held outside the hospital setting to relieve learners of concurrent clinical responsibilities and to encourage engagement. Each exercise includes dedicated time for both feedback and self-reflection. At the end of the course, each learner identifies two skills to apply in everyday practice. These skills are written on a postcard that is mailed back to participants 1 month after the course to reinforce these self-identified goals.

The Critical Care Communication Project has been studied, with self-reported efficacy based on survey questions as the primary outcome. The survey included each of the curriculum thematic domains, as well as additional fields exploring participants' self-reported efficacy in leading discussions about treatment options or discontinuation of life support, address religious or spiritual needs, deal with SDM denial, and address requests to hasten death and manage pain. On pre- and post-course surveys, 95% of participants reported improvement in at least 1 of the 11 core skills, with a median improvement noted in 10 out of 11 skills. Ninety-two percent of participants rated the course highly, with 80% recommending that the coursework be mandatory for PCCM training [32].

## *11.1.3 What Are Elements of an Effective ICS Curriculum?*

### 11.1.3.1 Setting

First and foremost, it is essential to recognize that while dedicating time to ICS training is crucial, it is equally important to protect that time, by minimizing distractions and providing structure. ICS training often stands apart from other elements of a program's PCCM curriculum and can suffer from the lack of coherent framework. When possible, integration (and therefore contextualization) of ICS exercises into a broader PCCM curriculum may make the material more accessible for learners and yield greater impact.

### 11.1.3.2 Core Principles

As with any other procedural skill, methods for training, practice, and assessment should be standardized between learners. Selecting the "right" ICS for practice will depend on the skill level of the learners and the curriculum objectives. While novice learners might focus on fundamentals of patient-centered communication (e.g., maintaining eye contact, asking open-ended questions during a history, making empathic statements), intermediate or advanced learners may focus more on delivering significant news or guiding discussions of goals of care. Ideally, these skills would be approached as part of longitudinal (and ultimately life-long) ICS development.

Back and colleagues provide a helpful discussion of core principles of ICS that can be applied across a variety of programs [33]:

- *Put the learner at the center*. Efforts should be made to shrink the distance between the learners by emphasizing skill practice, discovery, reflection, and feedback over didactic elements.
- *Act as facilitators, not instructors.* Within a broader thematic exercise, learners should be guided toward individual goal-setting with regard to discrete skills. Feedback should be oriented toward positive reinforcement instead of critique. (The facilitator opens by asking the learner "What went well?" following their simulated patient exercise, and "What would you like to do differently next time?" before resuming role-play.)
- *Emphasize reflection.* Learners will arrive to ICS training with variable prior exposure to the material and variable comfort levels. An ICS curriculum should allow for graduated development that remains personalized, ensuring that training principles apply to novices and experts alike. The importance of reflection for this sort of training cannot be overemphasized. Reflection allows learners to gain insight into their own behavior, and to focus on skills that can be translated from an exercise into their future practice.
- *Establish ground rules and encourage learners as a community.* ICS experiences, particularly with simulated patients, can be vulnerable; establishing "rules" for rotation of roles, opportunities to "time-out" or solicit advice, and setting a tone for positive and constructive feedback, facilitate a productive educational environment. Furthermore, though individual learners seek individual growth, orienting a group toward communal experience allows opportunities for learning from observing as well as doing. Cultivating skills in observation and feedback lay the ground work for trainees to become effective future educators.

#### 11.1.3.3 Cognitive Roadmaps

Several validated cognitive tools have been developed and deployed in ICS training settings. These are easily accessible to learners and provide helpful roadmaps to apply in structured exercises involving challenging conversations.

Roadmaps such as SPIKES [34], ABCDE [35], GUIDE [36], and BREAKS [37] contain common elements and themes (Table 11.4 and Fig. 11.1). Each roadmap provides a scaffolding for thoughtful preparation that is applicable across a wide range of clinical conversation scenarios. In the teaching setting, they provide learners with a framework on which to "hang" the theory and skills being honed, and can help facilitators to organize question prompts for further discussion (Table 11.5). Outside the classroom environment, they can later serve as a "checklist" to focus

**Table 11.4** Utilizing the "SPIKES" ICS cognitive roadmap

| Mnemonic | Definition | Example of skill |
|---|---|---|
| SPIKES [33] | **S**etting | Select a quiet, comfortable meeting place |
| | **P**erception | Elicit patient's/family's understanding of current situation |
| | **I**nvitation | Ask for permission to share serious news |
| | **K**nowledge | Share new information in small parcels, pausing for emotion and questions |
| | **E**mpathy | Explore emotion with "NURSE" statements: "I can't imagine how upsetting this has been for you" |
| | **S**ummary/next steps | Recap the overall message that was shared and identify concrete next steps in the plan |

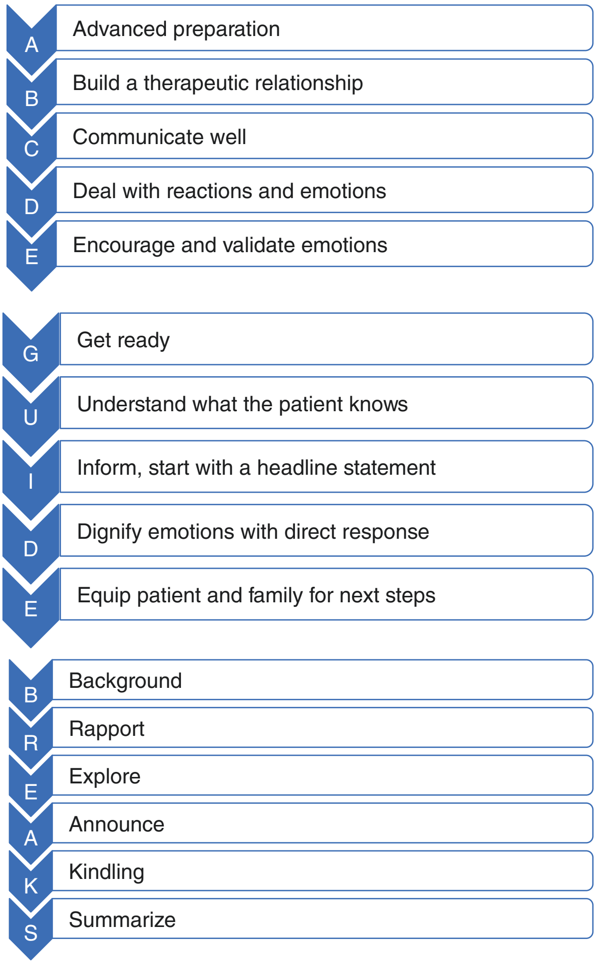


**Fig. 11.1** Examples of other ICS cognitive roadmaps

**Table 11.5** Example of integrating a cognitive roadmap into ICS small group simulated patient exercises and discussion

| "SPIKES" step [33] | Notes | Suggested questions for group |
|---|---|---|
| Setting | Thoughtful preparation includes knowledge of the patient's case, pre-defined goals (knowledge-sharing vs knowledge-gathering vs shift in goals-of-care or plan), and creation of appropriate time and space for conversation to take place | What are your goals for this conversation? |
| | | What do you anticipate will be most challenging for you? |
| | | What tools do you use to center yourself before a difficult conversation? |
| Perception | Patients, families, and physicians may have very different perceptions of the patient's clinical status. Alternatively, knowledge transfer may be framed as ask-tell-ask cycles | What questions do you use to gauge what the patient and/or family know? |
| Invitation | All parties must be willingly engaged on a topic of discussion to move forward effectively | What verbal and nonverbal signals do you use to telegraph a shift in the conversation? |
| | | How can you respond empathetically if you sense ambivalence? |
| Knowledge | Presenting difficult information frankly, and with a minimum of jargon, can be a struggle for all learners. It can be helpful to guide them in creation of a "headline" statement to focus the discussion | What are words you struggle with in such conversations? (e.g., death, dying) |
| | | If you are discussing a complex clinical scenario, what is the one thing you want your patient and her family to understand and remember? |
| Emotion | Emotions should be expected, and should be explicitly acknowledged by the listener. Be aware of emotion cloaked as a cognitive question | What strategies can you use to align with patients expressing emotion? |
| | | How do you manage your own emotion during conversations? |
| Summary | Depending on the particulars of a conversation, the summary may serve to either reinforce the new knowledge shared or clarify the plan of care created | What do you identify as the "take-home message" for this conversation? |
| | | What should the family members expect to happen next, based on the conversation? |
| | | If further discussions or decisions are still needed, how do you frame those needs? |

learners as they prepare for difficult conversations in their clinical practice. In each of these frameworks, preparation is emphasized as a crucial element for successful conversations with patients or families.

Cultivating empathetic responses in trainees is a complex process, as situational awareness, self-awareness, personal communication style, and comfort

**Table 11.6** The NURSE framework for empathic communication [37]

| | |
|---|---|
| **N**aming emotions | *"It sounds like this has been really upsetting for you"* |
| **U**nderstanding | *"This must have upended everything at home"* |
| **R**espect | *"I have admired your strength during your wife's illness"* |
| **S**upport | *"We are here to work through this together"* |
| **E**xploration of difficult subjects | *"Tell me more about…"* |

level play significant roles in developing an appropriate empathetic response. Building self-awareness is helpful, as some individuals will retreat to jargon or pile on additional information when faced with emotions, while others will over-empathize and risk losing the purpose of the conversation. The NURSE framework [38] provides helpful guideposts in responding to emotion with empathy (Table 11.6) [39]. Regardless of the techniques used for responding to emotion with empathy, it may be helpful to encourage learners to leave their comfort zone and to experiment with new phrases or approaches while practicing ICS in a safe environment.

The REMAP cognitive construct is of particular relevance to the PCCM ICS curriculum, as it is specifically intended for conversations about prognosis and goals of care [36]. It contains many of the same elements of the other tools discussed, focusing on goals of care, often at EOL. Table 11.7 demonstrates how a learner at both a "novice" and, later, at "intermediate/advanced" stage might utilize REMAP in simulated patient sessions during ICS training.

It can be helpful to pair such roadmaps with more general discussions of the subliminal power of language and its connections to the inherent biases we all share. To some extent, teaching ICS requires reframing the nature of the discussion being held. Specifically, avoiding characterization of news as "bad" may make the exercises in communication training more comfortable. Characterizing news or content as "bad" is a values-based judgment that may imply pre-assignation of a particular emotional response. For this reason, we suggest framing lessons as "delivering significant news."

#### 11.1.3.4 Simulation Sessions

As discussed earlier, most existing studies and curricula have employed simulation, both through guided role-play and simulated patient scenarios to maximize verisimilitude in the exercises. This is consistent with typical use of simulation in many educational realms, particularly procedural training, and is an approach strongly endorsed based on existing evidence. Furthermore, simulated patient-based training exercises are less logistically challenging to deploy, contain less inherent risk than real-world immersion experiences, and provide opportunity to standardize curriculum exposure.

**Table 11.7** Application of the REMAP framework to a critical care scenario

H.M. is a relatively mature 1st-year PCCM trainee compared with her peers. Prior to participating in ICS workshops, her self-reported comfort and knowledge about communicating serious news with patients and families was "very good to excellent"
As part of ICS training, she participated in an exercise with a simulated family member of a patient with advanced COPD and escalating episodes of acute respiratory failure. The patient is now unable to wean from the ventilator after a week of support. Cognitive roadmaps, including REMAP, are introduced prior to the simulation exercise
Below are examples of H.M.'s approach during the initial simulation exercise ("novice learner") and at a follow-up simulation session after completing the year-long course ("intermediate-advanced learner")

| **"REMAP" step** [35] | **Novice learner** | **Intermediate-advanced learner** |
|---|---|---|
| *R*eframe why the status quo isn't working | "Your mom isn't getting better" | "I know your mother has been able to come off the ventilator before, but this time appears to be different" |
| *E*xpect emotion and empathize | She acknowledged emotion ("I can see this is upsetting you") but quickly changed the subject | She used NURSE approaches and prompted further exploration of emotion. "I can't imagine how upsetting this must be" |
| *M*ap the future | She tried to elicit the patient's wishes, but approached decisions in a task-oriented manner using euphemisms. "At this point, we need to know if your mom would want a tracheostomy or if she would want to be let go of peacefully" | She explored values to help frame decisions. "These next steps can be so tough. As we think about what your mom would want, can you tell me more about the past few months at home, and help me understand what's most important to her?" |
| *A*lign with patient values | She respected expressed wishes about individual decisions, but did not explore broader goals. "OK, let me talk to the surgical service about getting her on the schedule for a tracheostomy" | "Based on what I am hearing, it sounds like your mom would consider a tracheostomy, but would want to know she could still spend time doing the activities that bring her joy. Let's talk more about how to do that" |
| *P*lan care that matches the patient's values | There was no specific summary of the conversation other than that a surgical consult would be placed | "We will ask the surgeons to meet with you and discuss the operation further. In the meantime, we will continue to treat the pneumonia and see if she's able to participate with physical therapy" |

It is important, however, to recognize the limits of simulation-based ICS training. Even the most skilled simulated patients cannot achieve complete suspension of reality, and learners and physicians will typically respond differently to a simulated patient than to a real-world patient [40]. Therefore, use of a rich simulated patient-based curriculum does not obviate the need for evaluation, feedback, and reflection in real-world settings to guide ongoing ICS development as training evolves to a higher level.

It is also important to recognize that a simulated patient will not accurately represent a full spectrum of patients or families from culturally diverse, disadvantaged, or low health literacy backgrounds. This highlights the importance of coupling ICS training with awareness of cross-cultural care.

Computer-based simulation training, as either the primary source of simulation training or as a curricular adjunct, has been explored in a limited number of studies, and has been effective when paired with targeted feedback [41]. One such program used an interactive software platform which provided targeted feedback to learners. The impact of the training module was assessed through evaluation of audio recordings from subsequent doctor-patient interactions, as well as patient-experience surveys. Physicians made more empathic statements post-training, and patients reported a higher level of trust in physicians who had undergone training. Interestingly, however, patients did not subjectively rate communication skills higher in the intervention group compared to the control group, potentially highlighting the challenges of selecting measurable metrics for curriculum success [42].

Computer-based simulation exercises may be helpful in curricula where there are resources or logistical barriers to simulated patient-based programs, or as a means of continuing to reinforce and practice skills outside the in-person, small group setting.

#### 11.1.3.5 Objective Structured Clinical Examination (OSCE)-Based Evaluation

Feedback on communication skills is most effective when paired with direct, objective, and systematic assessment tools applied during OSCE. Though multiple tools exist to evaluate the efficacy of patient-centered communication in the educational setting, most instruments have not been thoroughly assessed for reliability and generalizability [43]. Furthermore, most existing tools are aimed at assessing the "patient-centeredness" of encounters, and are generally not aimed at capturing content-specific communication skills (discussing serious news or addressing goals of care). Still, such assessments can provide the foundation for targeted feedback that guides self-assessment and reflection. Inviting feedback in the form of patient or SDM-satisfaction questionnaires can provide a means of incorporating real-world, "360-degree" assessments into guided feedback sessions [44].

#### 11.1.3.6 Selection of Metrics

Meaningful metrics for teaching strategies can be difficult to establish, and this is particularly true of ICS training [45]. Learning metrics generally fall into four different domains: knowledge, content skills, process skills, and perceptual skills. Individual programs and curricula may draw differently from these areas depending on pedagogic approaches and available resources, but the optimal balance in ICS remains unclear [46]. Even when improvements in skill metrics are achieved, it can be challenging to connect success of an educational program to a desired clinical outcome. Indeed, the concept of "effectiveness" is a loaded one – depending on how this is defined, it will drive the aims of a program, what is measured, and the expected outcomes.

Given the complexity of clinical and emotional situations during critical illness and/or in the EOL setting, it is even more difficult to demonstrate that ICS training translates into improved patient outcomes or patient/family satisfaction, even when improvement in self-efficacy or the ICS skillset can be objectively demonstrated [47].

It is certainly easier to design curricula aimed at achieving immediate impacts on the learner (e.g., improved attitude toward material, expansion of knowledge, elevation of skills), than to ensure sustained changes in "on-the-job" behavior or an impact on patient outcomes. Additionally, though self-reported assessments may be an important aspect of reflection and growth, it is important to note that such assessments are notoriously poor correlates of observed competencies in actual clinical practice and should be considered just one of many dimensions in milestone evaluation [48].

An awareness of the limits of existing metrics can help to guide assessment of ICS training programs and emphasize the value of intangible broader impact of ICS education. Indeed, rigorous assessment is of independent value in shaping future program growth, emphasizing a neutral examination of the impact of ICS curricula [49]. This also prompts a fundamental examination of how we think training should translate into practice change, and whether this should occur at the level of individual learners or an organization.

### *11.1.4 What Are the Challenges?*

The best practices for adoption of evidence-based curricula for ICS training in PCCM is in evolution. In addition to the challenges specific to simulation-based training and selection of effective metrics addressed above, there are other conceptual and practical barriers inherent to creation of an effective ICS curriculum.

Interactive sessions to practice ICS with appropriate supervision and structured feedback require the investment of resources and time and therefore are still frequently lacking from PCCM programs. In many instances, early adoption of ICS curriculum content may be limited to didactic lectures or passive observation, neither of which has been shown to impact learners' skill mastery [50]. This should be borne in mind, as an ineffective initial program may lead to resistance regarding more elaborate resource investment. It is also unclear whether level of engagement influences efficacy – motivated learners may be more likely to benefit from training than unmotivated learners, despite the latter group demonstrating the most need for improvement.

In general, medical education has undergone a pedagogical shift from focus on acquisition of skills and knowledge relevant to medicine in an apprentice-style framework to experience-based growth of learners into flexible, team-focused medical professionals [51]. As a result, there is a dearth of qualified medical professionals who have personally undergone this training; even fewer qualified medical professionals are available to implement this kind of program during PCCM training.

Implementation of ICS for learners, therefore, also requires simultaneous efforts dedicated to reorienting faculty and teachers.

### *11.1.5 How Can ICS Training Effectively Move Beyond the Classroom?*

Ultimately, the goal is to move ICS training from educational settings to actual clinical practice. Effective implementation and transition of ICS training in clinical practice requires that PCCM educators be trained to observe, facilitate, and provide feedback to allow learners to apply ICS and guide reflection on their experiences with real-world cases.

The Oncotalk Teach program was developed as a complement to Oncotalk and provides a window into potential models for educating the ICS educator [52]. The classical model of medicine as an immersive apprenticeship assumes that as students leave the didactic classroom, they mainly develop and refine skills, including ICS, through practice and by observing behavior modeled by senior clinicians. To translate modern ICS curricula objectives from educational retreats into the "real-world" clinical setting, faculty must be equipped to effectively teach ICS in this setting. At the same time, it is important to acknowledge that most faculty will have

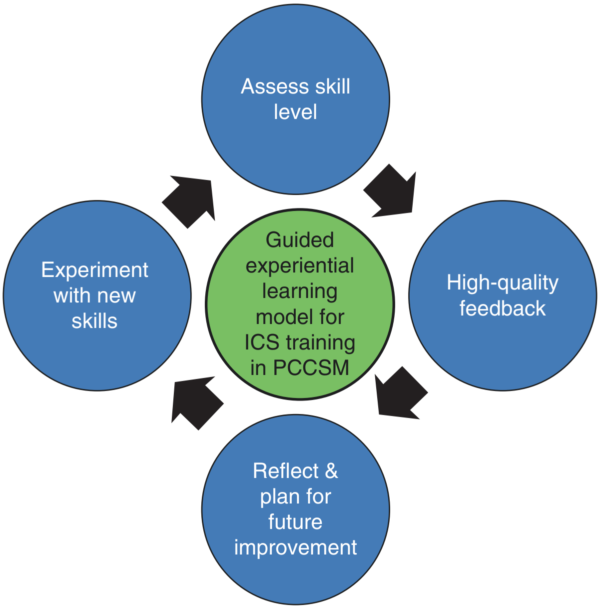


**Fig. 11.2** Approach to experiential learning for communication skills training

learned their own skills via more classical methods, or may have received no formal ICS training at all.

Oncotalk Teach consists of two faculty retreats aimed at aligning faculty teaching methods with the objectives of ICS curricula. It begins with discussion of ICS teaching paradigms and cognitive roadmaps, but emphasizes skill development as observers and facilitators in sessions with simulated fellow-patient pairs and web-based exercises (Fig. 11.2). Though there is still definite value to modeling advanced ICS skills, this approach emphasizes guided experiential learning, with teachers first assessing the skill level of the learner, then helping them to engage in active planning to set the stage for successful conversations, and then facilitating learner self-reflection while providing structured, high-value feedback. Follow-up retreat sessions with additional simulation practice can allow teachers to self-assess their growth and further refine their teaching skillset.

One PCCM-specific study of first-year fellows coupled a typical didactic and small group simulation workshop on patient-centered communication and shared decision-making with subsequent real-world assessments [53]. In this case, each PCCM fellow was observed during two supervised family meetings by a Palliative Care Medicine faculty member who gathered data, provided feedback, and guided self-reflection. Both self-assessed and objectively assessed skills improved over time, as did fellows' self-reported confidence and self-efficacy. A Family Meeting Behavior Skills Checklist was developed and validated for use in the assessments [54]. The Checklist assessed for behaviors included in several published communication frameworks (such as SPIKES) and also evaluated documentation of the family meeting in the medical record. The study authors felt this checklist functioned well not only as an assessment tool, but as a cognitive roadmap for future practice.

## 11.2 Conclusion

The true aim of ICS training, of course, is to permanently alter the learner's approach to ICS in practice. Increased workloads, time pressures, poor skill-modeling, and skill devaluation all unfortunately conspire against retention of these important communication skills, which will inevitably degrade over time if not practiced [55]. Truly successful ICS training must therefore be coupled with corresponding change at the institutional level. PCCM practices and training programs must evolve in parallel and complimentary ways to appropriately value ideal communication between ourselves, colleagues, patients, and families.

The clinical relevancy of developing effective and efficient interpersonal communication skills is substantive, and devoting resources to optimize learners' ability to interact with patients and families is critical. ICS education is a rapidly growing field in PCCM, characterized by opportunities for continued growth, innovation, and investigation. As a component of PCCM training, ICS education has the potential to transform both teachers and learners, and to shape the practice of medicine in an enduring way. High-quality ICS training can have an immediate impact on learners' skills and enthusiasm for refining their own skillset, while also providing meaningful and rewarding experiences for faculty [33, 56]. To pave the path forward, it will be essential to approach ICS educational strategies and curricula in a rigorous and scientific way to ultimately yield best practices.

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# Chapter 12
# Teaching with Simulation

**Alison S. Clay and Jeffrey A. Gold**

## 12.1 Introduction: Value of Simulation

Aviation and healthcare share several important attributes that highlight the importance of simulation (Table 12.1) [1]. The first similarity is the tragedy of death in the face of human error. The airline industry faced public outcry after several notable airline crashes in the 1970s [2]. One of the most prominent crashes was Eastern Air Lines Flight 401. While on approach for landing, the pilots aborted their landing because they mistakenly believed the landing gear was not "down" as indicated by the failure of the landing gear dashboard light to illuminate. During troubleshooting, crew members went below to visually assess the status of the gear and the plane's autopilot was activated. The plane began to lose altitude, but everyone failed to hear the low-altitude alarm. The plane crashed in the Everglades with 103 fatalities. The subsequent investigation revealed that the landing gear was correctly deployed, and that the cascade of events was triggered by the faulty warning light. A second tragedy was attributed to communication error: in 1977, two 747s collided on a runway, killing 583 people when the pilots and control tower miscommunicated [2].

Death in healthcare is usually more intimate and less public, at least until the Institute of Medicine published *To Err is Human*, attributing more than 98,000 deaths per year to medical error – the equivalent of losing more than one 737 airplane full of passengers every single day.

A second similarity between the aviation industry and healthcare is the hierarchical nature of both systems. Both are systems where it may be difficult for team

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_12

**Table 12.1** Similarities between aviation and healthcare that highlight importance of simulation

| Similarities between aviation and healthcare |
|---|
| Tragedy of death when something goes wrong |
| Rare events may contribute to morbidity/mortality |
| Presence of hierarchy |
| Reliance on teams |
| Impact of fatigue/night shifts |
| Use of monitoring equipment |
| Potential for alarm fatigue |
| Use of simulation for training, practice, and assessment |

members to speak up, whether within a single profession (pilot-copilot, or student-intern-resident-attending) or between professions (pilot-crew member, nurse-doctor) [3–5]. In response to the detrimental effects of hierarchy, the airline industry developed and deployed Crew Resource Management (CRM) methodologies. While retaining the traditional command hierarchy, CRM allows for all members of the cockpit crew to question and provide input. CRM not only improves communication but also team problem-solving skills and overall efficiency. CRM has been adapted to healthcare, most notably in its integration into the core principles of TeamSTEPPS, from the Agency for Healthcare Research and Quality (AHRQ) [6–10].

A third similarity between aviation and healthcare is the role of fatigue and night shifts as potential causes of adverse safety events. The airline industry last set duty hours for pilots in January 2014, requiring 10 hours off duty between shifts and 8 hours of uninterrupted sleep between shifts [11]. Graduate medical education last reformed duty hours in January of 2017, requiring no more than 24 hours of continuous work per shift and no more than 80 hours per week averaged over 4 weeks [12]. The discussion of work hours is particularly appropriate to Critical Care Medicine, as fatigue has been cited as a cause of significant diagnostic and medication-related errors made by physicians in the intensive care unit (ICU) [13].

Finally, both industries are highly reliant on equipment and alarms. In both industries, professionals need to be trained for extremely low frequency but high-risk events, such as equipment malfunction or failure. As a result, professionals in both fields are also highly subject to alert fatigue. This was exemplified by the Eastern Airlines Flight 403 disaster, and is an issue at the forefront of ICU safety.

The aviation industry has addressed many of its system- and practice-based challenges with the broad incorporation of flight simulators for training, practice, and assessment. Similarly, simulation has been increasingly used in healthcare as a powerful educational and assessment modality, echoing the role of simulation in the aviation industry.

## 12.2 What Is Simulation?

Simulation is defined as “a technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions" [14]. To achieve an effective simulation experience, one must employ a combination of technology, personnel, and equipment to reproduce the "realism" or fidelity of the exercise. The degree of fidelity is determined by available resources, number and type of learners, and overall learning objectives (to be discussed in ensuing sections). As a result, simulation can be something as simple as role-play between two learners or insertion of a central line into ballistics jelly, or as complex as a virtual gaming environment or a mock operating room theater.

## 12.3 Educational Theory for Simulation

In addition to the natural impact of simulation on patient safety, there are also many educational and theoretical justifications for using simulation as a training and educational intervention (Table 12.2). Simulation is consistent with adult learning theory, provides deliberate practice, trains non-cognitive domains, and allows for standardized assessment.

Simulation provides the opportunity to apply material traditionally learned in the classroom by leveraging different instructional strategies to improve acquisition and application of knowledge [15]. Technology allows for self-directed learning via flipped classroom techniques, as learners can prepare for educational sessions at home, and then apply learned material in a practice-type setting [16]. Learners can individually pace their learning, repeating sections or returning to videos of themselves engaging in simulation scenarios as needed. Use of technology-enhanced learning, including the flipped classroom, video games, and other simulation experiences, is generally preferred by Millennials and Generation Z learners, the current and future learners in healthcare professions [15, 17].

**Table 12.2** Reasons why simulation is effective education

| Important aspects of simulation | |
|---|---|
| Addresses principles of adult learning | Allows self-pacing and ability to review material after the fact |
| | Experiential/application instead of medical knowledge |
| | Use of technology preferred by Millennials |
| Provides deliberate practice | Practice the same skills over and over to develop expertise |
| | Spaced repetition to main skills |
| | Video review to allow for evaluation of one's own performance |
| | Coaching to improve skills |
| | Calibrate cognitive load for novice versus experienced learners |
| | Train for rare events |
| Addresses non-cognitive domains | Allows learners to address emotions experienced in the clinical setting through simulation |
| | Teaches communication and teamwork skills explicitly |
| Allows for assessment | Standardized cases allow for assessment of learners |

Simulation is experiential learning which allows for deliberate practice, defined as dedicatedly and reflectively practicing skills repeatedly until there is less variation in those skills to allow for achieving mastery [15, 18, 19]. It has been theorized that it takes 10,000 hours of deliberate practice before one can achieve true mastery and excellence in a specific skill or skillset [6, 20]. With video-recording debriefing, simulation allows learners to review their own performance in certain skills, reflect on their actions, and debrief the reasons for their decisions in the moment [19]. After receiving feedback, learners may apply what they learned to a new simulation scenario [15]. Such reflective practice contributes to effective and meaningful learning [21, 22].

The use of controlled, purposively designed cases and scenarios offers distinct and unique advantages over other types of education. Optimally, simulation is designed iteratively to allow learners to master simple tasks at first and then to add complexity, transitioning from novice toward expert [21–23]. Such progression calibrates the appropriate cognitive load for each individual to optimize learning [24]. Case fidelity and complexity increases as the learner advances. As fidelity increases and simulation more closely mimics real-life experiences, the learner practices skills complicated by psychological responses and emotions frequently encountered in actual clinical practice [21]. Leveraging the concept of spaced education, the same or similar cases may be revisited at intentionally sequenced time intervals to prevent decay of knowledge [16]. As learners gain experience, they are exposed to simulations that may occur rarely in clinical encounters to prepare for unexpected, but important, clinical scenarios.

Simulation-based education has gained increasing importance in light of duty hour restrictions [25]. Studies in the nursing literature suggest that simulation could potentially replace clinical training to prepare individuals for licensure. In a multicenter trial, nursing students randomized to traditional simulation (<10% of training), moderate simulation (25% of training), and significant simulation (50% of training) demonstrated no differences in licensure exams or assessment of clinical skills either during nursing school or in the first 6 months of practice [26].

By focusing on the application of knowledge in real-life clinical settings, simulation allows for training and assessment in non-cognitive domains. At the center of this is a focus on communication skills. In scenarios involving interdisciplinary and/or interprofessional teams, teamwork skills improve with simulation [27]. Specifically, leadership [28–30], situational awareness [28], delegation [29], assertion [30, 31], creation of shared mental models [29], and structured communication [29, 30, 32] improve with simulation experiences. As medical education moves to competency-based assessments through the adoption of core competencies (including system-based practice, practice-based learning, communication, and professionalism), core entrustable professional activities, and milestones, simulation is uniquely positioned to facilitate instruction in and assessment of these domains, particularly through inclusion of members of the interprofessional team [22].

## 12.4 Simulation in Pulmonary and Critical Care Medicine

Within Pulmonary and Critical Care Medicine (PCCM), simulation is commonly employed and improves education, skill, and patient care outcomes (Table 12.3).

**Table 12.3** Examples of use of simulation in pulmonary/critical care medicine

| Examples of use of simulation in pulmonary/critical care medicine | |
|---|---|
| Procedural training | Central venous line placement |
| | Bronchoscopy |
| | Emergent and difficult airway |
| | Thoracentesis |
| | Chest tube placement |
| Team training | Rapid response teams |
| | Trauma resuscitations |
| | Pediatric life support |
| | Advanced cardiac life support |
| | Patient safety/evaluate for hazards of hospitalization |
| Communication training | Breaking bad news |
| | Goals of care/end-of-life conversation |
| | Disclosure of medical errors |
| Evaluation of the healthcare system | Electronic health record |
| | Human-machine interface |
| | Effectiveness of hospital policies |
| | Design of healthcare space |

Simulation with task trainers to teach central venous catheter (CVC) insertion leads to acquisition [33] and retention of skill [34], and results in fewer needle passes and reduction in catheter-related blood stream infection [35]. When task trainers are combined with virtual and/or augmented reality, learning satisfaction [36], self-confidence, number of attempts, and time to CVC placement are all improved [37]. Similarly, bronchoscopy and advanced airway simulation increases rate of skill acquisition and competence [38–40]. Based on the benefits of simulation training on improving technical skills, simulation is recommended for procedural competency by multiple professional societies [41].

In addition to specific skills training, an array of studies document the benefit of simulation in team-based management activities, including rapid response teams, trauma resuscitations, and pediatric [42] and advanced cardiac life support team performance [43]. Team training has been shown to improve patient care efficiency [34] and patient safety [44, 45]. Similar improvements have been observed in ICU training activities. In one study, interns who were trained via simulation in the management of shock outperformed 3rd year residents on bedside assessment of 20 key performance indicators related to management of critically ill patients [7].

Simulation also trains providers in effective communication techniques. Simulation is used for training in how to have difficult conversations with patients and/or families, including how to break bad news [46–48], set goals of care, engage in end-of-life discussions [46, 49], and disclose medical errors [50] (see Chap. 11). Practicing these types of conversations improves learner self-confidence [46–49, 51, 52] and communication as judged by expert faculty [52] or simulated patients [47, 49, 53].

Simulation helps study the performance of systems to determine system flaws that impact individual and team performance in patient care [54]. Simulation of the

ICU environment helps teach teams how to identify common hazards of hospitalization in the ICU, including risk factors for delirium, pressure ulcers, and hospital-acquired infections [55, 56]. Simulation of the electronic health record (EHR) in the ICU helps individuals and teams discover problems with their navigation of the EHR, identification of medication errors, and/or evaluation of trends of data [57–59]. *In situ* simulations (those occurring within patient care areas in health systems and not in a simulation lab) identify issues with hospital policies, human-machine interfaces [60], areas where teams consistently struggle (e.g., anticipation during crisis situations and late responses to alarms) [61, 62], and other latent system threats (look-alike medications, missing equipment, lack of adequate staffing) [63, 64].

Boot camps combine multiple types of simulation experiences into a single curriculum to prepare trainees for upcoming residencies [65] or fellowships [66]. Simulation can be used to assess for minimum competence during clerkships [65] and can be used to evaluate milestones and core entrustable professional activities [67, 68].

## 12.5 Limitations of Simulation

Simulation is not without potential risks and limitations. First, simulation can be costly. The investment in equipment, faculty training, and faculty observation for simulation are significant. In one orthopedic residency program that performs competency-based assessment of all residents, costs were nearly 15-fold higher than pre-simulation education expenditures [69]. Simulation increases time demands on faculty, which can significantly impair the ability to recruit enough faculty to sustain simulation teaching sessions and/or a simulation curriculum [70].

Although simulation may demonstrably improve performance of defined process measures on validated checklists, simulation's impact on clinically meaningful patient outcomes is less clear. While simulation improves patient outcomes for CVC placement and some team training skills [71], universal patient-level benefit from simulation-based education is not consistently demonstrated in the literature. One large study looked at the impact of end-of-life communication training (which was comprised of eight simulation sessions) on patient-reported quality of communication. The study not only found no difference in the quality of communication between simulation-based training and standard communication teaching sessions, but also found an increase in depressive symptoms in patients who were counselled by resident or nurses who had participated in the simulation-based communication training [72].

## 12.6 General Design Principles

Simulation is a technique to help one achieve specific education and/or training objectives. Therefore, an educator should start with defined learning objectives, and then decide if simulation is the *most appropriate* modality to achieve those objectives. Training objectives often fall into four broad categories.

1. Increasing general knowledge about either a disease, management strategy, and/or clinical reasoning skills (often with novice learners).
2. Improving clinical practice. Often used with intermediate and advanced learners; examples range from training on situational awareness, to improving technical proficiency with procedures, to improving team-based communication.
3. Understanding the health system. For example, using simulation to optimize or evaluate a new clinical space (or planned space).
4. Academic discovery. Development of new educational tools/strategies, medical devices, or clinical care pathways.

Regardless of the reason for the simulation-based educational activity, one should use same general principles for defining learning objectives for simulation-based teaching as with any other educational modality. Learning objectives should be appropriate to the level of learner in the time allotted for the simulation. One of the most common pitfalls in simulation design is creating activities with an inappropriately high level of complexity for the learners' experience level, resulting in cognitive overload and decreased effectiveness of the activity. For example, teaching novice learners about CVC placement was more effective when the activity was broken into "smaller" steps, rather than teaching the entire procedure at once [24, 73].

## 12.7 Learners and Assessment Strategy

Once the reason and need for simulation are established, one should identify the learners involved, as this will impact assessment tools, performance measures, debriefing strategies, and overall scenario design. Specifically, determine the total number of learners, experience level (novice, intermediate, advanced), type of learner (physicians, nurses, pharmacists), and whether the activity will require a mix of type and experience level. Next, the time frame in which the activity occurs and the number of faculty or staff needed must be considered. Time and faculty/staff availability are critical resources for ensuring sustainability.

Once the learners and the learning activity are defined, the next step is to define the performance indicators to be assessed. Performance indicators are process measures to be achieved by learners within the simulation experience(s). Performance indicators can span the entire range of patient care activities, from recognizing a disease state (e.g., ARDS), to performing all the steps of a specific procedure (e.g., a CVC checklist), to even more generic patient care activities (e.g., using a specific order set or ensuring handwashing before and after examining a patient). It is key that performance indicators not only be appropriate for the level of learner, but that they are created in conjunction with content expertise for that professional group. Furthermore, local or other experts must agree that the performance indicators are accurate and reflect best practices of clinical care. Without such agreement, conflict between the explicit and implicit curriculum can derail learning [74].

Assessment of learners can be subdivided into *formative* assessment, which focuses on allowing learners to discover their strengths and weakness and use deliberative practice for continued improvement of performance. In addition, simulation can be used for *summative* assessment. For summative assessments, the simulation activity is used as a means to ensure learners have achieved an established level of knowledge or performance at the end of a course or training program. Summative assessments are often high-stakes activities, where the performance in the simulation directly contributes to an actual course grade and/or is used to determine readiness for advancement in a program or course. High-stakes summative simulations require even greater attention to structure, fidelity, and reproducibility to ensure that all learners receive a fair, accurate, and reliable assessment.

The tools used for assessment fall into broad categories: checklists or global assessments, with many activities using a combination of both tools. While checklists have the advantage of ensuring each step of a process or series of performance indicators are achieved, global rating scores may be more accurate and reliable for assessment of overall competence [75]. Ideally, as with all assessment tools, if one must develop a new tool, it is critical to follow tips that facilitate creating a tool that is valid and reliable and has adequate discriminatory capability (i.e., does it discriminate individuals who are less expert from those who are more expert?) [76, 77].

## 12.8 Scenario Design

### *12.8.1 Scenario Design: Fidelity and Equipment*

One of the main factors to consider in designing a simulation activity is the degree of fidelity, or realism, required to achieve the learning or training goals. While it is tempting to believe that fidelity is critical to simulation effectiveness, a number of studies suggest fidelity has little impact on overall success of the activity [9, 10]. However, these results may be skewed by selection bias [8]. When considering fidelity, three sub-areas are important: environmental fidelity, equipment or technological fidelity, and psychological fidelity.

*Environmental fidelity* is how realistically the simulation space reproduces the actual clinical space. Environmental fidelity is important if the activity contains performance measures which are specific to the clinical enterprise and/or if the goal of the simulation is to test the effectiveness of the clinical enterprise itself. Whether or not to use a simulation space or the healthcare setting (with *in situ* simulation) depends on the objectives of the simulation. For example, consider team training for ACLS - if the goal is to optimize adherence to ACLS guidelines and teamwork, a dedicated simulation space may suffice. However, if the response time of code team members is a key performance measure, this will need to happen *in situ*. While it may seem natural to always conduct simulation *in situ* because of fidelity considerations, one must be cognizant of the impact this can have on the care of actual patients and patient flow in crowded healthcare systems, and the potential lack of dedicated space for observation and/or debriefing.

*Equipment or technological fidelity* comprises all of the medical devices which normally would be used in actual clinical delivery of care. Again, learning objectives, performance measures, and learner experience level will determine how essential equipment or technological fidelity is for a given simulation scenario. For example, in simulations focused on treatment of sepsis by established healthcare providers, it may be essential to use the same IV pumps and monitors used in clinical practice. Conversely, for CVC insertion training with novice learners, it may not be necessary to have the exact same ultrasound machine used in the hospital.

Finally, there is *psychological fidelity*, or how "real" the exercise feels for the learner(s). Rapid advancement in simulation technology has allowed instructors to improve the domain of psychological fidelity. However, it should again be stressed that the most technologically advanced simulator is not necessarily required to achieve learner "buy-in" and suspension of disbelief.

Once fidelity is determined, a list of required equipment should be generated. There are six broad categories of *simulation-specific* equipment (Table 12.4). When considering equipment, consider not only the availability of the equipment, but whether or not the equipment can replicate the human condition required for the scenario. For example, a high-fidelity simulator maybe capable of being used with a ventilator, but it may not be possible to reproduce the mechanics of severe ARDS or deliver the appropriate ventilator settings safely without damaging the mannequin.

### *12.8.2 Scenario Design: Human Resources*

In addition to equipment, one should consider the *human resources required to conduct simulations*. In addition to the primary instructor, additional simulation operations specialists (a.k.a., simulation technicians) may be required to set up the simulation room, prepare the equipment, and/or run the simulator and/or mannequin. Depending on the scenario, simulated patients (medical models or standardized patients) and/or simulated health professionals may also be needed.

*Medical Models*: These are unique types of simulated patients used specifically for physical exam and/or ultrasound training.

*Simulated Patients (SPs)*: SPs serve as a proxy for actual patients and usually do not have a healthcare background. There is a rich and robust literature on the use of SPs to both achieve necessary fidelity and to facilitate training in patient-provider communication. SPs are tasked not only with playing the role of the patient, but often also have a defined role in assessment of the learner. Optimal preparation for and use of SPs is outlined in a recent consensus best practice statement [20].

*Simulated Health Professionals*: These individuals are planted in the scenario to help with flow or fidelity. These are often referred to as "confederates." These may be either professionally concordant (e.g., a physician playing the role of physician) or professionally discordant (a physician playing the role of a

**Table 12.4** Types of simulation equipment

| Category | Description | Advantages | Considerations/ barriers |
|---|---|---|---|
| Task trainers | Low-fidelity mannequins used for practicing basic technical skills (e.g., central line trainers or IV arms) | Low cost and thus able to have multiple units for large-scale education | In isolation, does not reproduce the sociotechnical factors to be accounted for during procedures |
| High-fidelity mannequins | Mannequins which with integrated electronics can reproduce vitals and physiologic responses. Most can relatively closely reproduce all aspects of human condition | Can establish a high degree of fidelity for complex management scenarios | Very expensive capital costs<br>Need personnel to run the mannequin and observe the simulation |
| Virtual reality trainer-haptic skills trainer | Can be manual (laparoscopic boxes) or computer-based. Variations include trainers with feedback (haptic) or without. Examples include bronchoscopy/endoscopy simulator and ultrasound simulators | Only established way to practice many invasive complex procedures<br>Simulators are used for licensure and certification | Costs of the more advanced trainers<br>Usually not portable<br>Allows for training on the actual equipment to be used during the procedure |
| Standardized patients/ medical models | Humans as either models for physical exam (medical models) or as simulated patients | Allows for standard training on communication and other social interactions<br>Great degree of fidelity for training on actual physical exam | Need a mechanism to recruit and train them to deliver standardized content |
| Moulage | The use of make-up and props to help improve the realism of a scenario. Can range from makeup to simulated wounds/ burns. Can be used on either mannequins or human subjects | Often low-cost way to greatly enhance psychological fidelity | Usually requires someone with specialized expertise to create |
| Biologic tissues | Use of either human cadaveric tissue or live animals for training on invasive procedures | Allows for integration of training on invasive procedures with training on specific equipment | Need for special regulations and often special space<br>Ethical issues with use and acquiring cadaveric tissue and with using animals for invasive procedure training |

nurse). One must be cognizant of having professionally discordant confederates as this, depending on the learning objectives, may establish an unrealistic expectation for workflow for those professional groups in the actual healthcare system.

### *12.8.3 Scenario Design: Case Template*

After deciding the target learner audience, the equipment, and the necessary human resources, the next step is to *construct the scenario template* for the simulation scenario. For patient care-based scenarios, either with SPs or mannequins, the scenario template includes all aspects of the scenario (Table 12.5). If multiple stations are necessary, the time spent at each station is also articulated. Aspects to consider in developing a simulation template include:

1. Using a pre-existing template or set form for all simulations: This makes it easier for the same simulations to be run by multiple individuals.
2. Keep the template as simple as possible: Design the scenario specifically to allow learners to meet the pre-specified performance indications and achieve the learning objectives. Try not to "do everything" in one simulation.
3. Determine critical actions: For flow through the scenario, decide whether the clinical flow should be "hardwired" and proceed independently of learner action *or* whether the flow will adjust for learner action. If the latter, build a series of several "what if" events into the template to plan for the most common contingences (e.g., differential hemodynamic responses to norepinephrine versus dobutamine).
4. Include appropriate experts while designing the simulation: If the simulation is interprofessional in nature, be sure to involve content experts from all of the included professions to ensure the case will allow all learners to achieve their specific performance measures.
5. Include adequate time for pre-briefing and debriefing: Account for the time required for delivery of any pre-briefing materials, time dedicated to orientation to the simulation environment, and any time required to complete any post-simulation assessments or evaluations. Add in the time necessary for the simulation itself. Decide upfront if every learner will serve every role in a simulation or not (e.g., for code simulation, does everyone need a turn as code leader or is it simply important for everyone to participate). The importance of role assignments and expectations is a critical decision, particularly if the simulation is to be used for summative

**Table 12.5** Components of scenario template

| Component | Example(s) |
|---|---|
| Pre-briefing materials | Pre-simulation knowledge assessment |
| Equipment | What mannequin/supplies/medications are needed |
| Simulation room orientation script | How much time is spent and what is covered every time (e.g., how to use the defibrillator with a mannequin) |
| Pre-scenario briefing | Sign-out about the patient |
| Clinical flow | How the vitals and exam will change over time |
| | Consider pre-built "if-then" contingencies |
| Scripts for patient/standardized patient and other participants | For example, how does patient answer questions about allergies, family history, end-of-life preferences, etc. |
| Assessment tools | Checklists and/or global rating scales |

assessment. Finally, dedicate adequate time for debriefing (see below.) A general rule of thumb is to plan for 1–1.5 minutes of debriefing time for every 1 minute of simulation time.

## 12.9 Running the Simulation: The Dry Run and Actual Simulation

The next step in developing a simulation-based educational scenario is to review the logistics of the scenario and perform a "dry run" prior to deployment with learners. If there is a dedicated simulation operations specialist, including this person in a logistics review and dry run is critical. Ideally, the dry run will include previewing the functionality and performance of all of the equipment to be used, preparing SPs and confederates, and providing guidance for faculty members, particularly if multiple faculty members will be running the simulation over a period of time.

### *12.9.1 Define and Script the Orientation to the Simulation Theater and the Simulation Scenarios*

Room orientation is an important component for all simulations, as it improves learners' comfort with the environment, establishes the ground rules for the simulation, decreases the likelihood that performance will be confounded by lack of familiarity with the equipment or surroundings, and reduces the likelihood that a learner could perform activities which could harm equipment. Learners should be allowed to ask as many questions as necessary about the physical room set up, location of supplies, and other logistic considerations. Room orientation should be completely standardized between groups to ensure consistency between learners.

Other important aspects of each simulation include timing, order of participation, and observation of simulations. Use of a timer during simulation ensures that scenarios adhere to the pre-specified time schedule. Participation order should be decided, either by soliciting volunteers or through assignment. Assigning team members is especially useful if groups contain learners of mixed skill levels, to ensure fairly balanced groups (if that is a goal of the scenario design and consistent with learning objectives). Participants will learn and improve through observing their peers. Consequently, it is not unusual for the first group to participate to have the most significant initial performance gaps with subsequent groups learning from and building upon prior groups' performance. Faculty should acknowledge this during simulation setup and debriefing, and if multiple simulations are planned, consider varying the order of participation for the participants.

## 12.10 Debriefing

After completing the simulation scenario, dedicated time for debriefing and feedback is essential; this time separates simulation-based education from the feedback and training which occurs in the context of clinical care [78]. Self-discovery by the learner through debriefing forms the basis and power of simulation-based education. While a detailed description of all of the various theories of debriefing and debriefing strategies is beyond the scope of this chapter, the recently published criteria for best practices in debriefing provide a basic template for the requirements for a successful program. In these best practices of debriefing, there are five major criteria [79]:

1. Observation: Faculty who observe the simulation should perform the debriefing.
2. Training: Faculty who facilitate debriefing should be competent in the process of debriefing. This includes ensuring that the instructors understand the basic principles behind debriefing and that the learners' performance is assessed using objective tools and measures.
3. Learning Environment: Debriefing should be conducted in a safe learning environment that supports confidentiality and self-reflection. Debriefing can be judgmental, where one assumes the learner consciously intended a given outcome (e.g., blaming for a bad outcome), nonjudgmental (e.g., having no preconceived notion of the learners intent), or "good judgment" where the de-briefer assumes that the learner is always attempting to do their best and the best for their patient. Debriefing with "good judgment" should be the basis for all debriefing sessions, as it creates a safe learning environment and allows learners to explore why goals of the scenario may not have been achieved [80, 81].
4. Structured Format: Debriefing should be based on a structured framework. Many frameworks exist, but one of the most common is PEARLS – *P*romoting *E*xcellence *A*nd *R*eflective *L*earning in *S*imulation [82]. The framework integrates three basic educational concepts: learner self-assessment, facilitating focused discussion, and providing information in the form of directive feedback. Execution of a debriefing framework hinges on the use of a debriefing script which can be broken into four sections (Table 12.6).
5. Reflect Learning Objectives: Debriefing should be congruent with the learning objectives, and debriefing is an opportunity to ensure these are addressed. However, learning objectives may be addressed over the duration of the session, and not every objective can or will be addressed during each debriefing or simulation. For example, a group of eight learners may be scheduled for a simulation session focused on resuscitation in sepsis. As part of the structure of the session, learners each take turns in pairs, participating in the scenario with the other six learners observing. After each team has participated, the entire cohort (all eight learners) will participate in the debriefing and eventually, over the course of all four debriefings, all of the pre-specified learning objectives will be addressed.

**Table 12.6** Components of PEARLS framework

| Stage | Definition | Example |
|---|---|---|
| Reaction | Focuses on understanding and exploring how learners are feeling about the simulation and their performance | "How are you feeling?" |
| Description | Learners are tasked with describing what happened in the scenario. It is important that learners provide the description with the facilitator *guiding* the discussion | "After the defibrillation attempt, what happened next?" |
| Analysis | After describing the event, the goal is to have learners self-analyze their performance. Ideally, this is driven by the learners themselves. Use of additional questioning tools can help facilitate this stage of the discussion | Use of plus/delta/gamma: learners discuss what went well (plus), what could have been done differently (delta), and what will be done differently next time (gamma). The plus/delta/gamma approach can be extremely useful, specifically during the analysis, application, and summary sections of the debrief [88] |
| Application/ summary | Learners are encouraged to summarize what they learned from the experience and to identify specific takeaway points | Ask each learner to state one or two take-home points from the activity |

## 12.11 Assessment of the Simulation Exercise

At the conclusion of the simulation exercise, it is important to assess the effectiveness of the session itself, both with regard to the effectiveness of knowledge acquisition as well as with regard to the acceptability of the scenario. For the learners, this could include knowledge-based post-tests and/or assessment of the impact of the activity on delivery of care. Feedback should be solicited from learners on the quality of the simulation, any technical issues, the scenario content, and instructor effectiveness. To ensure consistency across faculty who facilitate simulation, faculty should be regularly monitored and evaluated. One objective tool for this is DASH (*D*ebriefing *A*ssessment for *S*imulation in *H*ealthcare) which addresses the main criteria required for successful debriefing. Even if this tool is not used in its entirety, the structure DASH provides is a strong framework for global training and assessment of new instructors [83, 84].

## 12.12 Practical Tricks and Tools to Building an Effective Simulation

In this chapter, we outline the main components which must be considered and addressed for developing and implementing a successful simulation exercise. Often, failure of a simulation exercise can be traced back to one of a series of predictable pitfalls, most notably the lack of experience of facilitators or instructors in preparing and running the simulation and/or debriefing. One downstream impact of this is that the simulation uses higher than necessary degree of fidelity, based on the fallacy that higher fidelity is always better. Higher fidelity not only increases costs, and resources, but increases the likelihood of technical failures. Higher than necessary fidelity often leads to unnecessary complexity in scenario design, resulting in increased cognitive load for learners, such that primary learning objectives are missed.

Related to this is “trying to do too much” by not adjusting learning objectives and simulation activity for learner experience, which can adversely impact a simulation scenario. The strategies and scenario design for novice learners are often different than for intermediate and experienced learners. “Trying to do too much” manifests as cognitive overload for learners, which decreases the activity’s effectiveness. Again, this issue can be mitigated by focusing on a discrete number of learning objectives for the simulation and ensuring that the simulation and debriefing is designed to specifically address these objectives. For example, in a sepsis simulation, the objectives for novice learners may be to recognize sepsis, activate the sepsis team, and start initial resuscitation with appropriate fluids. Adjusting the scenario such that the patient develops rapid atrial fibrillation would distract from measuring this goal in a novice learner and create undue confusion. However, the cognitive challenge of rapid atrial fibrillation to assess situational awareness and clinical practice skills may be appropriate for more advanced learners.

One should also be cognizant of affective overload in simulation design. For example, whether or not to allow the simulated patient to “die” is controversial [85]. At least one randomized trial showed that allowing the simulated patient to die not only increased stress responses at the time of the simulation, but also reduced ratings of competence 3 months after the simulation in a follow-up simulation [86].

Finally, it is important to ensure that there is “buy-in” from frontline clinical staff to engrain the knowledge and behaviors taught in simulation scenarios, thus augmenting the ability of simulation to truly change behavior at the point of care. For example, simulation-based teamwork studies intended to foster trainees’ assertion in the operating room demonstrate, that these skills are not transferable to real-world patient encounters without faculty who encourage the behavior in actual clinical practice [87]. While acknowledging these potential pitfalls, there are several helpful tips and considerations to design as effective simulation scenarios as possible (Table 12.7).

## 12.13 Conclusion

Simulation is a powerful modality to aid in the acquisition of knowledge, and simulation provides opportunities for deliberate practice to improve acquisition of technical skills. Developing a successful simulation teaching session or simulation program hinges upon matching the appropriate level of technology and

**Table 12.7** Tips for having a successful simulation program

| Tip | Examples |
|---|---|
| Leverage your existing resources | Use existing medical equipment |
| | Search MedEdPORTAL for simulation scenarios |
| | Vary clinical contexts to utilize the same simulation scenarios |
| Be cost effective | Use low fidelity or make your own task trainers, such as pouring own molds or using spare ribs for chest tubes [89, 90] |
| | Use of disease survivors |
| Be creative | Moulage to improve fidelity of mannequin or standardized patients |
| | Hybrid simulations (e.g., using standardized patients with high-fidelity mannequins) |
| Provide cognitive aids | Cognitive aids improve team performance in simulations compared to teams asked to perform the same simulation without cognitive aids [91] |
| Teach emotional intelligence | Trainees with higher emotional intelligence perform better in simulated crises [92] |
| Use and engage the observers | Observing ACLS simulations has the same educational impact as participating [93] |
| | Asking learners to identify others' mistakes in a non-judgmental manner can improve performance of the team [94, 95] |
| Ensure deliberate practice | It takes at least 3–4 simulation sessions to prevent decay in skills for lumbar puncture [96] |
| | Teach imagery – mentally rehearsing steps results in improved skills [97] |
| Be reflective | Always assess whether learning objectives are being achieved |

realism with learner-specific learning objectives. As with all educational strategies, assessment of the outcome and impact of simulation is imperative to successful evolution of the simulation program.

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# Chapter 13
# Procedural Teaching

**Anna K. Brady and Rosemary Adamson**

## 13.1 Teaching Procedures

Coaching a trainee during a procedure often presents challenges for PCCM supervising physicians. The teacher must assess a learner, determine the appropriate level of autonomy for that learner, and direct the motor movements of the learner, all while ensuring a safe and successful procedure. Most supervising physicians receive no training on how to teach a procedure. A solid understanding of the theoretical basis and evidence behind teaching procedures can help PCCM physicians determine and assess the approach to take when supervising a procedure.

### *13.1.1 Theory*

There are several educational theories and constructs that apply to procedural instruction. Some, such as the theory of situated learning and Vygotsky's zone of proximal development, are general pedagogical theories that will resonate with educators in graduate medical education (GME).

Perhaps the most readily accessible educational theory that applies to procedural training in GME is that of *situated learning*. Developed in the 1970s as a way to understand apprenticeship systems, situated learning holds that knowledge trans-

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_13

mission occurs through participation and social interaction [1, 2]. Learners are integrated into the work environment and begin with "legitimate peripheral participation," in which they are given tasks commensurate with their level of responsibility (i.e., small and less important tasks at first). Situated learning emphasizes the interaction among members of a "community of practice," especially social and verbal interactions [1]. Where procedural teaching is concerned, situated learning suggests that learners should take on small parts of the procedure when they start and only slowly build up towards performing the entire procedure; they should not be expected to do an entire procedure from start to finish immediately.

A second general educational theory with similar lessons for procedural teachers is Vygotsky's zone of proximal development. Postulating that there are three zones of competence for all learners – skills the learner can do independently, skills that can be done with guidance, and skills that the learner cannot do – Vygotsky argued that learning occurs in the middle zone, called the *zone of proximal development* or ZPD [2]. Notably, Vygotsky described the teacher in this zone of proximal development as a *more knowledgeable other* – a role which could be filled by a peer, not necessarily a supervisor. Similar to situated learning, Vygotsky's theory suggests that learners should focus on the component procedural skills in their ZPD, rather than attempting skills that they cannot do even with guidance. Therefore, supervising physicians should attempt to determine their learners' ZPD prior to a procedure. A useful way to help determine the ZPD for early learners can be to ask the trainee to describe the procedure in step by step fashion. Supervising physicians should recognize – and, importantly, should highlight to their learners – that even being involved in small parts of the procedure can be a valuable learning experience.

Apart from these general educational theories, there are specific taxonomies that have been developed with motor learning or skill development in mind. A commonly cited description of psychomotor learning is the seven-stage process described by Simpson [3] in the 1970s (Table 13.1).

Often the first two stages are eliminated in discussion of procedural education, but the last five stages are noted to have parallels to the Dreyfus model of expertise development [4], that is, the continuum from novice to expert. The Dreyfus stages begin with novice and transition through advanced beginner, competent, proficient, and expert, sometimes with a sixth stage of "master" [5]. However, there is disagreement on which stage a trainee must achieve prior to completion of training. That is, do trainees need to reach the level of "master" bronchoscopist by the completion of fellowship, or is "proficient" good enough?

In designing curricula for procedural education, modern authors have expanded upon these theoretical constructs. A general instructional design model such as the nine-step method of Robert Gagne can be used as the scaffold for teaching a procedure [6]. However, a newer model of instructional design that is intended specifically for complex tasks (and is very applicable to invasive procedures) is the 4C/ID-model developed by Van Merrienboer. The 4C/ID model was developed to minimize excessive cognitive load for complex skills, and it includes four components which are not necessarily sequential [7].

**Table 13.1** Simpson's stages of psychomotor learning. These taxonomies were the basis for developing appropriate learning objectives for psychomotor skills. Examples relevant to bronchoscopy are presented here

| Stage | Description | Example using bronchoscopy |
|---|---|---|
| Perception | Using sensory cues | Recognizes when bronchoscope is wedged |
| Set | Knowing own limitations, displaying readiness to act | Explains appropriate dosing of moderate sedation, asks for help if having problems dosing |
| Guided response | Imitation, trial and error | Displays topical anesthesia skills (practices administering topical anesthesia on own or with guidance) |
| Mechanism | Intermediate stage, habitual responses have developed, some confidence and proficiency | Completes airway inspection without assistance |
| Complex overt response | Automatic performance | Able to stay wedged during a bronchoalveolar lavage when patient coughing |
| Adaptation | Responds to unexpected developments | Reacts to bleeding from transbronchial lung biopsy |
| Originating | Develops own movements and techniques | Develops own technique for transbronchial biopsy |

First, the complex skill is broken down into specific *learning tasks* which are divided into simple and complex tasks, and simple tasks are given to the learners first, to keep cognitive load reasonable. Second, *part-task practice* is used to allow learners to rehearse individual micro-skills, particularly those that might be repeated during a procedure (e.g., using a bronchoscopy simulator to practice avoiding airway walls). The remaining components of the model are two types of information provided to the learners: *supportive information* and *just in time (JIT)* information. Supportive information is provided throughout the task and is not temporally related to the learning tasks; its goal is to bridge the space between the learner's prior knowledge about the complex skill and the desired level of knowledge (e.g., the risks, indications, and contraindications of a procedure). In contrast, JIT information is temporally related to the tasks the learner is attempting, and Van Merrienboer believes that instructors should use active learning methods to engage learners, rather than expect that learners will have retained this JIT information in their working memory [7]. For instance, JIT information might include referring a learner to a pocket card with the dosing of common induction and neuromuscular blockade agents prior to performing endotracheal intubation.

A comprehensive model of procedural education, based upon evidence but not yet tested itself, is the Learn-See-Practice-Prove-Do-Maintain model described in 2015 by Sawyer and colleagues [4]. This six-step model is grounded in the work of Simpson and Peyton and reflects the extant literature on procedural education. Included in the six steps are a cognitive phase (Learn and See) as well as a psychomotor phase, with all stages up until "Do" taking place *before* a trainee performs even part of a procedure on a real patient. This model relies heavily on simulation-based mastery learning (discussed below) for its Practice and Prove components and emphasizes the cognitive skills that must be mastered before attempting a procedure.

Finally, a simpler and more sequential model which focuses on motor aspects of teaching a procedure is Peyton's four-step method of procedural education: the four steps are demonstration, deconstruction, comprehension, and performance. In demonstration, the teacher completes the procedure from start to finish, fluently and without pauses; then, in deconstruction, the teacher narrates each step of the procedure by itself; during comprehension, the student instructs the teacher on each step; and finally, the student performs the procedure from start to finish [8, 9]. This granular approach may be helpful to those who are looking for a structure for their one-on-one teaching outside of a formal curriculum – such as the teaching that often occurs in the PCCM environment. Some learners will require the teacher to spend significant time in the demonstration and deconstruction steps (e.g., a resident on the pulmonary consult service who has never done a thoracentesis), whereas others might quickly move through those stages to arrive at the comprehension step (e.g., a pulmonary fellow). Peyton's method has been found to be a more effective means of teaching a technical skill than the "standard approach" [8, 9]. Some authors consider the most crucial step to be the third step, which involves the learner mentally and verbally rehearsing the procedure [9].

When it comes to the role of the faculty member in one-on-one teaching, there are several proposed models. The briefing-intraoperative teaching-debriefing (BID) model was developed as the surgical equivalent of the one-minute preceptor technique [10] and is described in Fig. 13.1, and examples relevant to PCCM procedures are shown in Table 13.2. The BID model is recommended as a best practice by surgical educators [11].

As described above, the BID model focuses on individualized trainee goals and requires both flexibility from instructors and engagement from learners (i.e., it does not work if supervisors adopt a one-size-fits-all approach to teaching a procedure).

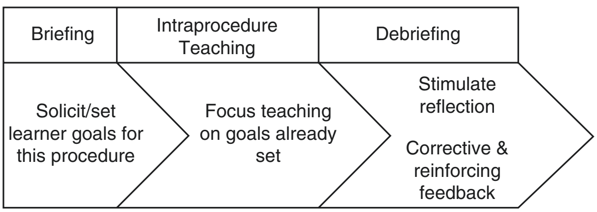


**Fig. 13.1** The briefing-intraprocedure teaching-debriefing model. In *briefing*, the supervising physician asks the trainee before the procedure what the trainee's goals are for that specific procedure; with a very early learner, the supervisor might instead suggest specific goals for learning. The *intraprocedure teaching* should then focus on the learner's specific goals. Finally, during *debriefing*, the supervisor elicits the learner's own self-assessment and provides both corrective and reinforcing feedback

**Table 13.2** The briefing-intraprocedure teaching-debriefing (BID) model. These examples are applicable to bronchoscopy, specifically, and are modified from Roberts's original description [10]. Further detail about how to use this model is found in that reference

| | Examples |
|---|---|
| Briefing | Teacher: "What would you like to work on during today's bronch?" |
| | Learner: "I would like to improve my efficiency during transbronchial biopsies." |
| | Or, with a novice learner: |
| | Teacher: "Today I want you to identify the airways you see and work on keeping the airway of interest at 12 o'clock on the screen." |
| Intraprocedure[a] teaching | Teacher: "We have some bleeding, but you are blocking the airway with your scope. The most important thing when there is bleeding is staying in position to prevent the blood from spilling more proximally." |
| Debriefing | Teacher: "How do you think the biopsies went today?" |
| | Learner: "Things went better after we reviewed what normal resistance to the forceps should feel like." |
| | Teacher: "Yes, I noticed that. As a general rule, if you get a lot of resistance when you pull back, that's an airway." |

[a]Originally described as "intraoperative" teaching

In sum, the educational theory that underpins procedural teaching strongly supports a stepwise and thoughtful approach to trainee involvement in procedures. In many cases it will be appropriate for early learners to perform some but not all steps of a procedure, and both teachers and learners should acknowledge that trainees will progress through stages of expertise rather than immediately become proficient at performing a given procedure. Finally, there are multiple frameworks that procedural teachers should reference for both curriculum design and bedside instruction.

## *13.1.2 Evidence*

### 13.1.2.1 Experiential Learning

Procedural training in PCCM has traditionally been experiential. A moderate body of evidence exists to support the general concept that as trainees acquire more experience with a procedure, their success rates increase and complication rates decrease, though published learning curves are not available for every procedure performed in PCCM. Perhaps the best studied procedure is endotracheal intubation, with some data suggesting about 50 intubations are needed for a 90% first pass success rate [12], though these studies were generally not conducted in the ICU setting.

Central venous catheterization (CVC) has also been well studied. In the era before ultrasound, Sznajder and colleagues documented increased rates of failure and complications for both subclavian and internal jugular CVC when performed by inexperienced clinicians, using a cutoff of 50 catheter insertions to distinguish between experienced and inexperienced [13]. An ultrasound-era, prospective, observational study in French ICUs found that for every ten internal jugular or femoral CVCs inserted by a trainee, the complication rate decreased by roughly 20% [14]. Notably, this decrease was not seen for subclavian CVC insertion (though trainees in this study inserted fewer CVCs at this site than the IJ and femoral sites). However, when investigators at Northwestern University assessed Internal Medicine (IM) residents with varying levels of experience with CVC, lumbar puncture, and other core IM procedures, they found that most residents could not achieve the minimum passing score on a checklist assessment even in the 3rd year of residency – though there was improvement in scores with increasing number of procedures (the highest scores were seen in residents who had performed a given procedure seven to ten times) [15]. These findings are striking, given that many IM training programs in the United States require no more than three to five CVCs (and other comparable procedures) to be performed before residents are "signed off" to do these procedures unsupervised [16]. It is highly likely that both IM trainees and even some early-in-training PCCM fellows will need supervision and teaching to safely insert CVCs and perform other bedside procedures safely in the ICU.

In an effort to improve the safety and success of procedures performed by trainees, some institutions have implemented a procedure service for core procedures performed by IM trainees [17–19]. The typical arrangement for a procedure service is for an attending PCCM or Hospitalist physician to either directly supervise or personally perform the procedure in question. Procedure services have been shown to improve trainee comfort with performing core IM procedures and improve best practices adherence [17–20]. Notably, studies of procedure services have not been powered to show reduction in complications. Likewise, procedural "boot camps" have become common and can be effective at knowledge transfer, with measures of short-term knowledge retention also improved in some cases [21].

#### 13.1.2.2 Simulation-Based Mastery Learning

The curricular approach with the strongest evidence base for procedural education is simulation-based mastery learning (SBML). First described with IM residents learning CVC placement at Northwestern University, this approach has been shown not only to improve success rates but also to improve patient-level outcomes [22]. The SBML approach is not simulation alone but is rather a very structured method of teaching and assessing procedural skills; notably, it also requires motivated learners and faculty instructors with requisite expertise both in the procedures being taught and the method of simulation. The components of SBML are shown in Table 13.3; "mastery" in this model is defined most often as a minimum passing score on the assessment tool [22, 23]. Trainees embark on deliberate practice using simulation until they reach the minimum passing score. Simulation-based mastery learning has been shown to improve outcomes and decrease cost of some core procedures in IM (e.g., central venous catheterization, paracentesis) [22, 24].

**Table 13.3** Components of simulation-based mastery learning for procedural education. Detailed examples can be found in [22, 25]

| Component | Details |
|---|---|
| Baseline skill testing | Written assessment and/or attempt at skill, scored with same checklist as assessment tool |
| Instruction | May include video, written, other instructional modalities |
| Deliberate practice | Adequate time for practice |
| | Safe space for practice (i.e., skills lab, simulation center, but not on patients) |
| | Adequate equipment for practice (not necessarily high fidelity) |
| Preset level of mastery | Mastery often defined as minimum passing score on a checklist |
| | Use of a tool with good validity evidence (see second half of chapter), whether previously or prospectively evaluated |
| Consequences | If learners do not meet mastery, they must resume deliberate practice until mastery is reached |

It is important to highlight that SBML is a much more comprehensive approach than asking a trainee to use a simulator or task trainer once, or giving the trainee time to practice with no specific goal in mind. Furthermore, SBML occurs prior to a trainee performing a procedure on real patients.

#### 13.1.2.3 One-on-One Teaching

Apart from simulation, much of the procedural teaching PCCM physicians provide happens at the bedside. Data from the surgical literature illustrate the utility of several teaching approaches in this setting.

First, pre-procedural teaching can be enhanced by helping trainees set goals. There are compelling data from undergraduate medical education surgical clerkships that helping learners to set goals can improve their learning of motor skills. Gardner and colleagues studied third-year medical students on their surgery clerkship, and demonstrated that when students were given learning goals (i.e., goals that focused on the *process* of acquiring a new skill), they performed better on new skills such as suturing and laparoscopic camera navigation than when they were given performance goals which focused on specific metrics such as number of procedures done or time to procedural completion. Both learning and performance goals were superior to a generic goal to “do your best” [26]. The learning goals encouraged students to think about *how* to master a task, as opposed to the performance goals, which were generally time- or number-based. An example of a good learning goal for bronchoscopy education would be to “identify which part of topical anesthesia is most difficult for you and focus on that skill over the next week” as opposed to “administer topical anesthesia on your own 10 times this week,” which is a performance goal.

Much of the data describing effective intraprocedural teaching are obtained from survey studies and interviews, generally from the point of view of resident learners.

Cox and Swanson studied attending surgeons at one academic center over 4 years in the late 1990s: out of ten intraoperative teaching behaviors provided to residents, the two that discriminated between superior (1 SD above mean teaching scores) and "mediocre" (1 SD below mean) teaching were that attending surgeons "demonstrate[d] awareness and sensitivity to resident learning needs" and "provide[d] direct and ongoing feedback regarding resident progress." Themes that emerged from qualitative analysis of residents' comments about superior teaching were demonstration of technical expertise and up-to-date knowledge; allowing and encouraging resident participation in procedures; and maintaining a learning climate of respect and support [27]. More objective determinations of procedural teaching skill, such as observed structured teaching evaluations, have not yet been demonstrated to be successful [28, 29].

A critical issue in teaching procedures is how much trust the teacher should place in the trainee; in other words, how much autonomy the trainee should have for a given procedure. During critical aspects of many procedures, the supervisor may only have seconds to make a decision about how much autonomy to allow a learner to have while performing the procedure on a patient. Notably, learners may want more autonomy during procedures than their supervisors feel is appropriate, and they may disagree with how much autonomy was actually offered [11]. How best to determine whether a trainee can perform part of a procedure independently is not agreed upon, but qualitative studies of how supervising physicians develop trust in their learners in non-procedural contexts indicate that trust develops based on a mix of trainee factors (e.g., stage of training), supervising physician personality factors, and experience [30]. It seems likely that these same factors might also influence the autonomy provided during procedural teaching.

Finally, where post-procedural debriefing is concerned, evidence suggests that use of a structured tool can improve the frequency with which trainee feedback is provided; it can also improve pre-procedure goal setting [31]. Tools specific to various procedures have been described (e.g., the Ontario Bronchoscopy Assessment Tool (OBAT) for bronchoscopy [32]), but there is not one universal debriefing tool used across all procedures and all disciplines.

### *13.1.3 Best Practices in Procedural Teaching*

Although more research in this field is clearly needed, given the relevant theory and the existing evidence, there are some generally agreed-upon best practices in teaching procedures (Table 13.4).

First, prior to attempting procedures on real patients (even under supervision), it is ideal for trainees to be taught and assessed using simulation-based mastery learning. For CVC insertion, existing SBML curricula are published [22]. For endotracheal intubation, published curricula applicable to PCCM include Mosier and colleagues' integrated curriculum [33]. Admittedly, different resources for simulation will be available at each institution, and resource limitation may play a role in curriculum design. Second, learners should not be expected to complete procedural

**Table 13.4** Best practices in procedural teaching

| |
|---|
| Use simulation-based mastery learning prior to trainee experience with patients |
| Assess trainee experience and determine what tasks within a procedure are appropriate for that trainee and patient *before* beginning the procedure |
| Help trainees set learning, rather than performance, goals when they are acquiring new skills |
| Use the BID model to structure pre-procedure assessment and post-procedure feedback |
| Adopt a respectful attitude toward trainees during procedural teaching |
| Model patient-centered care, best practices in communication, and professionalism during procedure |

tasks that are beyond their zone of proximal development. Therefore, before supervising a trainee, it is helpful for the teaching physician to determine the learner's ZPD by asking about the trainee's experience with the procedure (i.e., number of prior attempts at performing a procedure, prior struggles or complications). Likewise, it is a best practice for supervisors to adopt a structured approach to teaching a procedure, such as Peyton's four-step method, which is simple and easily adapted to working with trainees at various stages. In a similar fashion, supervising PCCM physicians can help trainees set learning rather than performance goals for a new procedure, and avoid telling trainees merely to "do their best."

During the one-on-one procedural teaching that occurs in the busy PCCM environment, the BID model or similar structured approach can be useful. Finally, formative assessment should be completed, if not after every procedure then at intervals throughout a learner's training progression (e.g., after every 25 bronchoscopies). The second half of this chapter will address formative and summative assessment.

## 13.2 Assessing Procedural Competence

How to assess the competence of medical trainees is a timely and complicated issue. This section will focus on issues most relevant to the assessment of procedural competence. For additional information, readers are referred to articles and books dedicated to this topic [34, 35].

### *13.2.1 Theory*

Assessments serve multiple purposes. Assessments are used to grade learners, to evaluate curricula that lead up to assessments, and to safeguard the public from incompetent physicians. Assessments that truly add value in these areas can only be developed with a good understanding of the relevant literature. The following topics are intended to provide an overview of the assessment literature for educators in PCCM including the validity of assessment tools, the use of formative and summative assessment, and the utility of assessments.

#### 13.2.1.1 Validity

Validity is the concept that an assessment truly tests what it is intended to measure. For example, a checklist assessment of the insertion of a central venous catheter intended to evaluate competence at CVC insertion is valid only if it truly does assess successful placement of a CVC, as opposed to assessing communication skills, learner confidence, or some other parameter. Figure 13.2 provides a visual representation of the concept of assessment tool validity. So how can we know if an assessment is valid?

Historically, there have been a number of validity frameworks. Currently, Messick's framework is the most widely accepted [36], including by the Standards for Educational and Psychological Testing [37]. Messick's framework is described in more detail below. The validity of an assessment tool should be viewed as an argument requiring multiple sources of evidence to be convincing. Validity is not binary, rather an instrument can have more, or less, evidence for its validity. Importantly, validity is not a property of the tool, but rather of the interpretations made from its use. This means that strong evidence for the validity of an assessment instrument in one situation does not necessarily translate into strong evidence for the tool's use at another institution or with different learners. A number of excellent review articles are available on this subject [38–40].

Messick's framework describes five sources of validity evidence (summarized in Fig. 13.3). *Content* refers to the development of the tool: how were items chosen to be included? who wrote the tool? *Response process* refers to the thought process of the test takers or raters: have raters received proper training on the assessment tool? do they understand the rating scale? *Internal structure* refers to the psychometric properties of the test: reliability and factor analysis are examples. *Relations to other*

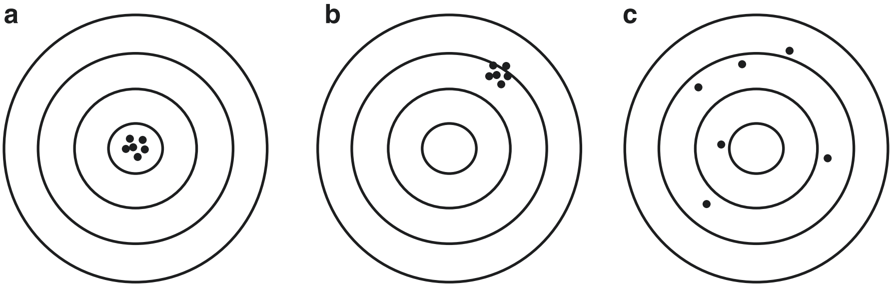


**Fig. 13.2** Assessment tool validity. The dots on these bull's-eyes represent learners' scores on a test, where a dot in the center of the bull's-eye indicates that the learner's test score accurately represents the learner's ability. Bull's-eye A represents a valid test. When these scores are used to evaluate the learners, valid interpretations about the learners are made. On bull's-eyes B and C, the learners' scores do not represent their actual abilities. Evaluations based on these test scores misrepresent the learners. Validity evidence is what allows us to rely on test scores to evaluate learners

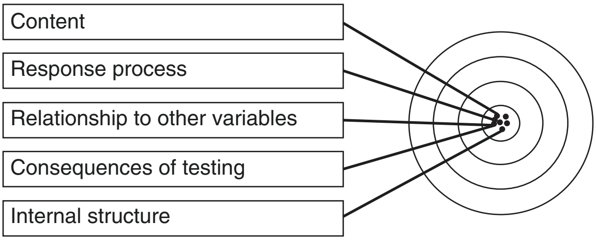


**Fig. 13.3** Messick's sources of validity evidence. The more evidence there is for the validity of a test, the more likely it is that the test is measuring what it claims to measure, and that scores on the test represent the learners' true ability

*variables* refers to correlation between scores on the test and other relevant variables: for tests of procedural competence, do test scores correlate with year of training or the individual's diagnostic yield? do test scores correlate inversely with the individual's rate of complications? *Consequences* refers to the evaluation of both intended and unintended consequences of the test, including the method used to determine pass/fail cut scores: what is the impact of the test on learners, raters, the training program, and patient care?

The need for evidence from each of these sources depends on the assessment tool in question and how it is being used. An assessment of trainee procedural competence performed in the 1st month after graduation from medical school designed to provide formative feedback for the learners and information about further training requirements for the program requires less evidence of validity than a summative assessment being performed to judge trainee competence to advance to the next level in their career.

Understanding the concept of the validity of assessment tools is important not only for researchers developing new tools, but for all educators who wish to use any such assessment tool. Physicians typically educate themselves about the known uses and limitations of diagnostic tests before using them for patients, and the same proceess of familiarization should be true for using assessment tools. For example, it is recognized that it is extremely useful to check a d-dimer in a patient presenting to the Emergency Department with a low probability of having a pulmonary embolism, while it is also known that this test is essentially meaningless in hospitalized patients. Similarly, it should be recognized that if a procedural assessment tool has been shown to distinguish between medical students and experienced physicians, that does not mean that it will meaningfully distinguish between first- and second-year residents. Indeed, the development of assessment tools has many similarities to the development of diagnostic tools: gathering robust validity evidence for a tool requires a research program consisting of studies designed to test the key validity assumptions.

Utility = Reliability × Validity × Educational Impact × Acceptability × Cost Effectiveness

**Fig. 13.4** Van der Vleuten's utility model of assessment [43]. Reliability: Do the results remain the same when the test is repeated under different conditions? Validity: Does the test truly measure what it is intended to measure? Educational impact: Does the test have a beneficial effect for those tested and/or the institution? Acceptability: Is the test acceptable to evaluators and those being tested? Cost-effectiveness: Is the cost of the test worth the time and effort involved for evaluators, and those being tested?

#### 13.2.1.2 Formative and Summative Assessment

As mentioned previously, assessment serves multiple purposes. Two of those purposes are 1) informing learners about their performance, so that they can make changes (formative assessment), and 2) informing the assessor (and potentially others) about the learners' performance, so that they can make decisions about the learners (summative assessment) [41].

Related to formative assessment is the concept of *assessment for learning*, in which assessment is used to help learners to want to learn and to feel able to learn. In this model, the assessor/teacher and learner develop an ongoing relationship that develops the learner's understanding of and perspectives about their own learning [42].

#### 13.2.1.3 Utility

Utility is a useful concept when choosing or developing an assessment tool. Utility incorporates validity and adds practical questions about the educational impact, acceptability, and cost-effectiveness of the assessment tool (Fig. 13.4).

Van der Vleuten intended this definition be used as a conceptual framework. He did not intend for this equation to be used numerically, since most of these elements cannot be quantified. However, he deliberately multiplied the elements to emphasize that if one element is zero, the utility of the entire assessment tool will be zero. For example, if a tool is unacceptable to its proposed users, it will not be used, even if it is extremely good by all other measures.

Van der Vleuten encourages the view that assessment should not be thought of narrowly, but rather as an educational design problem encompassing the whole curriculum [44]. A narrow view of assessment focuses on the development of isolated, all-encompassing tools. An educational design perspective incorporates the understanding that assessment of skills and attributes of interest often requires multiple different types of assessments, that assessment drives learning, and that assessment is therefore interwoven with all other aspects of a curriculum. This perspective is consistent with many curriculum design frameworks [45, 46].

## 13.2.2 *Evidence*

### 13.2.2.1 Assessment Drives Learning

There is substantial evidence for the assertion that assessment drives learning. Research in cognitive psychology demonstrates that tests promote better retention of knowledge, a result called the “testing effect” [47]. It has been demonstrated that medical students’ motivation to learn is affected by the weighting of subject matter in the assessment [48] and that residents spend more time studying when they are closer to their board exams [49]. It has also been shown that medical students’ learning of resuscitation skills is increased by a test at the end of a simulation course [50] and that neurologists’ retention of material from a CME course is increased by repeated testing [51]. Given that learners “learn to the test,” educators should exercise caution when choosing the material for assessments and ensure that the assessment aligns well with the curriculum learning objectives [44].

### 13.2.2.2 Checklists Versus Global Rating Scales

There is a debate in the medical education literature regarding whether it is better to use checklists or global rating scales to assess procedural skills and performance [52–56]. A review of the available evidence suggests that this question does not have a simple answer, and that checklists and global rating scales are probably better suited to different purposes.

The use of checklists has become commonplace in medicine, including when assessing procedural performance. One systematic review of simulation-based education for CVC insertion found that only 2 of the 20 studies included used global rating scales [57]. This may be because checklists are often thought to provide greater objectivity than global rating scales. However, studies have shown that global rating scales outperform checklists in terms of reliability ratings [52, 53, 56], checklists often fail to differentiate between intermediate and expert performance [54, 56], and high scores on checklists do not guarantee competence [52, 55].

It may be that checklists and global rating scales should be viewed as complementary, rather than alternative, types of assessment tools. Since checklists provide step-by-step task outlines, they can guide novice trainees through the procedure, and they may provide formative feedback to intermediate level learners. A separate checklist is required for every procedure under evaluation, whereas a single global rating scale can be used for multiple different procedures. Global rating scales are better at detecting different levels of expertise.

### 13.2.2.3 Application of Validity Evidence Framework

Box 13.1 summarizes a study of assessment tools for lumbar puncture. This example illustrates how validity evidence frameworks can be applied to develop useful information about assessment tools' performance.

**Box 13.1 Example of Developing Validity Evidence**
Irene Ma's comparison of global rating scales and checklists for the assessment of IM residents' CVC insertion skills provides an excellent example of the process of assessment tool development [52]. This study compared three previously published assessment tools.

This study provides substantial evidence of validity for the tools used: a panel of local experts evaluated the tools for **content** validity. The tools were piloted locally, and modified and adapted when necessary. The Evaluators received training on the tools prior to independently evaluating residents' CVC insertion performance. Training of the evaluators provides evidence for **response process** validity. Extensive statistical analyses were performed to determine inter-rater and inter-item reliability. This provided evidence of **internal structure** validity. The outcome of the study demonstrated that checklists lack validity evidence for correlation with other variables, whereas global rating scales adequately captured competent, safe CVC insertion. This study was performed as part of a research program on assessments of procedural competence.

This study also highlights other important aspects of the assessment of competence. Residents were evaluated at the end of a CVC insertion workshop, illustrating how it is best to perform assessment within the context of a curriculum. The residents were also given formative feedback immediately after their evaluated CVC insertion performance, offering them the chance to learn from the assessment.

### *13.2.3 Best Practices in the Assessment of Procedural Competence*

Several recommendations for best practice can be taken from this review of assessments of procedural skills (Table 13.5). First, assessment tools should be developed within the context of educational curricula. The content of the assessment tool should be informed by the learning objectives of the curriculum, because the assessment will drive learning. Secondly, it is important to use assessment tools with reasonable validity evidence. In order to do this, educators should search for existing tools within the published literature (e.g., MedEdPORTAL, standard medical journal search engines), before independently creating new assessment tools (Table 13.6). Educators should evaluate the validity evidence of these tools, as well as their utility. Select the tool with the most validity evidence and consider performing initial validation studies at one's institution with local learners before using the assessment tool with all learners. If there is no exisiting tool with good validity evidence, then consider developing a novel tool, using a validity framework. Whether using an existing tool from the literature or developing a new tool, consider whether a checklist or a global rating scale, or both, best fit the goals of assessment. Lastly, whenever possible, consider studying the selected tool and publishing the study results, in order to add to the available validity evidence.

**Table 13.5** Best practices for assessment of procedural competence

| |
|---|
| Embed assessment within a curriculum of procedural teaching |
| The assessment must reflect the curricular learning objectives |
| Whenever possible, use pre-existing assessment tools |
| Evaluate the validity evidence and the utility of the existing tools |
| Consider whether a checklist and/or global rating scale best suits the purpose |
| When possible, study the chosen tool, to add to its validity evidence |

**Table 13.6** Existing assessment tools for common PCCM procedures

| Procedure | Existing assessment tools |
|---|---|
| Bronchoscopy | Ontario Bronchoscopy Assessment Tool (OBAT) [32] |
| | Konge's Bronchoscopy Assessment Tool [58] |
| | Bronchoscopy Skills and Tasks Assessment Tool (BSTAT) [59], available from bronchoscopy international: https://bronchoscopy.org/downloads1/ |
| EBUS bronchoscopy | Endobronchial Ultrasound Skills and Tasks Assessment Tool (EBUS-STAT) [60] |
| CVC insertion | Ma's Global Rating Scale and two checklists [52] |
| | Included in the six bedside procedures (see appendices in [55] for actual assessment tools) |
| | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |
| Arterial line insertion | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |
| Endotracheal intubation | See [61, 62] |
| | Included in the six bedside procedures (see appendices in [55] for actual assessment tools) |
| | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |
| | Checklists available from the National Registry of Emergency Medical Technicians https://content.nremt.org/static/documents/FP410%20Direct%20Orotracheal%20Intubation%20Adult.pdf?3%2F28%2F2016+9%3A56%3A15+AM |
| Thoracentesis | Ultrasound-Guided Thoracentesis Skills and Tasks Assessment Test (UGSTAT) [63], available from bronchoscopy international: https://bronchoscopy.org/downloads1/ |
| | Included in the six bedside procedures [55], see appendices for actual assessment tools |
| | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |

(continued)

**Table 13.6** (continued)

| Procedure | Existing assessment tools |
|---|---|
| Paracentesis | Included in the six bedside procedures (see appendices in [55] for actual assessment tools) |
| | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |
| Lumbar puncture | Error-focused checklist for LP [64] |
| | Included in the six bedside procedures (see appendices in [55] for actual assessment tools) |
| | Included in the Procedural Competency Assessment Tools (PCATs) endorsed by the Council of Academic Family Medicine http://resourcelibrary.stfm.org/viewdocument/procedure-competency-assessment-too |
| Global rating scales (can be used for any procedure) | Direct Observation of Procedural Skills (DOPS) |
| | From the Intercollegiate Surgical Curriculum Programme (UK) https://www.iscp.ac.uk/static/public/DOPSJul2015.pdf |
| | From the Royal Australian College of Physicians https://www.racp.edu.au/docs/default-source/default-document-library/direct-observation-of-procedural-skills-rating-form.pdf?sfvrsn=4 |
| | Objective Structured Assessment of Technical Skills (OSATS) [65] |

### *13.2.4 Chapter Summary*

This chapter provides a brief review of the current, rapidly expanding literature on procedural teaching and assessment with an emphasis on considerations for learners in PCCM. This overview reinforces that the “see one, do one, teach one” approach is anachronistic and deficient, and illustrates that there is a contemporary, scientifically grounded approach to procedural teaching and assessment.

Teaching procedures ideally occurs within the context of a curriculum, starting in the simulation center and continuing in the clinical setting. Teaching encounters should include a discussion before the procedure, teaching during the procedure, and a review after the procedure. The pre-procedure discussion assists in identifying the learner’s ZPD and identifying her or his learning goal. During the procedure, comments are best targeted to this learning goal. The post-procedure review helps the learner modify her/his learning goal for the next procedure.

As with so much in medical education, following sound educational principles when teaching procedures may seem like it will take longer than a less structured approach, but this investment of time is likely to pay off by improving subsequent teaching episodes and, hopefully, by setting the stage for learners to become reflective and more autonomous practitioners.

Formal assessment of procedural competence should also be situated within a curriculum, with learning objectives informing assessment and providing for both formative and summative assessment. The development of assessment tools can be thought of as a research program, with attention given to the development of multiple forms of validity evidence. In this way, assessments add value for the learners, for the teachers, and for patient safety.

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# Chapter 14
# Web-Based Learning

**Souvik Chatterjee and Nitin Seam**

## 14.1 Introduction

The Internet age has resulted in an explosion of technological advances that will result in a fundamental shift in education to increased use of web-based learning [1]. As there are many terms describing the use of technology, computers, and the Internet to assist in education, the focus of this chapter will be specifically on web-based learning, defined as "the use of the Internet to support and mediate educational activities [2]." Though the shift toward web-based learning is in early stages in medical education, it is advancing rapidly in other fields of higher education. For example, many universities offer massive open online courses (MOOCs) in a variety of fields. MOOC participation in 2012–2016 from Harvard and MIT alone resulted in the creation of 245,000 certificates, 4.5 million total course participants, and 2.4 million unique users [3]. Student enrollment in online classes has risen steadily, with growth in online student participation 2015 up 11.3% in private non-profit institutions [4]. The use of web-based learning has also increased significantly in medical education. Recent survey data from 214 Internal Medicine program directors showed that 72% use some form of self-paced asynchronous web-based learning, while 40% use synchronous (live real-time, simultaneous) web-based learning in their training programs [5]. Among board-certified US physicians, 97% report using web-based learning, and most anticipate a more integral role for web-based learning in medical education in the years to come [6].

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_14

In the current medical climate, factors such as hospital costs, pressure to document productivity, and time limitations are important drivers for increased use of web-based learning in medical education. The era of duty-hour restrictions, high-output clinical care, and time-intensive electronic documentation has put pressure on traditional medical education, such as 1-hour didactic conferences, exhaustive bedside teaching rounds, and morning reports. Though all types of education require time for educators to teach, and time for trainees to learn to be effective, time is an increasingly rare commodity in modern medical practice [7].

Trainees now spend less time in the hospital, and even less of that time at the bedside engaged in educational activities. In addition, financial pressures resulted in a decrease in length of patients' hospital stay by nearly one-third, resulting in significant work compression for faculty and trainees [8, 9]. Evaluation of the type of resident work performed has found more than one third of resident time is dedicated to delivering patient care "of marginal" or "no educational value" [10, 11]. The climate of work compression was exacerbated by the ACGME-mandated duty hour restrictions first implemented in 2003, resulting in a significant decrease in time for education, as well as a decrease in quality of care observed in some academic medical centers. In an environment where time for education is threatened, and many are asked to do more with less, educators have looked to new technologies to increase efficiency in medical education. While nothing replaces more time dedicated to education, well-designed web-based learning can provide high-quality medical education, even in the current time-pressured climate.

## 14.2 Access: Web 1.0 Versus 2.0 Web-Based Learning

One commonly touted benefit of the Internet is acces*s* to information. Nearly 75% of all adults have searched health information online, and one third of adults have used the Internet to diagnose themselves or someone else [12, 13].

Web 1.0 refers to static web pages connected by hyperlinks and serves as a mechanism of convenient access for viewing content from a website (e.g., text, video, images, audio) without interaction. Much of the online educational material related to medicine is in a web 1.0 format. For example, online medical journals are typically in a web 1.0 format, though with differing degrees of quality and reputation. At one end of the spectrum, there are peer-reviewed online journal articles published on websites of high-impact journals such as the *New England Journal of Medicine* (NEJM) and *American Journal of Respiratory and Critical Care Medicine*, as compared to proliferating open-access online-only journals that promise rapid publication with questionable scientific rigor.

Medical textbooks are often available online through institutional libraries, and several peer-reviewed narrative-based Web 1.0 sites such as UpToDate (https://www.uptodate.com, Wolters Kluwer Health) or Medscape (https://www.medscape.com, WebMD LLC) are important sources of information for medical trainees and professionals. Web 1.0 is a passive learning experience but allows for access to a seemingly endless amount of information via various media including text, podcasts, videos, and images.

In contrast, web 2.0 websites emphasize user-generated content, ease of use, and operability across platforms and devices. Physicians share and consume content across interactive wikis, blogs, video sharing websites, and social networks. Though this interactive, "read-write" version of the Internet provides an opportunity for shared conversation and collaboration among potentially previously isolated individuals and ideas, it is challenged by variability in quality of content since much of the web 2.0 content is user-generated. The popular NEJM Critical Care Challenge, for example, presents a case, poses a question, and then polls readers and publishes readers' comments. While the resultant expert answer is often well-cited and associated with a published review or other peer-reviewed source, the quality of readers' comments may not meet standards of quality for use in medical practice, though they may be interpreted as such by some readers.

## 14.3 Accuracy of Web-Based Content

In medical education, though real-time access to information can be invaluable, the quality of information accessed is of paramount importance. Whether through web 1.0 or 2.0, there is wide variation in quality of available web-based content. Unfortunately, metrics measuring the quality of information on the Internet are not widely used [14]. Many websites lack processes for vetting the accuracy of user-posted content. Yet, due to ease of use and access, as well as time pressure, trainees consult websites via Internet search engines with greater frequency than traditional sources of information such as online textbooks and journals [15].

In contrast to the mental algorithms and motivations of physicians searching for accurate answers directed to patient care, proprietary algorithms that maximize website hits and advertising dollars are used by search engines to create search results. As an example of the effectiveness of web searches in making correct clinical diagnoses, a study from 2006 used three to five search terms in an online search from cases published in "Case Records of the New England Journal of Medicine" to determine how often the search led to an accurate diagnosis. The study authors based search terms on unique signs and symptoms (e.g., "wheeze, weight loss, ANCA, hemoptysis, hematuria" or "polyps, telangiectasia, epistaxis, anemia") prior to reading the differential diagnosis and conclusion of the case [16]. Using this method, the correct diagnosis was identified by web search 58% of the time. This level of accuracy of web searches is clearly inadequate for patient care, particularly when considering that a team of physicians identified the key terms to search. Educators have the opportunity to bridge this gap and provide accurate, high-quality web-based content that is also easily accessible to the learner.

## 14.4 Assessment, Analytics, and Learning Management Systems

The most obvious power of web-based learning is the ability to efficiently access immense amounts of information from multiple sources. However, an extremely powerful potential benefit of web-based learning is the use of automated, unbiased, and quantitative data capture with analysis, referred to as analytics. Medical training activities have been organized to improve specific aspects of performance through repetition and refinement, or "deliberate practice" [17]. In the past, educators have analyzed performance by the apprenticeship model of deliberate practice, typified by years of training in which mentors identify trainees' strengths, weaknesses, and personality traits during medical education and clinical practice. These subjective assessments are also reasonably obtained from several clinician-mentors and maintain value if the assessments remain longitudinal with incorporated actionable feedback.

Escalating time pressures on clinician educators, as well as work compression for learners, has made such an apprenticeship model in which physician mentors collect individualized, often subjective, information from years of direct observation of a medical trainee less feasible. However, web-based learning applications have processing power to collect and interpret numerous data points in seconds. For example, programs like The Human Diagnosis Project (www.humandx.org), a web-based application in which users can solve case vignettes by free-texting a differential diagnosis as case information is revealed, allows for software capture of greater than 100 data points related to the creation of a differential diagnosis on each solve attempt. While solving a case online is clearly different than admitting, caring for, and presenting a patient on rounds, online platforms can focus on a single aspect of medical training, such as diagnostic performance, while capturing a large amount of data. This process can then be repeated and refined in a variety of online contexts and patient presentations. In theory, educators can utilize these data to provide individualized insight into learners' knowledge gaps. Though it remains unclear how effectively this method approximates traditional observation of trainees, it can serve as a useful objective adjunct to direct observation.

A learning management system (LMS) is defined as a software application that allows for administering, tracking, and reporting of educational programs [18]. Versions that provide meaningful interpretation and feedback of the captured data continue to evolve and allow educators easy, well-formatted access to objective trainee data (Table 14.1). Though all LMSs allow access to content, embedded assessment, and analytics, distinguishing features of LMSs include ease of integration of existing content, instructor support, and mobile access [19].

Several LMSs are currently used in medical education. While some are open-source and do not require a licensing fee (e.g., Moodle and Sakai), others require upfront fees (e.g., Blackboard, Canvas (Instructure Inc.), Desire2Learn). However, even open-source options require infrastructure and support, including setting up a server, software customization, and hosting the LMS, which requires individual

**Table 14.1** Features of learning management systems

| Access | Assessments | Analytics |
|---|---|---|
| Text | Pretest | Dashboards |
| Word documents<br>PDF files | Assess baseline knowledge of curricular content | Students and instructors track progress and compare relative success |
| Audio podcasts | Embedded assessments | Individualized learning plans |
| MP3<br>MP4<br>WAV | Threshold score to proceed with curriculum | Automated curricular modifications based on embedded assessments |
| Videos | Posttest | Feedback |
| Screen capture of brief recorded lessons, webinars<br>Whiteboard screencasting | Instructor may set threshold for passing score | Automated and quantitative immediate feedback with performance comparisons across users and institutions |

Learning management systems (LMSs) facilitate web-based learning in three broad categories: access to content, assessment of learning, and analytics. LMSs allow instructors to post and learners to access content from a variety of media sources. Instructors can embed assessments before, during, and after completing a web-based learning curriculum, and learners can proceed to upcoming content based on their assessment scores. Instructors can track learner progress, improvement in score after curriculum completion, and determine if specific content requires revision. Learners can compare their progress to peers

proficiency with web development or institutional support. Though LMSs are a powerful tool that can provide educators with a centralized web-based platform to post educational content and assessments and track abundant objective data, there is a paucity of evidence regarding their optimal use in medical education.

## 14.5 In-Person Versus Web-Based Learning

Whether developing in-person or web-based curricula, one must adhere to fundamental principles of curricular design, such as Kern's six-step approach for curriculum development [20]. The continuous and interactive cycle of general and specific needs assessment, goals and objectives, educational strategies, implementation, and evaluation and feedback is vital to successful development of a web-based curriculum. Before discussing educational strategies related to web-based learning, it is important to note specific challenges related to in-person learning. As one creates a lecture or PowerPoint slides for a talk, the sequence of information delivery is fixed, linear, and defined by the teacher. The time of the talk is set and is independent of an individual learner's level of attention, fatigue, hunger, and frequency of messages regarding patient care. The delivery of such traditional in-person content is subject to logistical constraints, including the availability of the teacher and learners, as well as physical learning space. Though some learners may be able to adapt and effectively follow in-person education despite these internal and external pressures, some learners may not be able to adapt and concentrate.

Well-designed web-based learning has several advantages that may overcome some of the barriers to effective delivery of in-person, time-constrained, didactic medical education. Students can study web-based content at a time when learner attention is focused; formative assessments can be directly embedded in web-based content; and modifications can be implemented for web-based content based on assessment results. Since web-based learning allows for variability of the order in which educational material is consumed, it enables learners with different learning styles to experience both the processing and perception continuum with their preferred learning style as described by Kolb [21, 22]. For example, in learning about ventilator dyssynchrony, an assimilating (think/watch) learner could choose to first read online text on principles of mechanical ventilation and be assessed in theory, whereas an accommodating (feel/do) learner could start by accessing clinical vignettes and patient management assessments.

Despite the potential of web-based educational resources, we must emphasize that there is little robust evidence evaluating whether web-based learning is superior to or even non-inferior to traditional learning in medical education. It is also important to note that historic media comparison studies have determined that the type of media does not appear to influence learning under any conditions [23].

Studies evaluating web-based learning in medicine have produced mixed results. In a study evaluating the efficacy of an online delirium curriculum, fourth-year medical students completing two online modules containing videos, mock charts, informational slides, and real-time assessments performed equally well in pre- and post-test measures as students who attended a 1-hour lecture on the same topic [24]. In contrast, in a study of medical students in Germany, learners who participated in a web-based module developed for endocrine pharmacology embedded within a LMS had higher post-test scores compared to learners participating in both lecture-based and small group learning [25].

Several meta-analyses have been performed that compare in-person and web-based learning. A meta-analysis of Internet-based instruction for health professionals (including students, dentists, and nurses) suggested similar effectiveness of web-based learning compared with non-Internet instructional methods [2]. This finding is consistent with a broad 2009 US Department of Education meta-analysis of 45 studies of web-based learning of students (age ranged from 13 to 44), describing web-based learning as equally effective as, but not necessarily superior to, other educational approaches [26].

However, in a majority of studies of web-based learning, it is structured as a "substitution" approach (i.e., posting a recorded in-person lecture on a website) or transference of existing pedagogy, rather than actively utilizing the aforementioned beneficial features of web-based learning to improve pedagogy [27]. This cautionary caveat is important when interpreting individual studies and meta-analyses that compare in-person and web-based learning. Comparisons should be made of well-designed content based on the fundamentals of curriculum design, and there is significant heterogeneity in quality of web-based curricula across these studies, such that no strong evidence-based conclusion about the comparative effectiveness of optimized web-based learning and traditional teaching methodologies can be made from the available evidence in the literature.

Acknowledging the inconclusive data regarding web-based learning, there are relevant fully web-based and hybrid curricula that both incorporate the specific benefits of web-based learning and address specific training issues that arise in pulmonary and critical care education. Examples of such web-based and hybrid curricula are presented below.

## 14.6 Practical Example 1: A Fully Web-Based Module on Ventilator Management

A 45-year-old HIV-positive patient with *Pneumocystis* pneumonia requiring mechanical ventilation is being cared for in the Medical Intensive Care Unit. At 3AM, the ICU resident is called to the bedside for an oxygen saturation of 88% with pulse 110 bpm and blood pressure of 114/64 mmHg. The patient is heavily sedated and passive on the following ventilator settings: volume assist control with a tidal volume of 350 mL, respiratory rate of 25 bpm, $FiO_2$ of 0.7, and PEEP of 14 cm $H_2O$. The peak pressure monitor on the ventilator is 55 cm $H_2O$, and the respiratory therapist (RT) is at the bedside. The patient is placed on a $FiO_2$ of 1.0, the alarm is silenced, and the RT performs in-line suctioning, which results in coughing with further ventilator alarming. A fentanyl bolus is given, and the PEEP is increased to 16 cm $H_2O$. The $O_2$ saturation increases to 91%, the resident orders a STAT chest radiograph and performs a physical exam which is notable for new finding of diminished breath sounds on patient's right side. Five minutes later, while waiting for the chest radiograph to be performed, the patient's $O_2$ saturation drops to 85% and the BP drops to 80/50 mmHg. A fluid bolus is started, but as this occurs, the patient arrests. ACLS is performed for 20 minutes but the patient ultimately dies. Peer review of the case determines that tension pneumothorax was the most likely diagnosis, and that this diagnosis was missed during the evaluation and resuscitation. A root cause analysis identifies a knowledge deficit in troubleshooting respiratory decompensation in mechanical ventilated management patients by the housestaff. You are asked to develop an educational curriculum to ensure that this performance deficit is addressed prior to residents taking overnight call in the ICU.

Data gathering, interpretation, and intervention often occur rapidly at the bedside when caring for critically ill patients, as the case of a tension pneumothorax above demonstrates. Rather than hope for on-the-job training or perfect timing for the chalk-talk on peak and plateau pressures (which was scheduled to occur 2 days after this event), a fully web-based module provides an opportunity to learn these essential concepts before they occur in the clinical setting. In fact, web 1.0 educational materials already exist on this topic (Life in the Fast Lane blog [https://lifeinthefastlane.com/ccc/high-airway-and-alveolar-pressures/]); and it would not require significant resources to either modify available materials or create and post a web 1.0 handout on an institutional intranet site. The educator must review this content for accuracy and appropriateness prior to posting, but would not have to develop all of it from scratch. This simple intervention could even be paired with emailed pre- and post-tests to assess knowledge acquisition.

However, as with other instructional modalities, an ideal online educational curriculum should utilize fundamental best practices of pedagogy. For the problem of decompensation in ventilated patients, it would be appropriate to develop web-based curriculum embedded within a LMS, based on Kern's six-step approach for curriculum development (Fig. 14.1) [20]. A LMS allows for technical ease of implementation of an online curriculum development and use of real-time analytics, such as altering content based on threshold scores and updating educators about learners' progress. For example, this curriculum would require both completing and passing a "basic concepts" portion prior to the first overnight ICU call.

If four senior residents were about to start an ICU rotation, all would go through the online curriculum and their supervisors would know their performance on specific content areas. A pretest embedded within a web-based module augments any anecdotal information from direct observation with a quantitative assessment to provide a more accurate needs assessment. Indeed, a pretest would not only inform the targeted needs assessment, but also provide formative evaluation and feedback. When utilized within a LMS, performance is quantified and displayed on an instructor's dashboard. Once the pretest is completed, learners proceed to the educational content. The method and content could be tailored to the individual, based on both pretest performance and frequent embedded assessments in the material itself. For example, a third-year resident who performs at the top decile on the pretest could bypass certain content areas and proceed directly to content related to advanced management. If individual assessments are passed, the content progresses. If not, remediation is required with additional and varying content (redirection to a relevant journal article or chapter from textbook on mechanical ventilation).

Quantitative formative assessment would not only be used by supervising educators, allowing tailored and focused bedside education on deficits, but also by the learner him or herself as a source of immediate feedback delivered online that should prompt reflection on areas of needed improvement. Prioritizing understanding learners' capabilities prior to error occurring in patient care activities is critical in reducing medical errors, and a LMS with a web-based curriculum and embedded assessments provides educators a platform to do so.

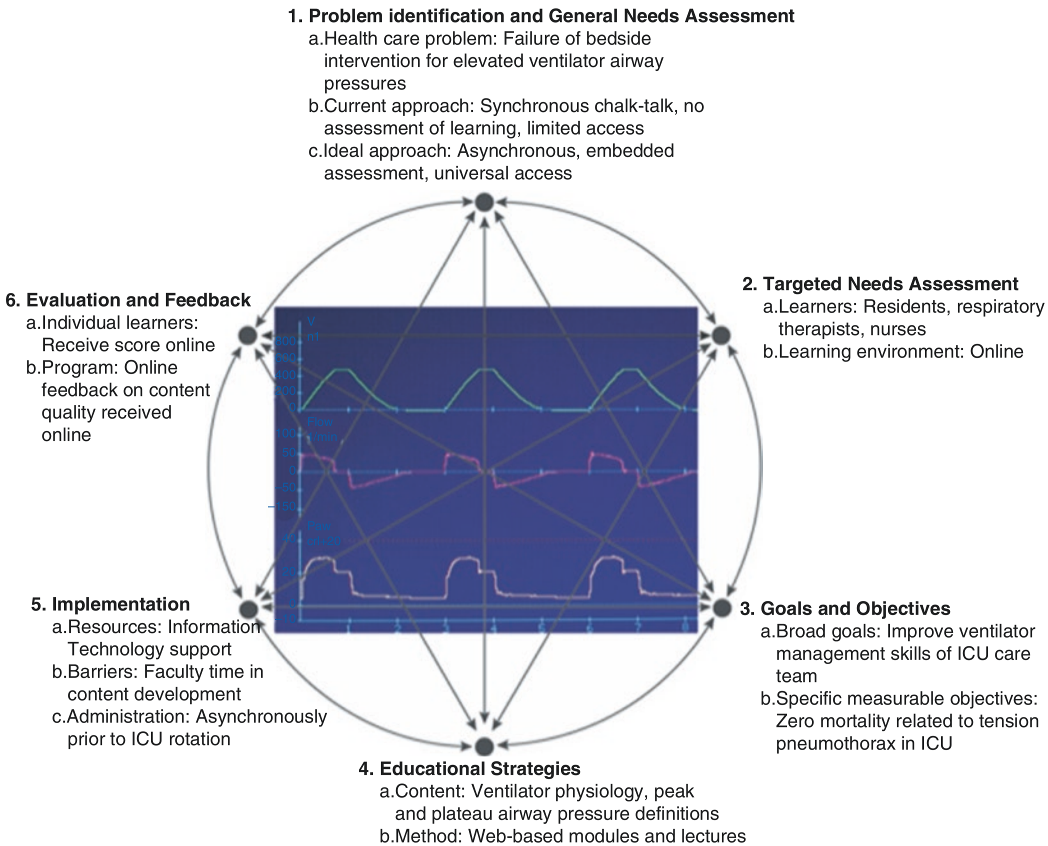


**Fig. 14.1** Development strategy for fully Web-based module on ventilator management. (Adapted from Kern et al. [20])

## 14.7 Practical Example 2: Hybrid Learning Bronchoscopy Training

While on the Pulmonary Consults rotation, your first-year pulmonary fellow evaluates a patient with recurrent right lower lobe infiltrate, cough, 3 LPM oxygen requirement, and a history of rheumatoid arthritis currently treated with etanercept. Given failure of empiric antibiotic therapy and an inability to obtain an adequate sputum sample, the patient is scheduled for bronchoscopy with bronchoalveolar lavage (BAL). On the day of the procedure, you see patients in your clinic and hurry to meet the fellow in the endoscopy suite 15 minutes prior to the scheduled procedure start time. Though the room is ready, the procedure consent form is blank because the fellow is uncomfortable describing the risks and benefits of the procedure. This is only her second bronchoscopy. After you obtain consent with the fellow observing, the nurse wheels the patient back to the endoscopy suite 5 minutes after the scheduled start time. Prior to starting the procedure, you review the CT scan with your fellow and decide to perform BAL in the superior segment of the right lower lobe. Since the fellow does not know how to anesthetize the upper airway, you describe and perform the process, and do the same for the administration of conscious sedation. The fellow then takes the bronchoscope for the procedure, and after significant difficulty introducing the bronchoscope into the nasopharynx, resulting in nasal trauma and bleeding, she passes the scope through the nares to the posterior oropharynx and hastily pushes the bronchoscope toward the vocal cords, hitting the right posterior vocal cord. Severe coughing ensues, additional sedation is given, and you quickly push 2 milliliters of 1% lidocaine through the bronchoscope onto the carina. The fellow then engages the right main stem bronchus, sweeps past the right upper lobe takeoff and right middle lobe while riding the airway wall, and ends up in the anterior basilar segment of the right lower lobe. She asks for her first aliquot and trap. At this time, you are already 20 minutes late and the next case is scheduled to begin in 10 minutes. Given the time constraints and challenge of teaching the fellow airway anatomy as she nervously tries to manipulate the scope into the appropriate segments, you take the bronchoscope, perform a quick airway inspection, and lavage the superior segment of the right lower lobe.

How could a web-based curriculum assist with improving the performance of a procedural skill as described above? A common approach to teaching bronchoscopy in fellowship may include an orientation to the endoscopy suite and a 'bronchoscopy basics' lecture early in the year. Unfortunately, the rest of procedural education is often on-the-job training. Using Kolb's learning styles in teaching bronchoscopy, educators may focus on the processing continuum (doing versus watching). However, there are several aspects of the procedure that are amenable to hybrid learning: combining web-based learning with other in-person methods. An online module could review indications and contraindications for bronchoscopy, describe the approach to anesthetizing the airway and traversing the upper airway, and show lower airway bronchoscopic anatomy. Such web-based content may be particularly useful in providing learning opportunities for those who start in Kolb's quadrants

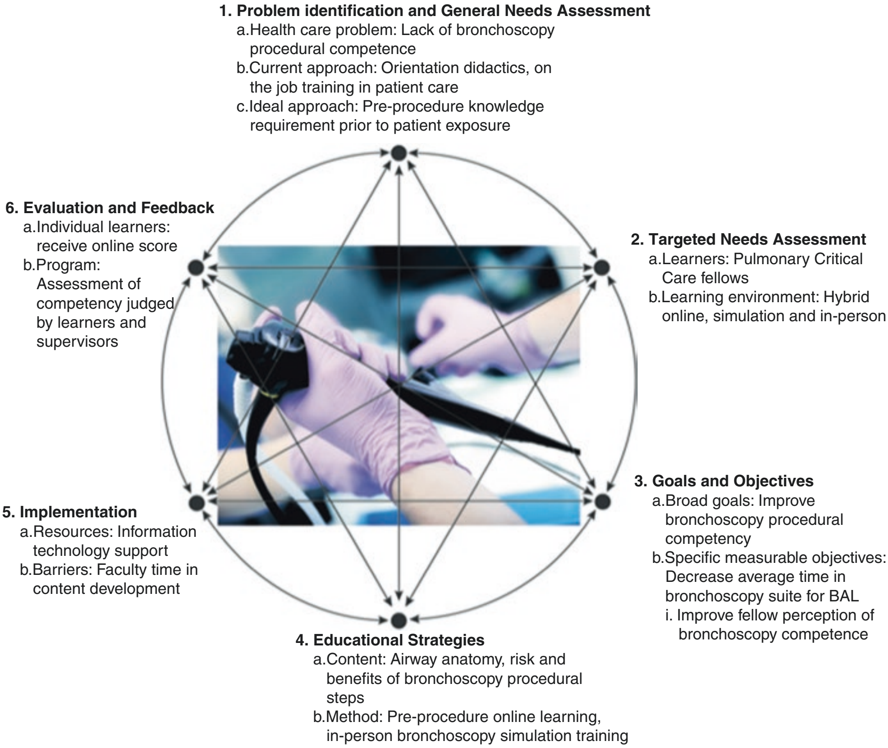


**Fig. 14.2** Development strategy for Hybrid Learning Bronchoscopy Training. (Adapted from Kern et al. [20])

related to thinking on the perception continuum. As one specific example, the University of Washington Division of Pulmonary, Critical Care, and Sleep Medicine produced several short videos regarding these steps that are hosted on The Best of ATS Video Lecture Series home page (https://www.thoracic.org/professionals/clinical-resources/video-lecture-series/bronchoscopy/index.php).

Ideally, these web-based learning modules would be housed on a LMS that allows trainees access to content including short lectures, texts, references to the literature, and videos of bronchoscopy with embedded brief learner assessments that must be completed prior to inserting a bronchoscope into a patient (Fig. 14.2).

For example, a brief video of bronchial anatomy with labels could be made or used from online sources, followed by a quiz with unlabeled images. Important knowledge concepts such as lidocaine toxicity and procedural risks in special populations could be addressed by short case vignettes with embedded questions.

Although practical but not ideal, web 1.0 information on this topic is also readily available on e-journals and UpToDate, and could be summarized and housed on an institutional website to allow trainees just-in-time access to these resources. As previously mentioned, external material from the Internet would need to be vetted for quality and accuracy by faculty educators. Using a hybrid model of teaching knowledge-based content would allow bedside or simulation-based education to focus on procedural aspects that require a physical presence, such as the proper technique in holding, driving, and navigating the bronchoscope.

Both of these examples of web-based learning initially require considerable time and resources to develop from scratch. The reality of time constraints in modern-day medicine is an obstacle to web-based learning, both for the educator to develop and maintain web-based content and for the learner to complete web-based learning activities. The educator still needs protected time to create a web-based learning curriculum, build assessments, and update web-based materials in response to analysis and evolving clinical evidence. Though a LMS makes assessments and analytics more efficient for the educator, local resources may not be available to support and maintain a robust LMS. For the learner, there are other important questions related to web-based learning. Does the time required to go through the curriculum count against the ACGME-mandated 80-hour work week? If so, are learners excused from clinical duty to complete the curriculum? Are the web-based materials offered by an educator or training program more valuable than what one can find independently on the Internet?

## 14.8 Future Directions and Questions

In reflecting on the future of web-based learning in medicine, it must be acknowledged that we live in an era of exponential technological growth, so the societal and educational impact of new technologies is unpredictable. It is remarkable that only 20 years ago, companies that dominate technology and the way we consume it daily were either not yet founded (Google, Facebook) or fledgling (Apple's stock price nadir was in 1997 with the first iPhone 10 years away).

While no one can predict the future, technology companies are actively investing in artificial intelligence, and significant progress has already been made in developing this technology (e.g., IBM's Watson.) It is easy to envision a future in which machine-learning and artificial intelligence applications are embedded into LMSs and web-based educational resources.

To evolve the online learning environment into a fully independent virtual educational experience with individualized learning plans, preliminary investigations of "intelligent tutoring systems," which are adaptive online instructional systems that incorporate domain knowledge and pedagogy, have shown promise [28]. Indeed, early stages of educational "data mining," a discovery process of identifying nonobvious patterns in large collections of educational data, are an emerging field of research. In educational data mining, data from web-based learning can be analyzed via visualization, statistical values, clustering, and classification [29]. In the future, medical educators will develop content and shape iterative pedagogic improvements by interpreting the vast amount of available data in web-based learning.

**Table 14.2** Social media: opportunities and challenges in medical education. The opportunities and challenges of implementing social media in medical education. For every potential benefit of social media, there are significant challenges to its successful implementation. Medical educators must carefully assess the risk benefit ratio before jumping into social media in their educational programs

| Opportunities | Challenges |
|---|---|
| *Educators* – access to shared and crowdsourced ideas with opportunities for feedback and development | Imbalance between quantity and quality – over-simplification of complex topics through abundance of superficiality |
| *Learners* **–** exposure to an expansive variety of ideas and content beyond confines of local institution | Accurately assessing validity and reliability of information |
| *Constant and rapid connectivity and engagement* **–** education outside the wards and classroom | Work/life separation |
| *Networking* **–** building and maintaining relationships across distances | Cybersecurity and privacy vulnerability |

## 14.9 Social Media

Social networking applications such as Facebook, Twitter, and Snapchat are the primary media by which billions of users consume information and exchange ideas. Informally, social media provides medical educators with the opportunity to share cases, clinical pearls, and comment on recent publications in an open forum (Table 14.2). For example, a Twitter post by Dr. Sam Ghali (@EM_RESUS) includes a bedside echocardiography video clip of a large thrombus in the RA and RV, tagged "initial diagnosis of sepsis and NSTEMI" creating an anecdote impressing upon his followers the importance of bedside echocardiography. Just as with other content on the Internet, information found on social media requires critical evaluation for quality, and misinformation is possible. However, because of the absence of context, brevity of content delivery, and mixing of fact and opinion on social media, in-depth analysis for reliability and validity may be challenging. Despite this, the power to reach and connect with large numbers on social media should not be ignored. Early results of medical education social media interventions designed to promote learner engagement, feedback, and collaboration are encouraging [30]. As a specific example, educators have used social media to "push" ultrasound images with educational pearls to users on a frequent and recurring basis as a supplement to a traditional ultrasound curriculum; incorporated online wikis, groups, and blogs to augment collaboration of small groups; and augmented reflection and collaboration in a medical humanities curriculum [31, 32]. Educators can serve as honest influencers on social media by creating and disseminating quality content and expert ideas as more and more learners subscribe to information on social media rather than traditional outlets. Professionally, recognition of scientific impact through content dissemination on social media complements traditional citation metrics and could be used in academic promotion [33].

## 14.10 Conclusion

Quality pulmonary and critical care web-based educational content utilizes the inherent benefits of the flexibility of the Internet, assessment, analytics, and large-scale dissemination while adhering to principles and best practices of curriculum development and learning theory. As we seek to determine the optimal role for web-based learning in medicine, well-designed web-based content, not substitution methods, should be studied in comparison to well-designed in-person educational content. Systematic evaluation of the value of this content has lagged, and is an important future direction for assessment and research. Web-based learning has developed rapidly with exponential technological innovation and decreasing time dedicated for medical education. In this context, medical educators are responsible for the future development, implementation, assessment, and modification of high-quality web-based learning content.

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# Chapter 15
# The Role of Feedback in Teaching

**Nicola Faichney and Emer Kelly**

## 15.1 Introduction

Feedback is an essential component in the learning cycle which drives professional development in medicine. Ende defined feedback as "information describing students' or house officers' performance in a given activity that is intended to guide their future performance in that same or a related activity" [1]. A more streamlined and basic description of feedback might be "tell me how I am doing so I can do better" [2].

Despite feedback being a cornerstone of medical education and training, best practices for providing effective feedback are primarily based on expert opinion. As rigorous evidence comparing different strategies for providing feedback is lacking, consensus opinion drives our collective approach [3]. A generally accepted paradigm for providing feedback is the cycle of performance, feedback, reflection, action, improvement, and repeat performance (Fig. 15.1). There are necessary deviations from this approach, but this cycle generally forms the foundation for observation, feedback, and "closing the loop" with reflection and observation after receiving feedback.

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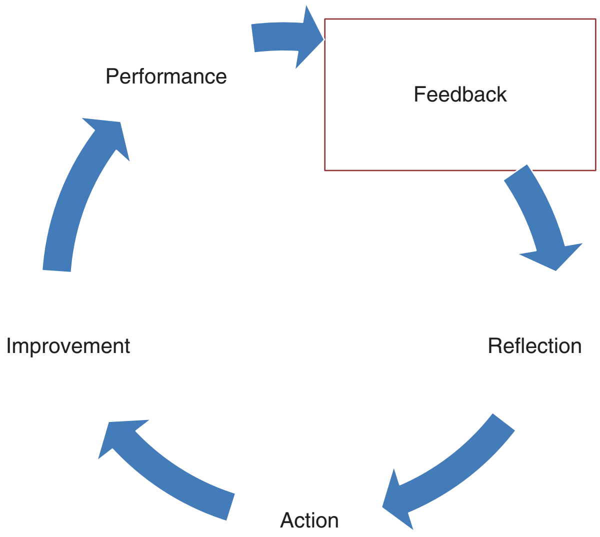
P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5_15

**Fig. 15.1** The cycle of performance and feedback in education and clinical practice




It is important to note that feedback can come from multiple different sources, including peers, interprofessional colleagues, attendings or instructors, patients and families, and other healthcare providers. In this chapter, the focus will be on feedback from an attending or instructor to a learner or trainee. Certainly, "360 degree evaluations," peer-to-peer and near-peer feedback, and patient or family input are important sources of information about and feedback on an individual's clinical performance, but these sources of feedback are beyond the scope of this chapter [4].

Feedback is dependent on accurate and reliable assessment of a learner's knowledge, skills, and attitudes. As assessment modalities can vary based on learner level and settings, the approach to assessing a Pulmonary and Critical Care Medicine (PCCM) fellow in clinic is different than assessing a first-year medical student's performance in a simulated clinical scenario [4]. The process of providing feedback, however, can be relatively consistent regardless of learner level or setting. This chapter will focus on the process of providing feedback; assessment and evaluation are not explicitly discussed.

Multiple aspects of providing feedback to learners will be discussed, and definitions of different types of feedback will be considered, including formative, summative, and temporally defined feedback. Best practices for providing feedback to learners will be reviewed, with an emphasis on the available evidence for engaging in effective feedback. Logistical considerations, including setting, timing, duration, and follow-up, will be discussed. Finally, specific recommendations for implementing best practices for providing effective feedback will be offered throughout the chapter. Providing feedback to clinical learners, particularly learners in PCCM, in the clinical setting will be the emphasis.

## 15.2 Why This Matters: Expectations and Effectiveness of Feedback

Learners at all levels of training and all members of the interdisciplinary team can benefit from feedback. If feedback is not provided to learners, good performance may not be reinforced, and poor performance may continue without correction. In the absence of feedback, the learner may assume that all is well, and that his or her performance does not require reflection or modification. Alternately, learners may look for surrogate indicators on their performance that are less accurate and effective than thoughtful, behaviorally specific feedback from supervisors. The absence of feedback may result in learners self-evaluating in a sporadic manner, working by trial and error, and becoming vulnerable to continued ineffective clinical behaviors [5].

While not giving feedback can be problematic, ineffective or misguided feedback may be even worse, as it has the potential to cause harm. Feedback intended to address a knowledge gap, if not carefully considered and provided to a learner, can result in demotivation and deterioration in performance. Sometimes feedback is avoided, as an instructor may be uncomfortable with addressing a learner's deficits or an instructor may believe that providing feedback is pointless because there is of a lack of resources to help the learner improve. However, fear of providing ineffective feedback and upsetting learners cannot be used as a reason to avoid attempting to provide feedback. To provide as effective feedback as possible, employing a constructive approach to feedback is important.

Providing constructive feedback is often perceived to be a difficult task, but the skills to provide effective feedback are obtainable. Working to develop and reinforce the skills to provide effective feedback to learners of all levels in a variety of clinical settings can promote learner self-assessment and self-directed learning which ultimately leads to better patient care [6].

In the current setting of competency-based medical education, learners are expected to reach given milestones [7]. Detailed and appropriate feedback on performance coupled with suggestions on how to improve can help learners meet these milestones [7]. Contemporary learners perceive that feedback, particularly behaviorally-focused and constructive feedback, can be valuable and in general are looking for more feedback.

Instructors often think that they are providing frequent and appropriate feedback, but, reciprocally, trainees often think that they get very little and often ineffective feedback [8]. Being cognizant of this common mismatch between these perceptions about the relative frequency and value of feedback is the first step in addressing this disconnect. One preliminary but potentially effective step toward addressing this mismatch is to create an educational environment where feedback is both expected and valued (see Sect. 15.5).

An additional benefit of creating an environment and culture of feedback is that such an environment encourages self-assessment, a key component of lifelong learning [9]. Regular, effective, formative feedback can encourage self-reflection and learner-initiated corrective actions, allowing learners to proactively correct deficiencies. How a learner receives and perceives external feedback from instructors (or others) will shape how the learner moves forward with incorporating and acting upon the constructive feedback provided.

## 15.3 Feedback Categories: Formative, Summative, Constructive, and Temporally Defined

### *15.3.1 Formative and Summative Feedback*

Feedback can be categorized in different ways. Formative feedback aims to provide guidance on a recent behavior to constructively impact future learning, provide reassurance, promote reflection, and shape values [10, 11]. Alternatively, summative feedback is a more comprehensive judgment about a learner's competence, fitness to practice, or qualification for advancement to higher levels of responsibility (see Fig. 15.2). Formative feedback is generally low-stakes and focused on more granular events or behaviors, while summative feedback is perceived to be more high-stakes and comprehensive. Formative feedback can be useful to learners of different levels in a variety of Pulmonary and Critical Care Medicine (PCCM)

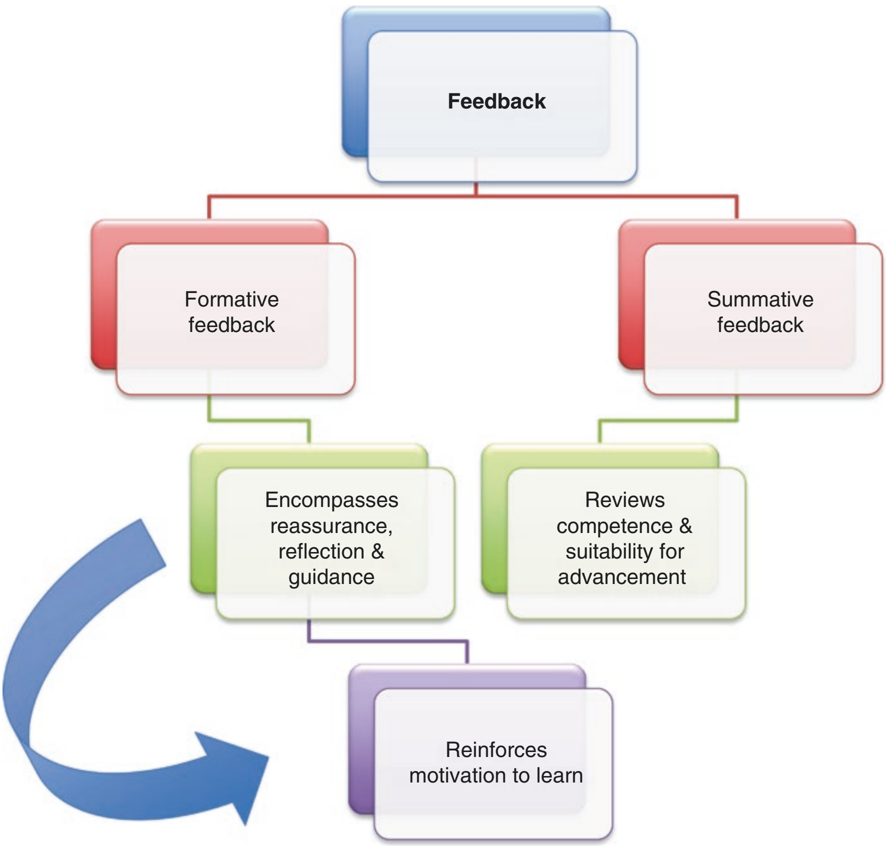



**Fig. 15.2** Formative and summative feedback

settings, helping build intrinsic motivations to learn and addressing knowledge deficits, as well as promoting best practices in clinical skills and reinforcing patient-centered, professional attitudes [3, 8, 10].

### 15.3.2 Positive, Negative, and Constructive Feedback

Feedback has often been defined as "positive" or "negative" in nature. This differentiation has fallen out of favor among educators, however, as the connotation of "negative" feedback is generally considered to be counter-productive (see Fig. 15.3). Furthermore, "positive" and "negative" feedback implies commentary about the learner as an individual rather than commentary about the learner's behaviors, skills, or performance. As such, labeling all feedback as "constructive" is preferred (see Fig. 15.4), whether the feedback is reinforcing a beneficial and effective behavior (e.g., what had been referred to as "positive" feedback) or providing guidance about a behavior that should be modified or avoided in the future (e.g., what had been referred to as "negative" feedback).

### 15.3.3 Feedback "Levels": Task Learning, Task Motivation, and Self-Related

Feedback can also be stratified by the "level" of the feedback. These levels are categorized based on the complexity of the process being addressed: task learning, task motivation, and meta-tasks (including self-related processes) [12].

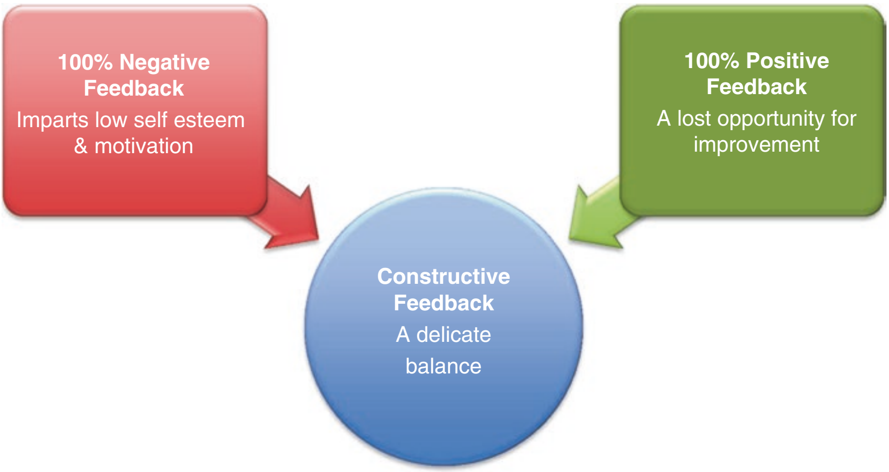



**Fig. 15.3** "Positive," "negative," and constructive feedback

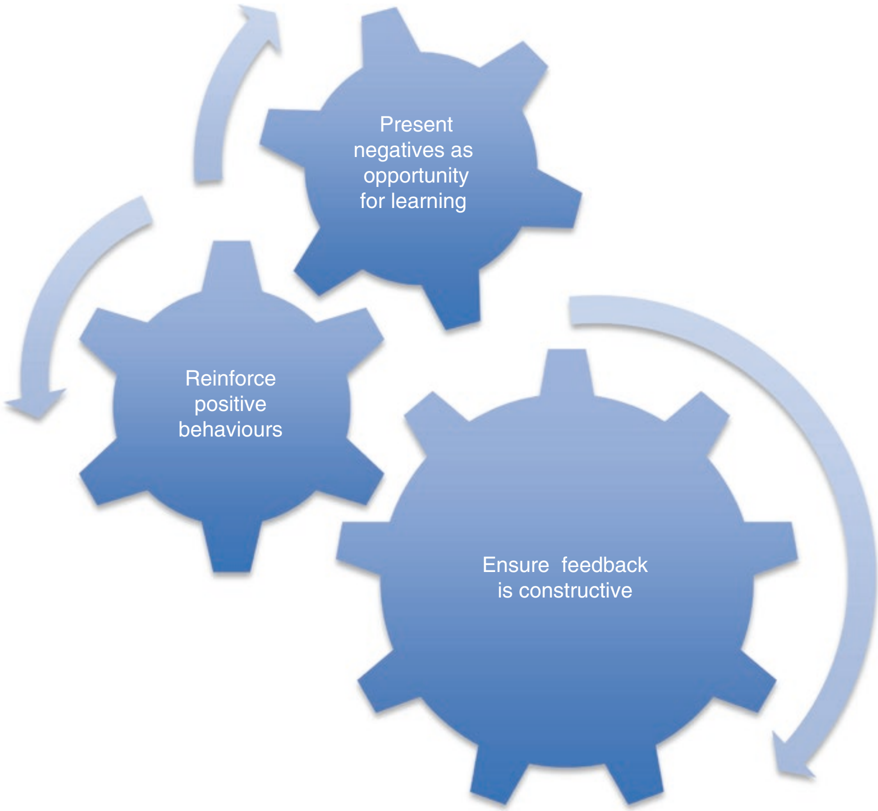



**Fig. 15.4** Strategies for providing constructive feedback

Task learning feedback involves discrete physical or focused cognitive skills [12]. Teaching components of performing a procedure and providing constructive commentary about how to organize a clinical note are examples of task learning feedback. When giving feedback about task learning, the content of the feedback is likely to be more straightforward and less personal. For example, task learning feedback provided to a learner attempting to insert a central line might include suggesting that she try a more acute angle for insertion of the guidewire or a more appropriate way to apply a dressing. This type of feedback is entirely constructive and can involve directive, stepwise instructions that leave the learner's sense of "self" intact.

Task motivation feedback more broadly involves the learner's sense of "self" and may result in more resistance or resentment from learners [12]. Commenting on issues of motivation, from self-motivated desire to learn to engage in or act on clinical scenarios, is an example of task motivation feedback. Feedback that is perceived to be directed at a learner's sense of self may provoke a strong emotional response including a sense of disappointment or shame. For example, feedback given on appropriate use of language in a sensitive family meeting may encroach on the sense of self and be met with more resistance than task learning feedback.

Meta-tasks and self-related processes by definition intrinsically involve a perception of "self" [12]. Feedback related to meta-tasks involves alerting a learner to a core behavior or attribute about which he or she was not aware, and making the learner aware that this behavior or attribute can threaten the learner's self-perception and self-esteem. For example, a learner may perceive himself as being collaborative with colleagues in the ICU, but his behaviors are actually perceived as abrasive and off-putting. Discussing this learner's behavior with him is discordant with his self-perception and may result in defensiveness, disbelief, and resentment.

Feedback related to the self is emotionally charged, and this can get in the way of a learner engaging in objective thinking about the feedback [13]. Reactions to constructive feedback are influenced by perceptions of accuracy, credibility of data, and usefulness of the feedback. It is never a goal of feedback to incite shame, as shamed individuals may internalize this response and feel inferior and defective [14, 15]. If the feedback is incongruent with self-perceptions of performance, the learner may disagree with the feedback, and have difficulty assimilating the information [16–19]. Strategies to combat resistance to feedback and resentment as a response to feedback are delineated below.

### 15.3.4 Temporally Based Definitions: Brief, Formal, and Major Feedback

In addition to delineating feedback as formative or summative, or constructive, feedback can also be classified based on the time required to provide feedback to a learner. Three broad temporal categories include brief, formal, and major feedback (see Fig. 15.5) [20]. Brief feedback may include activities such as providing concise constructive (and formative) commentary on a learner's performance of component of the physical exam or on how a learner elicited a patient's medical history.

In providing brief feedback, the goal is highly concrete, specific suggestions based on a learner's behavior. These observations are delivered in the moment, temporally linked to the immediate clinical setting and to the learner's performance. What makes such suggestions 'feedback' and not simple direction is, at least in part, the language used to provide the learner constructive commentary. Using a statement such as "Let me give you some feedback" consolidates that the instructor's comments represent a teachable moment for the learner.

As compared to brief feedback, formal feedback usually requires protecting a period of time to provide a more in-depth discussion of a learner's recent or overall performance. While brief feedback may take seconds to a few minutes, formal feedback may require 5–20 minutes (or longer) given the more in-depth nature of the comments provided to the learner. In addition, formal feedback should not be provided at

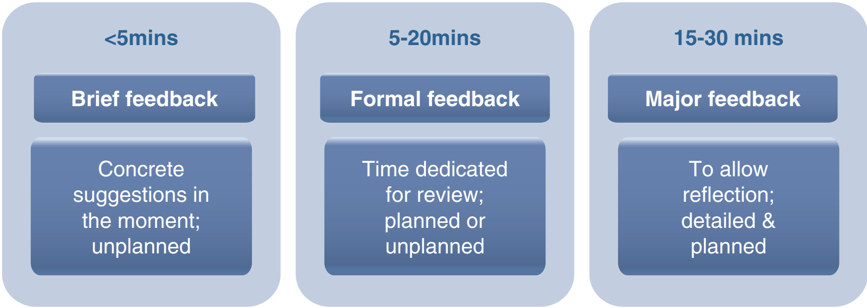



**Fig. 15.5** Temporally defined feedback: brief, formal, and major feedback

the bedside or in a busy clinical setting; a quiet environment in which the instructor and learner can engage in uninterrupted discussion is ideal for formal feedback.

Of note, formal feedback may be either formative or summative in nature. Formal feedback may encompass purely formative feedback about a learner's performance on a specific clinical task; for example, spending 5–10 minutes in a conference room discussing the skills and behaviors a learner used in leading a family meeting would constitute formal, formative feedback. Alternatively, formal feedback can be summative in nature. Spending 10–20 minutes discussing a learner's overall performance in pulmonary clinic over the past 4 weeks is summative, formal feedback. While more time-intensive than brief feedback, formal feedback can be incorporated into clinical learning, as long as instructors anticipate the time and logistical considerations needed to provide feedback in this manner.

Major feedback is the third category of temporally defined feedback. It is usually more detailed and summative in nature. Major feedback may take place at the midpoint or end of a clinical rotation on an occasion where 15–30 minutes may be set aside to extensively discuss the learner's overall performance on-service. The learner should be made aware of the feedback session in advance and have had the opportunity to reflect on his or her performance, such that the learner arrives prepared to review performance and hear and respond to feedback. Of note, major feedback is frequently employed in the preclinical setting, in which summative, midpoint, or end-of-course feedback is provided to students regarding their overall performance in the course.

## 15.4 Who Cares?

The psychological impact of feedback and how it affects human behavior is an important component of adult learning. Below are some of the factors that must be considered when preparing and giving feedback to learners.

### 15.4.1 What Drives Learners?

In every learning environment, from the classroom to the pulmonary clinic to the ICU, the basic needs of each individual learner need to be considered. Maslow's hierarchy of needs, first described in the mid-1940s, mirrors many other theories of developmental psychology and is relevant to the topic of feedback [21]. Specifically, Maslow's theory suggests that human needs are never completely satisfied. Once basic physiological and security needs are met, self-esteem is the next most important driving factor toward achieving personal satisfaction. Satisfaction refers to an individual feeling valued, receiving recognition and status, and actively participating in his or her community in a meaningful manner. Constructive feedback can contribute to a sense of personal satisfaction in learners, thereby addressing their psychological and professional needs regarding self-esteem [22].

Behavioral theory suggests that when a specific behavior is positively reinforced, it increases the likelihood that the behavior will be repeated [23]. While this may seem apparent, in the clinical learning environment, it is common that only incorrect behaviors are highlighted in an effort to help the learner from repeating ineffective or inappropriate clinical behaviors. This is the "desired effect," but by only providing feedback on behaviors that need to be corrected or modified, learners may become anxious about receiving feedback. When every constructive comment from an instructor is corrective, learners may become defensive and less receptive to feedback and to further learning. As such, providing a balance of both reinforcing (e.g., "positive") and corrective (e.g., "negative") constructive feedback is important to maintain learners self-esteem and openness to receiving further feedback.

Social cognitive theory and the concept of self-efficacy can also provide useful perspective on and guidance for providing feedback to learners [24]. Self-efficacy refers to how a learner perceives he or she can perform a task in a specific setting [25]. In medical education, too much self-efficacy, which equates to a heighted sense of one's ability, can be a dangerous trait [26]. Reciprocally, too little self-efficacy can reduce productivity performance below ability level as well as delay professional growth and achievement [22].

Overall, referencing Maslow's hierarchy of needs, behavioral theory, and social cognitive theory, it is apparent that learning goals and objectives need to be individualized and appropriate for an individual learner. From these learning goals and objectives, feedback needs to be constructive, specific, and founded on behavioral examples rather than individual characteristics or traits. Instructors need to be cognizant of learners' self-esteem and avoid antagonistic or threatening feedback as constructive and supportive feedback maximizes the likelihood that the learner will pay attention to and incorporate feedback into his or her future clinical performance [27].

### *15.4.2 Are There Generational Differences with Regard to Attitudes to Feedback?*

Contemporary adult learners bring different learning styles, attitudes, and expectations to the clinical learning environment, which must be considered when giving feedback. When working with and teaching to Millennials or Generation Y (matriculated post the year 2000), and the incoming Post-Millennials or Generation Z learners, there may be differences in attitudes to feedback. While care should be taken when applying general characteristics of a population to an individual, there may be broad attitudes or expectations that are applicable to different generations. As one example of this, when looking at key motives for learning, one study using the thematic apperception test on a cohort of Generation X and Millennial medical students intended to describe generational differences in motives for learning and effortful engagement [28]. This study identified *power*, defined as the motive to influence and the desire to have an impact on others, as being most important to Generation X-ers [28]. Millennials, however, are motivated by *Need for Achievement* and *Need for Affiliation*. The *Need for Achievement* is defined as the motive to success by doing things better than others with "surpassing standards of excellence" [29]. The *Need for Affiliation* is defined as the motive to share with others and the desire to establish, maintain, and/or restore positive relationships with others [29].

As Millennials are the most represented generation among contemporary students and trainees, understanding the general characteristics ascribed to this generation may help instructors provide feedback. Specific characteristics about Millennials that appear to be reproducible include facility and comfort with technology, an orientation toward teamwork and collaboration, and general interest in receiving feedback [29, 30]. It is worth emphasizing again that while these characteristics generally describe Millennials, they do not necessarily describe *all* Millennials.

These general characteristics of Millennials may influence their expectations regarding the frequency and content of feedback in the workplace. Specifically, Millennials are generally described as desiring more frequent and reinforcing feedback than prior generations, although the empirical data supporting this claim are limited. That being said, leveraging the perception that Millennials expect frequent feedback can be motivation to instructors to provide more frequent and effective contemporaneous formative feedback to all learners.

The purported orientation toward more reinforcing or "positive" feedback is a reminder to instructors to be cognizant of learners' self-esteem when delivering feedback, as self-esteem is a key factor in the drive for satisfaction and fulfillment. Perceived negativity in feedback may be disliked by learners in general, including Millennial learners, so consideration must be given to delivering feedback in a constructive and nonjudgmental manner, focusing on behaviors and skills rather than personality traits [29, 30].

In addition, there are some studies that purport that Millennial learners can be more anxious and less self-reliant than other generations [30]; however, these results are not definitive, and like any heterogeneous population, such attributes will vary on an individual basis. In general, with Millennials or any other learner group, being cognizant of and considering anxiety and issues with self-reliance or self-awareness should be considered when preparing and delivering feedback.

### *15.4.3 How Do Learners Perceive Feedback?*

A study done at the Imperial College in London looked at peer-to-peer feedback [31]. Most of the participants viewed feedback as both positive comments reinforcing correct behavior and negative constructive criticism to remedy mistakes. However, some learners felt the word feedback itself, regardless of the content of instructors' suggestions, had undesirable connotations. One emblematic quote from this study encapsulates this perspective: "You are watching for the mistakes, you are watching for all the negative things, you are waiting for them to slip up" [31].

The study identified the "personal discomfort" that peer-to-peer feedback-givers encounter when evaluating a deficient performance, and how sociocultural norms make it difficult to express corrective, constructive, or "negative" comments to others. In this study (and in actual clinical practice), finding the balance of providing honest feedback in an empathetic manner was a challenge for instructors [31]. Importantly, learners were dissatisfied when no constructive criticism was given, underscoring the importance of providing feedback that doesn't simply reinforce existing behaviors. Although this study applies to peer-to-peer feedback delivery, the same challenges apply in other feedback settings.

Adult learners must learn to expect feedback as a part of training. Learners recognize that there are varied teaching styles and skill sets between educators [32]. While approaches to education may vary between teachers, learners need to know feedback will be a part of each teaching session or clinical experience. Instructors can accomplish this by dedicating time at the beginning of a teaching session or clinical encounter to discuss the learners' motivations, goals, and objectives. A few minutes spent asking learners what they know about a topic or clinical experience can yield useful information about learners' knowledge, experience, and self-identified educational needs. Instructors can then let the learners know that the instructor will provide brief, formative, and focused feedback about the learners' performance, with an emphasis on the learners' self-identified goals, objectives, and deficits. Consistently engaging in this brief pre-assessment can help to establish a culture and environment of self-reflection, self-assessment, and feedback.

In addition, making feedback a standard expectation means learners can prepare in advance for specific behavioral observations and constructive advice. When feedback is a daily part of the learner's practice, incorporating the insights provided by instructors into changed behaviors should become easier. Constructive feedback needs to be respectful of the need for self-esteem and self-efficacy. If feedback delivers on this and is challenging but specific, it can address learners' needs and can support feelings of autonomy and competence in these adult learners [33].

## 15.5 Making It Happen

Feedback can occur in a variety of settings. As described above, formal or major summative feedback can occur in a conference room or office, free from interruptions and distractions. Alternatively, brief formative feedback can occur in the day-to-day clinical setting where patient care is being delivered. Such formative feedback is feedback on history taking, examination technique, differential diagnosis formulation, clinical documentation, critical thinking process, and procedure performance, among other discrete clinical or cognitive skills.

With regard to feedback, whether formative or summative, the first step is ensuring that learners and instructors have shared expectations about giving and receiving feedback. Founded on learning goals and objectives, ideally explicitly stated but frequently implicit or inferred, shared expectations for giving and receiving feedback ought to be delineated early in a clinical rotation. Specifically, it is important to spend a few minutes of an orientation session on the first day of an ICU rotation or prior to a clinical session to discuss the logistics of providing and receiving feedback. Instructors can probe learners' learning goals, and the timing, frequency, content, and nature of feedback can be briefly reviewed and agreed upon (see Table 15.1).

The manner in which feedback is delivered is important. Bing-You and colleagues, based on a survey of medical residents, found that trust and respect for the instructor make the learner more receptive to feedback [34]. Establishing trust between an instructor and learner is a complex process, underpinned by a mutual understanding of purpose and responsibility. More recently, this has been referred to as an "educational alliance" [35, 36].

The environment in which feedback occurs refers to both the physical space in which feedback is delivered, as well as the learning environment. The learning environment needs to be based on the adult learning model, built on mutual respect, emphasizing that the learner and instructor are working together to enhance learning. The physical environment in which feedback is provided can vary depending on the type of feedback being delivered. Formative brief feedback may occur at the bedside (e.g., corrective commentary while the learner is performing a thoracentesis), while summative major feedback requires a private space. Trying to deliver summative major feedback on a busy floor or in an elevator will not be conducive to a positive outcome, as the learner may be distracted or embarrassed. Alternatively, although the clinical environment, particularly the ICU, is often busy and at times

**Table 15.1** Approaches to providing feedback in the clinical setting

| Five steps of feedback |
|---|
| 1. Identify it: "This is feedback" |
| 2. Ask trainee 2–3 things they think they're doing well |
| 3. Ask trainee what they think they need to improve upon |
| 4. Agree on areas for development with an action plan for how to improve |
| 5. Summarize with a time scale and plan review |

hectic, providing contemporaneous formative brief feedback may be entirely appropriate to capture the moment and optimally reinforce or correct behaviors. If feedback is made a regular and expected part of training, the learner recognizes its importance and does not feel ambushed when feedback is provided.

## 15.6 Practical Applications

To go through the steps in giving feedback, let's consider the approach to giving feedback on a fellows' performance during a bronchoscopy. The fellow begins the bronchoscopy, and it immediately becomes clear that the patient has not received adequate topical anesthesia prior to the procedure, as the patient is coughing, choaking, and gagging when the fellow attempts to pass the bronchoscope through the vocal cords.

The instructor provides immediate, brief, formative feedback, alerting the fellow that he has to pause the procedure to provide more topical and possibly systemic analgesia. While waiting for the anesthesia to take effect, the attending asks the fellow about his prior bronchoscopies, what bronchoscopic skills he feels he needs to work on, and whether there is anything specific about bronchoscopy about which he is interested in learning. The goals of the learner need to be recognized and clearly identified, and this discussion allows the attending to probe the fellow's experience, self-perceived bronchoscopic skill, self-awareness, self-reflection, and general learning goals for the procedure.

Prior to reattempting bronchoscopy, the attending tells the fellow that she will provide "constructive feedback" during the bronchoscopy and that this feedback is intended to help improve his procedural skills. Furthermore, the attending tells the fellow that they will spend 5–10 minutes after the procedure debriefing to provide more feedback.

Now that the patient has been adequately anesthetized and sedated, the fellow is able to pass the bronchoscope through the vocal cords with relative ease. He performs a bronchoalveolar lavage without issues but demonstrates uncertainty about bronchial anatomy, evidenced by difficult naming bronchial segments and subsegments.

After the procedure is finished, the attending invites the fellow to debrief with a quick feedback session [10]. To set the appropriate environment, the attending and the fellow go to a work room separate from the bronchoscopy suite with the goal of minimizing interruptions or distractions. The attending begins the post-procedural feedback discussion with an opening statement: "How do you feel the bronchoscopy went?" Such an open-ended opening statement allows the fellow to indicate his perceptions and insights about the procedure, which is valuable for the attending as a marker of the fellow's self- and situational-awareness, and it prevents the attending from making assumptions that can lead to an incorrect impression of the fellow's understanding. Furthermore, requiring self-assessment brings the learner into the conversation. Reflective learners will aim to put feedback in the larger context, consider the meaning and the implications for skills and action, and place this within prior knowledge frameworks. Other ways to start the discussion about feedback might be with the question “What went well?” This is a good start and can set the scene for a positive tone in the feedback session. The person providing feedback gets to acknowledge and reinforce good practices, and this can motivate learners and prompt them to seek more feedback.

In this scenario, the fellow clearly states that he understands that the patient was not adequately anesthetized or sedated on the first bronchoscopy attempt and he expresses that he needs to learn more about bronchial anatomy. Starting with self-assessment is useful in this scenario as the learner has already identified the knowledge and skill deficiencies that need to be addressed. Using specific examples in giving feedback is important; the fellow identified specific components of the procedure that went well which allows for a focused, detailed, and effective discussion about behaviors and skills [37]. Given this insight, the feedback discussion can build on his perspective, and together the attending and fellow can propose relevant strategies for constructively modifying behavior in the future.

In terms of identifying manners by which the fellow can improve his skills, learners don’t trust and often dismiss feedback that did not originate from direct observation. By engaging in real-time observation and providing specific examples of a learner’s behavior, the instructor conveys her investment in the trainee.

In addition, in this scenario, the attending physician took a moment during their formal, formative feedback discussion to commend the fellow on how he performed the bronchoalveolar lavage. She notes that his technique was excellent, she specifically references how he effectively navigated the bronchoscope and the specimen trap during the procedure, and she reinforces best practices. Balancing reinforcing and constructive feedback is important, to ensure that learners perceive the instructors are not only praising or criticizing when providing feedback.

At the end of the formal, formative feedback session, the attending and fellow review what was discussed and agree upon a discrete “action plan” going forward. As feedback is about providing information and guidance to learners with the intention of narrowing the gap between actual and desired performance, providing a road map for next steps is an important part of the feedback process. To develop an action plan, learners should be invited to identify specific steps for improvement, as opposed to the instructor simply giving them a to-do list. This learner-centered approach again reinforces learner self-reflection and self-assessment. In this scenario, the fellow indicates that he is going to review the guidelines for conscious sedation and upper airway anesthesia and that he will work with a bronchoscopy simulator to endeavor to improve his understanding of airway anatomy. The attending suggests that reviewing a series of videos about bronchial anatomy may also be beneficial. Asking the learner to summarize the core points of feedback, with an emphasis on next steps and behavioral changes, is an effective manner to confirm the learner’s understanding of the feedback session.

Finally, at the end of the feedback session, the attending offers to follow up with the fellow regarding his “action plan,” from observing his performance on the bronchoscopy simulator to observing him perform future bronchoscopies. The fellow and attending agree to meet in the Simulation Center in a week to “close the loop” with regard to the “action plan” developed from this formal, formative feedback session.

In a study about feedback, Hewson and Little investigated feedback in a faculty development course to see if literature-based recommended techniques were effective [38]. The study had quantitative and qualitative elements, including measurement of nine descriptors of the content and process of giving feedback (see Table 15.2).

In this study, one subject reported being told that they were “so OCD,” which can be perceived as a personality trait and not a behavior [38]. A learner could take offence to such a personal remark, and this may negate other appropriate comments made in a feedback discussion. A much better way to draw attention to behaviors that might be described as “OCD” would be a statement such as: “At times during your history, you focused on extraneous details that took attention away from the main presenting complaint and its importance.”

**Table 15.2** Best practices for providing effective feedback to learners in different PCCM clinical settings [38]

| Effective components of giving feedback | Example |
|---|---|
| Based on direct observation | After presenting his patient with a COPD exacerbation on the pulmonary consult service, the attending takes the medical student aside and provides direct feedback using specific examples from the student’s presentation |
| Respectful environment | The PCCM fellow starts her month in the ICU with an orientation session in which she tells the interns and residents that she will provide them frequent, formative feedback and she asks them to do the same for her |
| Nonjudgmental delivery | After a difficult clinic visit in which a patient got angry about his new diagnosis of lung cancer, the attending first debriefs with the resident who primarily saw the patient and then provides behaviorally oriented feedback about the process of giving the patient difficult news |
| Focused on specifics | During brief, formative feedback, the attending advises the intern to not describe older patients as “cute,” “lovely,” or “adorable” to avoid the perception of objectifying or diminishing them |
| The “right” amount of feedback | After a contentious family meeting primarily run by the on-call resident, the PCCM fellow elects to identify and comment upon three specific behaviors that the resident could work on in future family meetings |
| Feedback emphasizing “what we can change” | Immediately after a clinic visit in which the attending observed a resident counsel a patient about smoking cessation, the attending provides feedback focused on the content and organization of the resident’s discussion with the patient |
| Goal-based feedback | After brief, formative feedback, the attending suggests three specific goals for the intern to work on for his next central line placement attempt |
| Specific suggestions for improvement | The attending notes that the fellow’s teaching session would be more effective if she identified the learning objectives up front and provided a concise summary of take-home points at the end |

Overall, this study's findings reinforce the themes highlighted in this chapter about best practices in providing feedback to medical learners.

## 15.7 Receiving Feedback

The focus of this chapter has been largely on the process of giving feedback; however, there are strategies for learners to effectively hear and incorporate feedback to improve future performance. Feedback needs to be truly heard and internalized in order for it to be effective.

An important step to effectively receiving feedback is for learners to engage in effective and honest self-assessment before a feedback conversation. While self-assessment is not enough on its own to affect significant behavioral change in novice medical learners, it is an important component of behavioral or summative feedback. Beyond simply encouraging learners to engage in self-assessment prior to a feedback session, it is important to provide them with tools and resources to perform honest and accurate self-assessments. Strategies can range from having learners engage in reflective writing exercises prior to a feedback discussion to having learners complete self-assessment checklists. These actions which encourage pausing, reflecting, and self-analyzing one's behavior can be a powerful means of preparing the learner for summative, formal, or major feedback.

Instructors should be aware, however, that while self-assessment is a valuable exercise, self-assessment has been reported to be less accurate than external observations. In particular, many learners tend to overestimate their competence due to lack of insight into their errors or issues [39–41]. Although self-assessment is essential to promote reflection, external feedback remains important to optimize self-awareness and behavioral change.

Previous work where feedback involved confronting individuals with evidence that they are biased has incited a defensive response [42, 43]. It is not uncommon for recipients of sensitive feedback to denigrate the measure of assessment and to avoid feedback altogether [42–44]. Understanding these potential responses to feedback can help the person providing feedback to guide a learner through understandable reactions to challenging feedback.

The Johari window, a model of self-awareness in interpersonal communications, can be a useful means of guiding learners through stereotypic response to challenging or sensitive feedback [45]. In the Johari window framework, four quadrants are explored within feedback:

1. Validating the known: behaviors known to self and others
2. Accepting the blind: behaviors unknown to self but known to others
3. Disclosure of hidden: behaviors known to self but unknown to others
4. Uncovering the unknown: behaviors unknown to self and others

In feedback sessions with learners, "validating the known" addresses components that the learner and instructor both identify as behaviors or issues to work on. From the above example of the fellow performing a bronchoscopy, he clearly identified issues with providing topical anesthesia and knowledge of bronchial anatomy as issues for future work. These are specific "known" issues, and the attending providing feedback engaged in "validating the known" in this scenario. Overall, "validating the known" may be an opportunity for a learner to find out if he or she is on the right track, both with regard to self-assessment and with regard to clinical performance.

"Accepting the blind" involves helping a learner to perceive an issue or behavioral problem about which he or she had not previously been aware. Specifically, "accepting the blind" means that a learner first acknowledges that an observation truly represents a knowledge, performance, or attitudinal issue and then accepts that this issue warrants attention and effort to achieve behavioral change. As a specific example, time efficiency on ward rounds with the pulmonary consult fellow might be brought up by the attending, and examples given of how efficiency has suffered and how it could be improved (e.g., by using a rounding template or having a time limit per patient) could be discussed. Being cognizant of learners' self-awareness and self-esteem is critical when alerting them to an issue about which they had previously been unaware.

It is important to "disclose the hidden" by asking learners if there is anything in particular that they are working on improving. In the above example, the attending asked the fellow if he could identify any bronchoscopic skills he needed to work on. Being explicit, inviting, and clear is critical to optimize the chances that a learner honestly shares his or her self-perceived learning goals.

Finally, "uncovering the unknown" can be challenging, but seeking feedback from those outside the feedback dyad, such as nursing staff, interns, patients, families, or others, can uncover areas of concern or for reinforcement.

As previously described in this chapter, an educational culture that is built around regular feedback should help the skills of receiving feedback to improve. Making feedback a routine part of the learner's day, and prioritizing formative feedback focused on discrete skills and knowledge, will decrease resistance and resentment. Helping learners to know how to hear feedback, take it on board, and make plans to take action is essential to their growth as a professional.

## 15.8 Conclusions

Feedback is an essential component of learning and of professional growth. Appropriate delivery of effective feedback can help learners to iteratively improve. Establishing a culture of regular feedback in the clinical setting is a critical foundation both to decrease learners' resistance to receiving and acting upon feedback and to improve instructors' comfort with giving formative, frequent, and constructive feedback. When delivering feedback, it is essential to be cognizant of what "type" of feedback one is providing. Formative, task-focused feedback provided at the bedside is appropriate; summative, formal feedback provided in the middle of a busy clinic session is not appropriate. Situational awareness is critical to giving and receiving feedback.

Determining learners' goals, objectives, and self-assessments is an important first step in providing effective feedback. Inviting learners to engage in effective and honest self-assessment of their strengths and weaknesses can be the scaffolding upon which to provide more focused, external, constructive feedback. Specific behavioral observations and examples of clinical behavior lend evidence to the points raised. Recognizing the challenges that learners meet in receiving constructive criticism may help deal with emotional responses, frequently characterized as threats to self-esteem and self-perception. Feedback is most effective when instructors partner with learners to develop an action plan and help create a stepwise path to enact constructive changes. Following up with learners after providing feedback to determine if and how effectively feedback was implemented is a crucial component of ensuring feedback goes beyond a single discussion.

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# Conclusion

Medical education strategies will continue to evolve as our understanding of best practices in cognitive psychology, educational theory, and evidence-based teaching practices continues to grow. The increase in medical education research over the past decade has fueled the shift in medical education teaching practices from passive, unidirectional transfer of information to more active, engaging, and interactive educational sessions. Continued evolution in teaching techniques and strategies are certain to occur over the coming years, as creative medical educators and medical education researchers develop and describe novel ways to engage and teach our learners. In addition to contributing to your current teaching practices, we hope that this textbook provides a foundation for you to approach and incorporate the inevitable next developments and evolutions in medical educational theory and practice.



P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5

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P. A. Kritek, J. B. Richards (eds.), *Medical Education in Pulmonary, Critical Care, and Sleep Medicine*, Respiratory Medicine,
https://doi.org/10.1007/978-3-030-10680-5