Enhancing Resident Skills in Mechanical Ventilation

What Do Residents Learn during Intensive Care Unit Rotations?

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During intensive care unit (ICU) rotations, internal medicine residents typically care for numerous patients who are mechanically ventilated (1). Although mechanical ventilation (MV) is a potentially life-saving intervention, there is also the potential for patient harm, which may be mitigated through close attention to lung-protective ventilation strategies and dynamic patient–ventilator interactions (2). In many centers, MV is frequently managed by nonintensivists without subspecialized training in critical care, thus requiring generalists, such as internists, to be facile with these core concepts (3). However, there is considerable heterogeneity in how MV is taught in residency, and there may be variable levels of competence for physicians who may ultimately be responsible for MV decision-making (4).

In this issue of *ATS Scholar*, Schroedl and colleagues describe the impact of their simulation-based mastery learning (SBML) curriculum for residents compared with a group exposed only to a traditional curriculum in the medical ICU (5). In addition to informal bedside teaching, both groups received 4 hours of general critical care didactics, of which a 30- to 45-minute session was focused on MV, including mode selection, respiratory mechanics, auto–positive end-expiratory pressure, and weaning. In addition to this traditional training, the SBML group underwent pretesting on an MV simulator, which entailed three scenarios with normal, restrictive, and obstructive physiology. These residents were evaluated against a 47-item checklist, which was developed by a panel of experts, with a predetermined minimum passing score (MPS) of 87%. After pretesting, the SBML group received 45 minutes of didactic instruction and another 45 minutes of deliberate practice on the simulator, during which the checklist was used as a general guide for iterative practice and feedback to teach key topics. At the end of the rotations, both groups completed a posttest with simulated MV scenarios. Of the 57 participants in the SBML group, the mean score improved from 51.4% for the pretest to 86.1% for the initial attempt of the posttest, which was significantly higher than the posttest of the traditional curriculum group (86.1% vs. 60.9%, $P < 0.001$). Only 2% of the traditionally trained residents met the MPS at posttest compared with 58% of the SBML group on their initial attempt. Because the SBML residents were required to meet or exceed

*B.W.L. is Associate Editor of *ATS Scholar*. His participation complies with American Thoracic Society requirements for recusal from review and decisions for authored works.

ATS Scholar Vol 2, Iss 1, pp 1–4, 2021

DOI: 10.34197/ats-scholar.2021-0012ED

the MPS, 24 SBML residents repeated the posttest one or more times to pass, and ultimately the mean score was 92.5% at the final posttest ($P < 0.001$). Although labor intensive and time-consuming for everyone involved, this study demonstrates the feasibility and the effectiveness of an SBML curriculum for teaching MV.

This study invokes the well-validated practice of SBML by exposing medical trainees to skill and allowing repeated practice to achieve a level of competence before engaging in higher stakes situations involving actual patient care. However, previous SBML studies have focused primarily on invasive procedures such as central venous catheter placement (6, 7), airway management (8), and pleural procedures (9, 10) as well as algorithm-based processes such as advanced cardiac life support (11, 12). Schroedl and colleagues now extend the utility of SBML beyond procedures and algorithms to MV, which is far more nuanced and layered than most of the skills to which SBML has classically been applied, as MV entails the integration of cardiopulmonary physiology understanding, dynamic ventilator data acquisition and application, waveform pattern recognition, and incorporation of the clinical context to critical thinking and diagnostic reasoning.

A defining feature of SBML is that all learners are required to achieve "mastery" by meeting a uniform measure of achievement such as an MPS, as was done in this study (13). To reach that measure of achievement, a core component of SBML is deliberate practice, which differs from general rehearsal in that it entails focused attention to the development of microskills with the goal of improved performance (14, 15). Operationally, this means breaking down complex routines into subcomponents and then allowing for skills-based training individualized to each learner so that the individual can strengthen areas of weakness via goal-oriented feedback. Learners progress through the material at their own pace, and these incremental goals must be achieved before moving on to the next training phase. Remediation is thus an integral component of deliberate practice, as was exemplified by the repeated posttesting and additional practice in this study.

However, when envisioning true expertise in a high-stakes and complex medical intervention, such as MV, there should be a considerable distinction between a novice learner who achieves an MPS on a checklist in a clinical simulation after a 1-month rotation versus a highly experienced practitioner with a deep understanding of the topic gained by longitudinal deliberate practice, who readily and flexibly applies that knowledge to diverse clinical encounters. Thus, although the deliberate practice has clear face validity as applied to a complex concept such as MV, the expectation for achievement of "mastery" is more problematic. In this study, although the SBML group all did achieve the MPS, the relevance of that accomplishment is less clear. The authors acknowledge that the study was not designed to detect patient-level outcomes and that their use of the term "mastery" relates to a specific educational philosophy described by Benjamin Bloom that emphasizes the ability for learners to achieve a prespecified level of understanding if given adequate time. Furthermore, there was no long-term follow up to assess retention of knowledge after the educational intervention. Moreover, the skills attained by the intervention group may be adequate for trainees with ongoing oversight by fellows and attending physicians but may be inadequate for independent

practice, in which case, it is counterintuitive to apply the term "mastery" to these learners. Rather, better terminology for these intermediate-level knowledge targets may be "competency-based learning," while reserving the term "mastery" for a more advanced level of achievement associated with true expertise, independence, and the ability to safely navigate high-stakes actual patient encounters day after day. That level of expertise is neither the goal for this educational intervention, nor should it necessarily be the expectation for residents rotating through the ICU. Although we may not conclude then that the SBML residents achieved true mastery of MV, this study clearly underscores the value of dedicated teaching via SBML.

Another very important finding in this study is that experience with mechanically ventilated patients during routine ICU rotations coupled with traditional teaching approaches was insufficient for achieving the educational goals, at least without additional dedicated educational effort. Thus, we should not assume that ICU rotations, without active learning or deliberate practice, will automatically produce physicians who can safely manage complex clinical topics, such as MV. A study by Seam and colleagues found that fellows in traditional training programs with a median of 23 months of fellowship training performed no better at recognizing common clinically significant ventilator waveform abnormalities than first year fellows at the very beginning of their fellowship. Despite 3–5 hours of MV didactics per year in addition to conventional bedside teaching and clinical exposure during multiple ICU rotations, the fellows' skills did not develop significantly (16). In fact, even practicing intensivists with years of experience performed poorly in identifying common patient–ventilator asynchronies (17). If this finding that traditional clinical rotations do not necessarily facilitate the development of basic competence is true for other complex topics beyond MV, the implication for medical educators as well as trainees would be profound and unsettling.

Ultimately, what should be the educational goal as it pertains to MV education? For residents in the ICU, basic competence to facilitate patient safety should be the primary objective, whereas true mastery should be the aspiration for fellows. This SBML curriculum fostered education of residents in MV basics, and future studies should ideally examine the impact of curricular modifications on longer-term skills retention by the learners and, if possible, patient-centered outcomes.

Author disclosures are available with the text of this article at www.atsjournals.org.

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