First Do No Harm: Preserving Patient Safety Without Sacrificing Procedural Education

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Invasive procedures are performed every day by physicians-in-training in American hospitals. Specific procedures vary from surgical interventions performed in the operating room to procedures such as bronchoscopy, temporary dialysis catheter insertion, and endoscopy performed at the bedside. A delicate balance exists in each situation because performing the procedure safely is paramount for patients, while acquiring clinical skills is a critical objective for medical learners. Maintaining this balance also is made challenging by critically ill patients, complex procedures, and the varying competence and experience of individual trainees. The difficulty in balancing these interests is shown by the fact that complications related to medical procedures are consistently reported as a significant cause of preventable morbidity and mortality among hospitalized patients.[1,2]

In this issue of the *Journal of Graduate Medical Education*, Grover and colleagues[3] present results of an online education program designed to improve internal medicine residents' knowledge of 2 bedside medical procedures, central venous catheter (CVC) and arterial line (AL) insertion. The authors enrolled 210 residents at 3 residency programs in an educational trial. Subjects were randomized to online educational material for CVC insertion, AL insertion, both, or neither, and completed an online test of their knowledge of CVC and AL insertion at baseline and again after performing 2 CVC or AL procedures in actual clinical care. Study outcomes were differences in test scores between residents who used the online intervention and those who had not, and resident confidence regarding CVC and AL insertion.

The investigators report several interesting findings. Although over half of study subjects were first-year trainees, residents were highly confident in their ability to perform these procedures with and without supervision. Despite high self-confidence, baseline test scores for both procedures were low, consistent with previous research,[4] highlighting the frequent disassociation between confidence and competence. In regard to the main study outcome, participants who used the online curriculum demonstrated a modest but statistically significant improvement in procedural knowledge compared to participants who performed the procedures but did not access the online materials. The authors conclude that online procedure training improves knowledge of procedures better than clinical experience alone. Limitations of the study include that outcomes reflect only medical knowledge, as an assessment of actual procedural skill was not performed. Also, less than 50% of residents completed the entire protocol (3 written examinations and 2 bedside procedures). This may be due in part to the declining frequency of internists performing these procedures as demonstrated in a recent national survey.[5]

Given the competing demands of patient safety and education, and in light of upcoming reductions in resident duty hours,[6] how can training programs ensure that trainees perform invasive procedures competently and safely? We recommend a multistep approach. First, programs should determine specific procedures residents should be able to perform and the level of supervision required. Second, education should be standardized for each trainee. Third, training programs should ensure competence through rigorous skill assessment.

Local factors and certification requirements from the American Board of Medical Specialties and the Accreditation Council for Graduate Medical Education (ACGME) inform the selection of procedures residents should perform. In addition to required procedures, individual specialties may also have additional procedures that are desirable or optional to achieve competence. For example, in internal medicine residency training, the American Board of Internal Medicine (ABIM)[7] requires residents to demonstrate knowledge of indications, contraindications, recognition and management of complications, specimen handling, and interpretation of results for a variety of procedures, including CVC and AL insertion. Competent performance of certain invasive procedures is also required, but this level of skill is not required for CVC or AL insertion. However, the ACGME[8] extends ABIM requirements by stating that internal medicine training programs must provide opportunities for individual residents to demonstrate competence in the performance of procedures listed by the ABIM as only requiring knowledge and interpretation (such as CVC and

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AL insertion). Online curricula such as the work of Grover et al help internal medicine residency programs meet ABIM requirements using an effective and time-efficient resource. Interventions that boost knowledge are also a promising starting point for documenting procedural competence, as procedural knowledge can serve as a foundation for procedural skill.

Once a set of procedures has been selected, programs should attempt to teach residents to perform them in a standardized way. The most effective procedural-skills interventions involve the opportunity for learners to engage in deliberate practice. Features of deliberate practice include repetitive skills practice under supervision of an engaged teacher, provision of individualized feedback, and an opportunity to correct errors through additional practice.[9] It is hard to achieve important clinical outcomes without sufficient deliberate practice because procedural tasks require integration of knowledge and psychomotor skills. In order to transfer skills to clinical practice, learners must be familiar with the context in which procedures are performed and have the opportunity to develop problem-solving skills.[10] For these reasons, an effective intervention to boost procedural skills includes both "knowledge and skill" training because both are needed to perform the procedure.

This is confirmed by Grover and colleagues' finding[3] that online education without hands-on practice had no effect on the rate of procedural complications such as arterial puncture and bleeding. Conversely, educational interventions featuring deliberate practice have translated to improved clinical care and reduced patient complications such as CVC-related bloodstream infections[11] and shoulder dystocia in neonates.[12]

Several approaches have been used to provide residents the opportunity to practice clinical skills in a safe and standardized way. Procedure teams have also been shown to be an effective method of improving resident skills while providing immediate faculty supervision.[13] Simulation provides a safe environment for skills practice in which the focus is on the learner, not the patient. This environment facilitates the critical integration of knowledge, skills, and attitudes needed to achieve competency. Recent studies[11,12,14,15] have demonstrated that such integrated training successfully transfers to patient care, the gold standard of educational outcomes. In a comprehensive simulation-based intervention, invasive procedures occur at the interface between simulated and clinical environments. Residents learn procedural skills in a simulated environment, perform them in the clinical environment, and return periodically to the simulated setting for additional skills practice and refresher training.

A final and critical part of procedural training is incorporation of rigorous assessment measures. Documentation of procedural competence is particularly important as risks of the invasive procedure increase. Clinical experience is not a proxy for skill[16]; thus reliance on procedure experience alone is insufficient. Similarly, as demonstrated in the current study,[3] self-confidence is also unreliable and cannot substitute for assessment of actual procedural skill.[4] A key feature of effective procedural training is the use of rigorous outcome measures that yield reliable data. Outcome measures must align with learning objectives in order to accurately assess the impact of an educational intervention.

In comprehensive procedural education, faculty members must define required skills, choose appropriate educational methods, develop relevant metrics, ensure reliability of test scores, and provide justification for the validity of test score inferences. Residents should be required to meet or exceed a minimum passing score before performing the procedure independently. This level of rigor is required in order to ensure that every individual performing a bedside invasive procedure is competent to do so.

In conclusion, educating residents to perform invasive procedures requires an ongoing balance between patient safety and training requirements. As shown by Grover et al,[3] online education can improve residents' knowledge and shows promise as part of a comprehensive approach to procedural training. To maximize education, residents should participate in structured programs, work closely with expert faculty to acquire skill, and demonstrate competence to perform procedures independently and safely. Institutions should provide resources and an environment that promotes patient safety through supervision, progressive responsibility, and oversight. In such a way, trainees can learn and perform essential competencies without unintended consequences to patient care quality.

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