

Quality and safety education in medical school

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Compared to many other fields, quality and safety is a relatively new discipline within medicine. Many efforts to improve quality and safety in healthcare are aimed at training practicing physicians and residents, through efforts such as safety courses, quality improvement project participation, and continuing medical education sessions.^{1,2} However, there has been increasing interest in beginning quality and safety education earlier in physicians' training. Upstream interventions during medical school can introduce future physicians to this crucial aspect of medical practice early in their careers and have the potential to significantly improve patient safety and quality of healthcare delivery. This article will discuss the considerations and dimensions of quality and safety training in medical education.

There are many aspects of safety and quality within the context of healthcare. The field encompasses a range of skills

and behaviors, including technical skills, crisis management, and personal and professional behaviors and qualities such as transparency, communication, and teamwork. Some of these, such as technical safety skills, anticipation and preparedness, and organizational skills are easily trainable, while others are less so, adding to the complexity of imparting quality and safety education to medical students.³ Thus, the question of how to best teach these principles and skills remains debated.

Although an increasing number of medical schools have implemented a patient safety curriculum over the past several years, there still exists a need to improve quality and safety teaching at this stage of training. Results from the 2012 Clerkship Directors in Internal Medicine Survey found that less than half of medical schools in North America had a formal patient safety curriculum. While this number has increased since the time of the survey, there are still deficits in reported satisfaction with medical students' competency in the areas of quality and safety at the end of their training.⁴⁻⁶

Not only is effective quality and safety training integral for medical students in their future practice as physicians, this training can also help stu-

dents play an immediate and integral role in reducing harm, identifying medical errors, and promoting patient safety while in medical school.⁷ Thus, establishing curricula that foster the development of safety skills in medical students is an immediate priority. Faculty development and institutional culture are essential elements to consider as well and will be discussed in this article.

Past and Current Educational Interventions for Quality and Safety

Quality and safety is a dynamic and interdisciplinary field, encompassing many areas including systems-based analysis, quality improvement methodology, and development of communication and teamwork skills.⁸ As such, there are several methods for its integration into medical school education, including formal didactic- and workshop-based curricula to teach the concepts of quality and safety, activities aimed at helping students develop skills related to quality and safety, and participation in quality improvement and patient safety projects.⁹ In developing quality and safety curricula, attention should be paid to the learning methods medical students perceive to be most helpful in acquiring knowledge and skills in this domain. Survey

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analyses of medical student attitudes toward safety and quality improvement education have found that they prefer real-life examples of quality improvement projects, participation in these projects with patients, problem-solving and brainstorming components, and real-life examples of medical errors, suggesting the value of integrating quality and safety teaching into clinical education.^{10,11} Indeed, many interventions have capitalized on the clinical experiences in medical school to present the principles of safety and quality.¹²⁻¹⁴

While the clinical stages of medical school provide an appropriate opportunity to teach about this topic, introduction to quality and safety principles during pre-clinical training can supplement more downstream interventions. Workshops and didactics during this time provide a foundation upon which students can later build during their clerkships and can prepare students to become active participants in promoting patient safety during their clinical rotations. For example, first- and second-year medical students participate in a surgical safety and quality improvement program at the Ohio State University Medical Center, completing a self-paced online module on patient-centered care and safety, leadership and teamwork, and quality improvement, followed by an orientation and use of the Surgical Safety Checklist.¹⁵ Following the program, students not only showed improved knowledge of quality improvement methodology, they displayed an attitudinal change that all health professionals are responsible for promoting quality improvement. Brown et al demonstrated the efficacy and feasibility of a pre-clerkship quality improvement initiative, in which first year medical students learned about the principles of quality improvement by identifying areas for improvement within their own curriculum. Students subsequently demonstrated increased knowledge about

quality improvement and motivation to engage in future quality improvement projects in the healthcare system.¹⁶

Longitudinal interventions that expose students to different components of the domain throughout the various stages of their medical education—including the pre-clinical and clinical years—are likely to provide a more comprehensive and enduring foundation in quality and safety practices compared to shorter interventions. For example, medical students at the Case Western Reserve University are first exposed to quality-of-care and patient safety principles during their first block of medical school, including through lectures and exercises on medical errors, root cause analysis, and medical micro and macro systems.¹⁷ They subsequently engage in clinical improvement projects during their inpatient or ambulatory experience, and during their clerkship years complete an interprofessional small group learning experience on root cause analysis. Similarly, a longitudinal curriculum spanning across all four years at Mayo Medical School was developed to teach students about medical errors and systems issues they may encounter in clinical practice.¹⁸

In addition to implementing safety and quality education throughout the different stages of medical school, utilizing a variety of teaching methods can engage students more fully in their quality and safety training. In the Case Western Reserve University curriculum mentioned above, students learn through didactics as well as small and large group exercises. At Mayo, the safety curriculum is taught using simulations, lectures, case discussions, video sessions with debriefings, and exercise-based discussions. A 3-day patient safety curriculum implemented at Johns Hopkins School of Medicine in 2012 taught students through case studies, small group exercises, simulations, and skills demonstrations, and reported significantly improved safety knowledge,

systems-thinking, and communication and safety skills.¹⁹ A mandatory quality safety course for upper year medical students at Vanderbilt University School of Medicine consisting of three one-month blocks utilizes didactics and weekly assignments along with experiential learning activities, including a quality improvement poster project that students presented at the conclusion of the course.²⁰ Such methods actively engage the learner and provide real-world context for the principles of quality and safety.

Developing curricula requires time, faculty, and financial resources, and may be the largest barrier to integrating more safety and quality teaching in medical education. In 2010, the World Health Organization's Alliance for Patient Safety developed a standard medical curriculum for patient safety—the WHO Patient Safety Curriculum Guide for Medical Schools—which includes a step-by-step instructor manual and comprehensive curriculum.²¹ This blueprint provides a starting point for schools looking to integrate quality and safety into their education.

The Role of Simulation

Simulation is becoming increasingly recognized as a valuable resource for quality and safety training during medical education.²² Many forms exist and continue to emerge, from robotic human-like mannequins to standardized patient interactions to high-tech simulation suites. These resources are commonly used by medical schools to teach important clinical skills and foster interprofessional learning; and medical students may indirectly learn about quality and safety in evaluating patient cases and practicing teamwork and communication skills during simulation trainings.²³ However, more explicit use of simulations to teach specifically on the principles of quality improvement and patient safety can help students build

competency in this area prior to residency. Importantly, simulations allow students to recognize common patient safety issues and make their own medical errors in a low-risk setting before entering their own clinical practice.²⁴ King et al argue that actively encouraging errors during simulation-based team training can help students develop better foresight and emotional control to manage similar situations in future clinical settings.²⁵

Several studies have been published on the use of simulation in quality and safety training specifically. For example, Thomas et al report on the efficacy of a ward round simulation incorporating distractions and interruptions—a significant contributor to error-making in clinical practice—in helping students minimize medical error.²⁶ Participation in the distraction-laden simulation significantly reduced medical errors in a subsequent simulation, and receipt of immediate feedback on the management of distractors reduced error-making to an even greater degree. Additionally, a simulation-based model that presents common hospital-based safety threats (such as medication errors, fall risks, and risks from upper extremity restraint or catheter use) and asks students to identify as many as possible has shown to be a feasible and efficacious method of providing safety-focused education to medical students.²⁷ The use of simulations, moreover, ultimately protects patients—and thus directly promotes patient safety—by shifting some learning environments from the real-world setting with real patients to simulated ones, reducing the probability of inadvertent harm.²⁸ The ethical benefits provide a strong imperative for the increased use of simulations in medical education, particularly in the context of quality and safety training.²⁹ Future research should also aim at further identifying how simulation objectively impacts students' long-term attitudes and behaviors regarding quality and safety.²⁴

Interprofessional Learning and Safety Education

All healthcare professionals—not just physicians—are responsible for practicing in ways that maximize patient safety and quality of service. As teamwork and communication are necessary skills for preventing medical errors, there has been a shift toward integrating quality and safety teaching among different health professional students. Many methods can accomplish this, including the use of simulations, joint didactics and small group exercises, clinical teachings, and interprofessional service learning projects.³⁰ Headrick et al, for example, made interprofessional learning a key aspect of the Retooling for Quality and Safety initiative, aimed at incorporating patient safety and quality improvement into medical and nursing school education.³¹ Curricular components included classroom activities, clinical activities, and simulations, and the majority involved students working together from both schools. The efficacy of applying the Team Strategies and Tools to Enhance Performance and Patient Safety (Team-STEPPS) communication training model to train interprofessional teams of students has been reported as well.³² In the study by Brock et al, upper-year medical, nursing, pharmacy, and physician assistant (PA) students participated in training that included didactic, simulation, and feedback components, and were found to have demonstrated attitudinal and knowledge shifts in areas such as communication and situation monitoring among others. Similarly, a course aimed at providing interprofessional education on patient safety among upper-level medical, nursing, and pharmacy students at the University of Maryland found high levels of interest in interprofessional learning and improvements in patient safety knowledge from participation.³³ Sessions included case-based discussions and a mock root cause analysis.

Longitudinal interprofessional training in particular can potentially further break down hierarchical barriers that contribute to ineffective teamwork in the healthcare setting. For example, a three-year interprofessional curriculum focused on quality improvement, patient safety, and teamwork was developed through collaboration between a medical, nursing, and physician assistant school in New England.³⁴ One component in the second year involves a medical error simulation, followed by planned unsuccessful and successful interactions with a dismissive authority figure, helping prepare students to navigate the hierarchical challenges to addressing safety issues in the clinic.

Developing interprofessional curricula is no easy task, requiring significant coordination between different schools with varying schedules and a large cohort of students. Thus, pre-developed educational materials to teach patient safety and quality to students in different health professional schools can be useful. For example, the use of courses offered by the Institute of Health's Open School has been implemented in an interprofessional setting among medical and other health students at University of South Dakota, for an inexpensive and feasible method of integrating interprofessional quality and safety education.³⁵ Interprofessional programs can provide foundational skills in cooperative and communicative care—an essential component of safe future practice.

Faculty Development and Role Modeling

One challenge to establishing quality and safety education in medical schools is finding instructors specifically trained in these disciplines. The cost, resources, and infrastructure necessary to train faculty in this domain may hinder curricular change. Thus, integration of quality and safety into medical school curricula necessitates feasible

and effective faculty development programs. Myers et al created an academy aimed at training medical educators to introduce quality improvement and patient safety principles into their own programs.³⁶ The three-day, in-person program consisted of instruction in not only quality and safety, but curriculum development, change management, and professional development. Expansion of faculty development programs in these areas can hopefully improve curricular change in quality and safety.

Moreover, all medical educators—not just those trained to teach on quality and safety—also play an implicit role in the quality and safety development of medical students through role-modeling. In a survey analysis, Martinez et al found that both training on how to respond to medical errors as well as exposure to positive role-modeling had positive influences on students' attitudes regarding error disclosure.³⁷ In contrast, negative role modeling was significantly associated with negative attitudes as well as a higher likelihood of students handling errors in a nontransparent manner, highlighting the need for medical educators who set positive examples in these domains for students.

In addition to teaching students, faculty also play a key role in driving curricular reform to further incorporate quality and safety principles.³⁸ Thus, it is crucial to not only provide all future medical professionals with the skills to promote quality and safety within their own medical practices, but to train future leaders in the field of quality and safety. While there are several quality and safety training programs offered at different institutions, many of these are fellowships at the graduate level separate from medical school. The Pritzker School of Medicine at the University of Chicago has implemented a 4-year scholarly track in quality and patient safety for medical students, incorporating an elective on quality-improvement

skills, participation in the Institute for Healthcare Improvement Open School, and a mentored research project.³⁹ Medical school scholarly tracks such as this can help train future leaders in quality and safety, who can also serve as the next generation of educators to introduce curricular change.

Establishing Safety Culture

Formal instruction alone is insufficient to train future physicians in the domain of quality and safety; trainees should operate within a culture that promotes safety starting in medical school. The workplace environment plays an integral role in this regard; climates that promote quality and accountability not only encourage error reporting among medical students but can also help ingrain positive and transparent behaviors when it comes to clinical error and patient safety for future practice.

Many medical students may feel uncomfortable questioning authority and reporting medical errors they witness during their clinical experiences. For example, a survey analysis of students at the University of California, San Francisco, found that a majority of students said they felt mistakes were held against them, and that they would not speak up if they saw a possible adverse event.⁴⁰ Moreover, more than half of students surveyed were afraid to ask questions if they felt they were witnessing something that did not seem right.

Establishing a culture that promotes transparency is integral for patient well-being and the development of future physicians. However, changing institutional culture can be challenging. Several measures can be taken to address the individual dynamics that contribute to culture. Leadership should prioritize patient safety in tangible ways, setting clear institutional goals and allocating resources for quality improvement.⁴¹ Additionally, urging medical educators to encourage error and safety reporting without consequence among students

can contribute to changing institutional culture. Moreover, an emphasis on interprofessional training enhances the teamwork and communication skills that are essential to ensuring patient safety, as was discussed in the previous section. Leape et al enumerate key concepts integral to creating a culture of safety and quality in healthcare organizations, including transparency, establishment of an integrated care platform, promoting joy and meaning in providers' work, and reforming medical education to include safety and improvement science, systems thinking, leadership, and teamwork—all necessary for developing quality and safety skills.⁴²

Additionally, it should be noted that provider burnout has been linked to medical error and diminished safety climate.^{43,44} Efforts to reduce burnout among physicians during all stages of their training—from medical school onward—can ultimately impact patient safety. Increasing recognition of the importance of self-care in preventing burnout and establishing measures to ensure medical student well-being can create greater engagement and meaning in work and eventually improve quality and safety culture.

Quality and Safety Training in Radiation Oncology

In recent years, attention to quality and safety within radiation oncology has increased. In 2010, the American Society of Radiation Oncology (ASTRO) launched Target Safely, a national campaign focused on improving patient safety and reducing errors.⁴⁵ The campaign included a recommendation to expand educational interventions on quality and safety, as well as to incorporate quality and safety content into ASTRO meetings.

Radiation oncology is an inherently interdisciplinary specialty involving communication and coordination between many different professionals, making quality and safety concerns a

particularly critical component of care. Interventions that involve all members of the care team—including physicians, physicists, nurses, PAs, therapists, and dosimetrists—may have the greatest potential in generating change. Success has been shown with implementation of a mandatory program in radiation oncology departments, even in large, multisite centers. Woodhouse et al report on a longitudinal quality and safety culture education program initiated in 2010 at the University of Pennsylvania.⁴⁶ The program consists of lectures, meetings, and interactive workshops for all department members across all Penn radiation locations. Achieving 100% participation rates, the program demonstrated significantly improved scores on content-based questionnaires following participation, with the largest improvements among radiation therapists. Moreover, high knowledge retention was shown on subsequent periodic assessments, indicating the longitudinal benefit as well as feasibility of such a program.

Simulation, discussed previously, may also play an important role in quality and safety training in radiation oncology, improving adherence to practice guidelines and ultimately patient safety. For example, a simulation-based training intervention for radiation oncology professionals at the University of North Carolina at Chapel Hill was found to significantly improve procedural compliance without impacting subjective workload.⁴⁷ In particular, simulation-based exercises may aid in learning new knowledge and skills in radiation, increasing the chance for error in a low-stakes simulated setting rather than in clinic.

Residency training has also become an increasingly recognized target for quality and safety educational interventions in radiation oncology. The need for improved education in quality and safety during residency has been documented. A survey analysis of radiation

oncology residents' experience with patient safety and quality improvement concepts found that more than 60% of respondents had little to no exposure of critical quality and safety concepts, including incident learning systems, root cause analysis, failure mode and effects analysis, and human factors engineering.⁴⁸ Moreover, only a small number (27%) felt confident that they received adequate patient safety training in their residency program.

Thus, there has been interest in identifying universal competencies and developing frameworks that can be used in quality and safety programs in radiation oncology residency. Yeung and Greenwalt report on a framework for quality improvement and patient safety education in radiation residency programs, citing both didactic and project-based experiences as necessary components for an effective educational intervention.⁴⁹ They argue that didactic components should not only teach the basic principles of quality improvement, but also focus on specific institutional goals. Moreover, role modeling by quality improvement faculty in everyday clinical practice is necessary for behavioral change aimed at promoting patient safety, as discussed. In helping define the content necessary for inclusion in such interventions, the 2015 international Delphi Study was conducted to develop a competency profile for quality and safety curricula in radiation oncology residency.⁵⁰ The study identified 90 items consisting of 18 key competencies, representing a potential minimum standard for safety and quality programs for radiation residencies. Such frameworks may provide a starting point for developing and implementing institutional-specific interventions.

Shorter initiatives that provide a foundation in quality and safety may be feasibly incorporated into radiation oncology residencies, and later expanded into more comprehensive, longitudinal interventions. For example, Fogh et al re-

port on a quality and safety mini-course for medical and physics radiation oncology residents at the University of California, San Francisco.⁵¹ Consisting of a series of didactics followed by interactive group discussions, the course was streamlined so it could be taught within a single day, and was found to significantly improve residents' perception of quality and safety. Quality and safety education for medical physics residencies has gained increasing attention as well.⁵² Programs specific for physics residencies and those specific for medical residencies may inform each other and complement more general, department-wide quality and safety education interventions.

Conclusions

The need for improved quality and safety education in medical curricula has been well documented. While an increasing number of schools are integrating essential components of this field into their teachings, debate remains over which methods are most effective. Moreover, curricular development alone is not sufficient enough to impart these skills to future physicians—creating a culture that promotes patient safety and quality improvement is equally important. Faculty development has posed a challenge to curricular reform, but programs aimed at training instructors are continuing to be created and improved upon. Interprofessional learning is another essential component of safety training and can help students develop skills in communication and teamwork essential to safe practice. Future studies should aim to qualitatively and quantitatively evaluate the longitudinal impact of quality and safety educational interventions in medical students.

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