**Nonmaleficence in Medical Training:**

**Balancing Patient Care and Efficient Education**

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**Abstract:**

Medical schools and teaching hospitals regard medical education as a core institutional value. In order for this education to progress, medical students and resident physicians must develop new skills throughout their time in training. Yet, when students are involved in the delivery of patient care, the value of education and training may be in opposition to a bioethical value necessary for delivering patient-centered care, nonmaleficence (“do no harm”). By including inexperienced students in the delivery of health care, there is inherently an increased risk of harm to patients. One way to mitigate this risk is to have all medical procedures, exams, and histories obtained by seasoned medical professionals. However, this would destroy the institution of medical education, and lead to a shortage of trained professionals. Still, in order for medical education to be successful, students and their supervisors must balance principles of nonmaleficence with those of education in order to insure both excellent patient care and medical training,

The virtue of *nonmaleficence* in medical bioethics is derived from the Latin maxim “primum non nocere”, translated “first, do no harm”. Functionally, this principle reminds practitioners that every medical action should be weighed against all benefits, risks, and consequences, and that occasionally the best treatment may be no treatment. One example of *nonmaleficence* includes a physician choosing to forgo ordering a CT scan after an informative physical exam to minimize radiation exposure for the patient. Intrinsically linked to the principle of nonmaleficence, is the physician’s role as a healer, not simply one that attempts to cure disease. It is the interplay between this role, and between the practice of nonmaleficence, that allows physicians to strive to maximize both short-, and long-term treatment of their patients. For example, in palliative medicine physicians will often elect to provide comfort at the end of life rather than extend life saving measures. Medical education, by virtue of its duel role in training and in patient care, may at times be in direct contrast to these values.

In medical education do-no-harm can also be applied to performing tasks appropriate to individuals’ level of competence and training, where each participating agent maintains responsibilities derived from their qualifications. Students, residents, and attending physicians alike maintain a beneficence-based responsibility to patients. Furthermore, attending physicians have a fiduciary responsibility to educate younger generations of doctors. Here, we present a broad discussion of the ethical dilemmas raised by the interaction of medical education and current patient care. Students and residents must respect the limitations of their knowledge and abilities. They should engage in sound do-no-harm-medicine by (1) deferring to supervising senior physicians, while actively attempting to gain proficiency in areas of weakness, (2) actively seeking good mentors for clinical guidance and (3) maintaining an inquisitive nature that continually seeks out better understandings of physiology, pathophysiology, and management options for all disease states a trainee may encounter.

**Background:**

***Ethics in Medicine***

Within the history of medicine in the United States, the identification of ethical standards for the profession predates even the idea of educational standards for medical schools or residency programs[1]. The American Medical Association (AMA) was first created in 1847 with the primary goal of raising ethical standards of medicine in the United States. In 1858 the AMA Counsel of Ethical and Judicial Affairs was established in order to implement an ethics code for the American medical profession. Both of these institutions arose before the Association of American Medical Colleges was founded in 1876, before the first residency program was established at Johns Hopkins Hospital in 1889, and before the Flexner Report was published to assess the quality of medical education in the Unites States in 1910. It stands that medical education in the modern era has prioritized patient-centered and ethical care since its inception.

Intrinsically linked to the ethics of medicine, is the physician’s role as a *healer-* not simply one that cures disease. It is the interplay between this role and nonmaleficence that allows physicians to strive to identify the goals of treatment for each individual person they are caring for. The management of end-of-life care is an often-cited example of the above. An experienced, non-maleficent physician will help guide each individual person and their family through these challenging and difficult decisions. In so doing, the bioethical principles of nonmaleficence autonomy, beneficence, and justice are also fulfilled. These principles have been established and promoted as the core institutional values of the medical profession for decades. During training, medical students and residents must learn not only the abstractions of physiology and pathology, but also the humanism embodied in their chosen profession.

**Nonmaleficence as an ethical tenet**

One core bioethical principle is that of *nonmaleficence*, which requires that physicians do no harm to the people they have pledged to help[2]. It is consistent with the classic Latin phrase, “primum non nocere”: “first, do no harm”. This principle reminds practitioners that benefits of medical action should always be weighed against all risks and consequences, and that occasionally the best treatment may be no treatment. In medical education do-no-harm can also be applied to performing tasks appropriate to individuals’ level of competence and training, where each participating agent maintains responsibilities derived from their qualifications. As such, students or residents may violate this principle when they act prematurely and perform tasks outside of their respective scopes of practice. For example, medical students during training may need to learn how to obtain peripheral intravenous access. However, practicing this skill may potentially result in unnecessary patient morbidity, such as prolonged procedure time, repeat procedures, and increased risk of hematoma, contamination and infection. Often, physicians-in-training are unknowingly asked to weigh the patients rights to no-harm with their own need to learn. In many cases, the solution to such scenarios is to permit invasive learning opportunities when the patients’ potential for loss or harm is judged minimal. For example, a new orthopedics intern would not be permitted the opportunity to perform a complete open reduction internal fixation of a broken bone independently, a situation in which the opportunity for serious harm to the patient is great. However, they may be permitted a first-assistant position, and allowed to perform the opening incision, a substantially less risky portion of the operation. These trade-offs are made daily, and throughout medical training, in order to attempt to maximize both patient safety and educational efficiency.

By allocating low impact roles to medical trainees, the industry has attempted to mitigate the risk associated with medical trainee involvement in patient care. This method operates under one of two assumptions, either (1) the tasks given to medical trainees are simple enough that little to no error can be made or (2) the tasks are such that any errors made would not result in an adverse patient outcome. In critically analyzing these assumptions, it becomes clear that the first is false. As an example, the relatively simple task of taking a blood pressure recently proved to be beyond the skill set of medical students across the country. In a study of 159 medical students from 37 different states, only one student was able to properly complete the eleven steps involved in taking a blood pressure[3]. More difficult to assess is whether the tasks assigned to trainees are those that permit error without causing adverse patient outcomes. Surely, a hypothetical situation can be drawn in which an inaccurate blood pressure measure could prevent a patient from receiving the care they need. Data on the role of trainees in medical errors is challenging to assess due to the team-work nature of medicine. However, in an analysis of closed 240 malpractice claims, it was found that trainee significantly contribute to medical errors especially in the context of lack of supervision[4]. This study found that in 240 cases evaluated, errors in judgment (173 of 240 [72%]), teamwork breakdowns (167 of 240 [70%]), and lack of technical competence (139 of 240 [58%]) were the most common contributing factors. Additionally, lack of supervision and handoff errors were most prevalent types of teamwork problems, and these errors disproportionately involved trainees (respectively, 54% involving trainees vs 7% without trainees [*P* < .001] and 20% vs 12% [*P* = .009])[4]. These studies suggest, it cannot be assumed that tasks assigned to trainees lack potential for adverse outcomes, nor is it true that the tasks are simplistic beyond potential for error. Medical trainees are capable of causing adverse patient outcomes. How then do we reconcile their need to learn with the pledge of non-maleficence.

***The Tension of Medical Education***

In addition to the betterment of patients, teaching hospitals and medical schools must prioritize the efficiency and utility of their educational pedagogy. Medical education must ensure a large quantity of information is adequately transferred to students in a short amount of time, and that trainees are able to master new and complex technical skills allowing them to independently practice medicine. Furthermore, the quantity of information such as those in basic sciences, pathophysiology, and pharmacology has exponentially grown in the last decades, all the while work hour restrictions have placed new time constraints on upcoming physicians. Until the present time, few alternatives to “hands-on” human experience could assist in training a student for many of these technical skills the student must acquire during their time in training. This scarcity of opportunities for the eager student to practice their new technical skills has even been the subject of historical controversy. In the 1788 Doctors’ Riots in New York City, city residents became outraged at the unethical procurement of corpses for anatomy dissection in medical schools and hospitals[5]. Even currently, the opportunities for students and residents to practice hands-on medicine is a selling point for many medical schools and residency training programs.

Throughout the history of medical education, a tension has inevitably developed between the necessary clinical and technical training of medical students and the fiduciary responsibility of medical institutions to not harm patients (nonmaleficence), to act in their best interest (beneficence), to respect their choices (Autonomy) and to do so without partiality to income, race or creed (justice). Furthermore, a constantly evolving landscape of medical student and resident education poses additional challenges for today’s student or physician attempting to navigate this tension. However, technical and regulatory innovation in the form of systemic institutional interventions, improved standardized assessment methods, learning modalities, and simulation centers, can provide new tools with which to optimize education with limited sacrifice of ethical patient care[6] (Figure1).

**Root Causes of Patient Harm: Special Cause and Common Cause Process Variation**

In the field of engineering, multiple systems for analyzing processes variation have arisen. One such technique was developed around 1924 by Walter Shewhart, who was a physicist, engineer, and statistician at Western Electric Company. He developed a system to assess process variation in the manufacturing process of telephone hardware. The types of variation he identified were called *assignable cause* (now known as special cause) and *chance cause* (common cause) variation[7]. Shewhart proposed that common cause variation occurs due to random variation in a system, the result of forces that are constantly active in a process. Conversely, special cause variation is due to isolated alterations in a system and the result of changes in the system itself[8]. Examples of special cause variation could include a computer crash, technical machine malfunction, or uneducated employee. Correcting this type of error usually can be accomplished with educating the uninformed worker or replacing a broken machine. This can be likened to fixing one broken cog in an otherwise working machine. An example of special cause variation may be predicting your drive to work to take 15 minutes, but actually requiring 25 because your car was out of gas. This is a predictable easily correctable variation in a repetitive process. Common cause variation, on the other hand, is more difficult to identify and correct. Common cause variation results from constant variation in a system, and may be called process “noise.” This noise is hard to predict and hard to change. An example of process common cause variation may be predicting it to take 15 minutes to drive to work, but actually driving for 25 minutes due to 10 minutes of traffic. This constantly active variation typically requires larger systemic or process-wide interventions to mitigate.

These engineering principles can also be applied to medical education as it related to ethical practices. Patient safety can be put at risk when trainees are involved in patient care. Some ways “do no harm” medicine may be violated when medical trainees are involved in care include having uneducated trainees who do not know how to be safely involved in patient care (special cause). Additionally, larger systemic interventions can be undertaken to improve the safety of clinical environments for patients without the direct input or consent of individuals in the process (common cause variation). It is most likely that the vast majority of medical trainees have no ill intent towards patients, or desire to compromise patient safety for individual learning, and so it is often the requirement of medical systems to spend more time on the more difficult task of creating robust medical systems and systems of medical education that are dually efficient at educating young physicians and maintaining patient safety at the same time.

**Possible solutions: resolving the tension:**

***Addressing the Special Causes***

An often forgotten task of medical training is to instill into developing doctors a sense of ethical responsibility for their patients. During training, all students have a professional responsibility to place the care of the patients above their own education. The non-maleficent student acknowledges the limitations of his training and seeks appropriate clinical scenarios to practice clinical skills, with complete patient consent . Students and young physicians may inadvertently confer increased risks to patients when they choose to care for an individual before they have acquired sufficient clinical or surgical mastery. It is the responsibility of medical schools and teaching hospitals to instill an intrinsic belief into students that patient safety is a priority that exists a priori to the students right to learn. Special causes that could lead to unethical treatment of patients includes instances where individuals either intentionally or unintentionally act in a way that is contrary to patient safety. These special causes can be addressed and corrected by trainee education, in contrast to common causes of process variation which requires larger systemic intervention to be altered.

A sound ethical practice requires trainees to be fully cognizant of their level of training and clinical skill - and to defer to supervising residents and attending physicians as necessary to maintain patient safety. In such situations, it is vital for students to be careful observers, actively striving to learn the new skills they observe. Students should learn to critically analyze each mentors’ style of care to identify practices that seem to be most successful in developing therapeutic relationships. Furthermore, all physicians have a professional responsibility to be a lifelong learner. Early in their careers medical trainees should acquire an inquisitive nature that continually seeks out better understandings of physiology, pathophysiology, and management options for all disease states a trainee may encounter.

Furthermore, maintaining respect for individuals is paramount for ensuring safe and ethical care to people. Individuals presenting for care in teaching institutions must be respected as autonomous individuals and not simply as objects for education or research without meaningful informed consent[9]. Individuals should be made aware when students and trainees are involved in their care, and practitioners should fully disclose their status and experience level to their patients. This can be accomplished seamlessly at the beginning of the medical interview or in pre-op before a surgery, and does not require a substantial amount of time commitment.

***Addressing the Common Causes***

In developing health care systems and educational curricula that prioritize patient safety and education simultaneously, multiple check-points should exist which are able to systematically eliminate the potential for patient harm. Some ways in which this can be incorporated into medical education include curriculum reform that lengthens clinical training periods. Many medical schools have transitioned, or are in the process of transitioning, from the traditional 2 + 2 model of training where the first two years of medical school are spent as “pre-clinical” years in the classroom and the third and fourth year are spent on the wards to a new 1.5 + 2.5 program where transition into clinical medicine occurs at an earlier stage in a students training. In theory, more clinical training should allow students increased opportunity to learn new skills from senior physicians. Other system-wide approaches to improving student training includes implementation of standardized assessment tools and observed clinical scenarios with live feedback for trainees, as well as protected teaching time for supervising physicians.

One study from Brigham & Women's Hospital Department of Surgery, Boston, Massachusetts, found that coaching of senior surgical residents improved residents’ performance of non-technical skills in a simulated laparoscopic cholecystectomy (p=0.04) by using the Non-Technical Skills for Surgeons (NOTSS) behavior rating system[10]. This system allows evaluation of non-technical skills in categories of situation awareness, decision-making, communication and teamwork, and leadership. The system utilizes video recordings of operative situations and allows surgeons to give feedback to trainees on non-operative aspects of surgery performance. Additionally, the study found improvements in outcomes such as time to call for help during bleeding, operative time, and path length of laparoscopic instruments. Through initiatives like these, structured observation and feedback can be built into medical training in order to better improve communication and awareness between team members, and safety for patients.

***Technological Advances***

The emergence of technological innovation in medical education has the potential to address ethical dilemmas in the education of trainees and simultaneously improve how we train the next generation of physicians. These technological advances have the potential of allowing trainees to become proficient in skills before performing them on people. Additionally, the recent invention and implementation of web-based medical education has radically altered the way medical students and resident physicians acquire their professional fund of knowledge. Virtual reality, simulation, and e-learning modalities have allowed trainees to adapt to the ever-expanding bank of literature present today. While the role of technology in the classroom has been well scrutinized, its potential for addressing age-old bioethical dilemmas in medicine has yet to be developed. As learning becomes further detached from the classroom, trainees have the opportunity to develop real-world skills long before they touch their very first patient. These advances may prove a useful way to mitigate the inherent potential for harm that exists in medical training.

Simulation training has been shown to improve many aspects of medical training. One Harvard study found that simulation training plus standard training of internal medicine interns improved procedural protocol adherence during central venous catheter placement as compared to standard training alone (p=0.024)[11]. Furthermore, another study from McGill University has shown that simulation-based training leads long term knowledge retention as compared to control training methods[12]. In this study, trainees’ knowledge of electrosurgical safety was assessed immediately after the intervention and at 3 months and 1 year. Following the intervention with electrosurgical simulation the intervention group had higher scores compared to controls at all measured time points: immediately (89% vs. 83%, p=0.02), 3 months (77% vs. 60%, p<0.01) and 1 year after curriculum (70% vs. 60%, p=0.02). These studies and many more have shown that simulation training is a beneficial tool for allowing trainees to gain both technical and team-base d interpersonal competencies, and to retain them for a greater period of time, which can lead to improved patient safety in clinical settings (Figure 1). Of interest, one study found that when simulation learning was incorporated into nursing school training, students performed better on Objective Simulated Clinical Exams, although they did not feel more confident in their technical ability[13]. Scores in the intervention group were significantly higher than a control group (p<0.001). The fact that confidence in performing procedural skills did not improve may suggest a need for continued repetitive instruction, even when tools like simulation learning are employed.

In addition to simulation training, e-learning has been shown to be an effective supplemental tool in medical education. E-learning is defined as the use of internet-based resources in education. These resources may include online patient cases, digital anatomic modeling, online tutorials, standardized educational videos that can assist in teaching a standardized curriculum to a large group of trainees, among other modalities. A 2016 systematic review identified e-learning as a beneficial tool in orthopedic surgery training for improving outcomes such as preparedness for clinical procedures, performance in clinical skills and self assessment of clinical abilities[14].

The use of simulation training, and e-learning have been well studied in surgical settings. These advances have improved outcomes like team communication, preparedness for clinical training, and patient safety. In the future, these modalities should be further incorporated into medical training at an earlier stage, such as during clinical years of undergraduate medical education. In so doing, we can hope to improve team communication and clinical skills from the onset of medical training, leading to further reduction in harm to patients. These modalities have and will continue to shape the new landscape of medical education in the 21st century and beyond, and have immense power to produce more competent physicians and interdisciplinary medical professionals.

**Conclusion:**

During medical training, involvement of students in patient care can lead to increased risk of harm to patients. Interventions at multiple levels can mitigate this risk and new advices in technology can help medical facilities train students in a safe environment. Nonetheless, students are, and will continue to be, responsible for patient safety in every action they take in training. By obtaining complete consent from patients for student involvement, and practicing clinical skills in a safe and observed environment, medical education can simultaneously promote education and patient safety.

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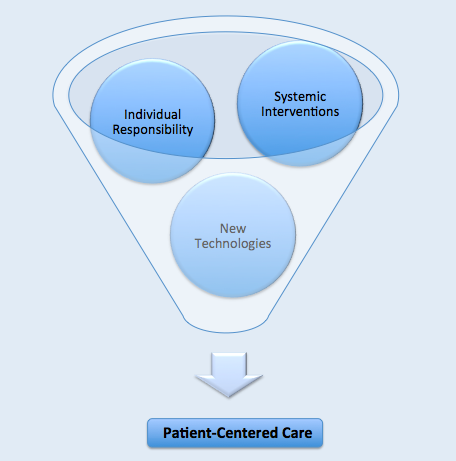
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**Figure 1:** Delineation of ethical responsibility that leads to improved patient care.