Mitigation of Preventable Medical Errors via the use of Human Resources and Human Factors

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May 2015

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Excerpt from the Hippocratic Oath

"…into whatever home I shall enter, it shall be for the good of the sick and of the well and….I will exercise my art solely for the cure of my patients and for the preventions of disease."

Taken from the Hippocratic Oath used by LSUHSC School of Medicine

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Drs. Mark Bing, PhD, and Tom Gudewicz, MD, for providing the initial idea for this thesis, as well as for all of their help and support during its production; thanks also to Dr. Paul Bing, MD., for acting as a valuable source of information. Additionally, I owe a huge debt of gratitude to my family and friends for their kind words of encouragement on the long path to medical school. In particular, special thanks go to my father, Dr. Terry Creel, MD, for being the one who sparked my initial interest in medicine and nurtured it along the way. Finally, I would like to thank all the other physicians that I have met, either through shadowing or day-to-day contact, for being examples of what medical students should strive to emulate.

The inspiration for this topic came directly from my adviser while I was taking his Management 391 - Organizational Behavior class in the fall of 2013. I had mentioned to him that I was looking for a topic for my Honors Thesis that would tie together my interest in medicine and my Bachelors in Business Administration, and he graciously allowed me to take part in some research that he and Dr. Tom Gudewicz, a surgical pathologist at Massachusetts General Hospital, were doing.

Abstract

The purpose of this thesis is to discuss historical and current rates of preventable medical errors (PMEs), their causes, and methods used to reduce them. I will also provide recommendations that I believe can help reduce the number of injuries and deaths that result from them. Data and information used in this thesis were drawn from a variety of sources. While the large majority was sourced from articles in academic journals, government health reports, Federal Flight Administration documents, phone interviews, and personal experiences in the medical field also provided invaluable information.

To summarize, there are two major types of preventable medical errors: structural errors and process errors. The first group involves errors that arise from issues with the structure of the medical facility (e.g. staff or equipment availability), while the second involve the commission or omission of some action by the healthcare provider (e.g. prescribing the wrong drug vs. failing to prescribe a drug at all). These error scan arise from a variety of different sources, but the primary ones are physician inattentiveness, complexity of a procedure, inexperienced healthcare providers, and breakdown in communication. Recommendations to combat these specific causes, as well as recommendations to improve patient safety overall include standardization of the entire medical industry, implementation of an anonymous reporting system, and increased education of medical personnel.

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Section I

Introduction

Six sigma and other quality control principles have been used to reduce error rates within manufacturing facilities to sometimes near infinitesimal levels. Alternatively, when lives are at stake within hospital settings, between 40,000 and 98,000 persons die annually from mishaps within these settings (IOM, 2000, p. 1). For several years now, the Joint Association for Accreditation of Hospital Organizations has been addressing specific safety issues and is attempting to follow patients through the whole entry-to-exit hospital process, similar to how individual items in a manufacturing process are followed during six sigma analysis. Using such a method is completely understandable: while error rates in manufacturing are generally around three incidents per million items, fatal errors in medicine occur at a rate of almost 3,000 per million patients. To put the severity of this issue into the more familiar context of the aviation industry (which also has a low six sigma error rate of three per million), a loaded Boeing 737 would have to crash every single day to achieve similar annual fatality levels (Gudewicz, interview, February 27, 2015). As a nation, we would such a thing as completely unacceptable, but it receives little attention when it happens in medicine.

The primary reason for this startling difference is that people expect to board a flight and arrive at their destination safely and on time; they are shocked when an accident happens that results in injury or death. In comparison, when individuals enter a hospital, some experience anxiety or distress, which is surprising given that hospitals are meant to be places of healing.

The central purpose of this thesis is to consider historical and current rates of preventable medical errors (PMEs), their causes, and the techniques that are used to reduce them. Additional approaches for lowering these rates via the use of human factors taken from other industries will also be discussed and proposed. Because one of the main goals of this thesis is to increase the quality and safety of patient care, it follows that it would tie in well with the Hippocratic Oath. The Hippocratic Oath, often attributed to the Classical Greek physician Hippocrates, is an oath that is traditionally taken by physicians in some form or another. In the original oath, the physician swears by Apollo to "exercise [his] art solely for the cure of [his] patients and for the preventions of disease." I would argue that preventable medical errors and the harm that they cause are in direct conflict with the tenets of this promise.

Section II

Background

In the year 2000, the Institute of Medicine (IOM) published a massive report titled *To Err is Human: Building a Safer Health System* which sought to call attention to and reduce rates of Preventable Medical Errors (PMEs). This study acted as a catalyst for a huge change in the medical industry: referenced over 750 times since its publication, it has "brought the issues of medical error and patient safety to the forefront of national concern" (Mahn-DiNicola, 2004, p. 3).

Rates

According to the IOM's report, "at least 44,000 and perhaps as many as 98,000 Americans die in hospitals each year as a result of medical errors." To put these numbers in context, the low end of the estimate would have ranked as the 8th leading cause of death at the time, beating out motor vehicle accidents (at 43,458), breast cancer (at 42,297), and AIDS (at 16,516) (IOM, 2001, p. 1). An article in the *Pennsylvania Nurse* puts the total economic cost of these errors in the $17 to $29 billion dollar range (Weingarten, 2013, p. 4). Breaking down these numbers even further, the IOM estimates that 7,000 deaths a year are the result of medication errors (defined by the FDA's website as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer"). These deaths could cost as much as $2 billion dollars (IOM, 2000, p. 2). It is important to note that medication errors include patients both inside and outside of hospitals; additionally, medication errors can take place during prescribing by physicians, dispensing by pharmacists, and even consumption by patients. Finally, the IOM suggests that "medication errors have the potential to increase as a major contributor to avoidable morbidity and mortality as new medications are introduced for a wider range of indications" (IOM, 2000, p. 27). Although it seems counterintuitive, this situation occurs because as the number of medications used by physicians increases, the risk of unforeseen interactions among them also increases. Incidentally, potentially harmful interactions among different medications are the reason why doctors ask patients about their current medication regimes.

Types

PMEs can be classified in a variety of ways, but the two broadest categories are structural errors and process errors. The first category, that of structural errors, involves problems such as "availability of staff or equipment" (Pucher et al., 2013, p. 1); these errors can be expensive to correct (with regard to hiring new personnel or purchasing new equipment) or require massive reorganization of how current resources are scheduled. For example, a study published in the *Journal of Internal and Emergency Medicine* in October of 2011 found that patients who were admitted to Emergency Departments in the highest quartile of crowding "had [greater than] twofold increased odds of experiencing a

PME relative to patients whose average crowding exposure was in the lowest quartile" (Epstein et al, 2011, p.177.).

Emergency Department overcrowding, like most structural errors, has no simple fix. If the department is understaffed, additional human resources, such as doctors or nurses, must be brought in to ease the load, which will increase costs associated with hiring, training, and paying new employees. If the department is simply too small, one of two undesirable endeavors must be undertaken: either a massive renovation to expand the facilities could take place, or excess patients must be sent to a hospital potentially further from the site of their emergency. The first alternative would leave the Emergency Department functioning at less than full capacity for the duration of the renovation, exacerbating the original problem of overcrowding (not to mention requiring huge capital expenditures). The second could delay care for patients desperately in need of it, potentially violating the Golden Hour of Emergency Medicine (which says that any patient who arrives to the emergency department within an hour of their accident has a significantly higher chance of survival). Furthermore, it is only a possibility if there is a secondary hospital available.

Process errors, on the other hand, involve errors of commission or omission: essentially, when a healthcare provider either delivers care in an incorrect fashion or fails to deliver care at all, respectively. Both cases have the potential to cause harm to a patient; a textbook example would involve the administration of drugs. The administration of inappropriate drugs, as well as an excessive drug dosage (commission errors), can be just as damaging as the failure to administer appropriate drugs (omission errors). In Dr. Atul Gawande's *The Checklist Manifesto*, he relates an anecdote that provides a real-life example of an error of commission (pp. 4-6). A healthy, 40 year-old man was undergoing surgery to remove a tumor in his stomach, and everything was normal until the cardiac monitor showed that the patient's heart had stopped completely. Dr. Gawande paints a graphic picture of the surgeon performing chest compressions while "patient's intestines [bulged] in and out of his open abdomen with each push." In the meantime, the other members of the surgical team raced to figure out what could have caused the asystole. After ruling out obvious solutions like massive internal hemorrhaging (as no blood was visible in the abdominal cavity) and a pneumothorax (a collapsed lung – no evidence of poor air movement into the lungs was apparent), the team retraced their steps and discovered that the anesthesiologist had ordered a dose of potassium to counteract the patient's low levels. Instead of the appropriate dosage, however, the anesthesiologist administered a dose that was 100 times what he had intended and well beyond a lethal dosage. Thankfully, the surgical team was able to correct this error, and the patient made a full recovery (Gawande, pp. 4-6).

Section III

Causes and Possible Solutions

While patients can be the cause of their own preventable medical errors (for example, by failing to inform their physician of allergies or failing to take medication as prescribed), I am choosing to focus this thesis on errors caused by healthcare providers, as described above. PMEs can be caused by a wide variety of sources: doctor inattentiveness, complexity of a medical procedure (that is, more steps allow for more error opportunities), inexperienced healthcare providers, and failure in communication (Barger et al, 2006, p. 2442; Gawande, 2009, p. 28; Philips and Barker, 2010, p. 776; Solet, Norvell, Rutan, & Frankel, 2005, p. 1095; Starner et al, 2013, "Conclusions and Relevance")

Doctor Fatigue

With regard to the effects of doctor tiredness, one study found that in months when medical residents worked five or more extended shifts (shifts in excess of 24 hours), they were significantly more likely to commit PMEs. Residents who participated in the study were asked to complete a survey that, among other things, asked about the number of extended-duration shifts that the resident worked, the number of errors they committed, and their belief about the relationship between those errors and their levels of fatigue. In those months where they worked five or more extended shifts, 16% reported that lack of sleep caused them to make a significant medical error with 0.4% of those errors resulting in a fatality. In months with zero extended-duration shifts, only 3.8% of residents reported that their lack of sleep led to a significant medical error, with 0.1% resulting in a fatality. Additionally, the survey also collected data regarding residents' abilities to stay awake during important periods of their day: A.) surgery; B.) patient examinations; C.) rounds with the attending physician; and D.) during lectures, seminars, or grand rounds. In months with five or more 24+ hour shifts, residents reported themselves "nodding off or falling asleep" at rates of A.) 7.4%, B.) 5.4%, C.) 22%, and D.) 70%; months with zero extended-duration shifts showed rates of A.) 2.8%, B.) 2.8%, C.) 8.1%, and D.) 46%, respectively. Sleep deprivation in doctors is therefore a multi-pronged threat to patients. Not only does it directly cause preventable medical errors by decreasing physician attentiveness, it also causes them indirectly by interfering with residents' medical educations (Barger et al, 2006, pp. 2443-2444.).

The obvious way to solve this problem is simply to let residents get more sleep. In reality, such a solution would require a huge cultural shift in residency programs nationwide and would most likely be met with resistance from post-residency physicians. After interviewing Dr. Terry Creel, who is an Emergency Physician in New Orleans, LA, I have come to realize that surviving a residency program composed of chains of sleepless nights is not only believed to be a rite of passage for young physicians but also a point of pride (T. Creel, personal interview, n.d.). In order to counteract this mindset, a very thorough program should be undertaken to educate more experienced physicians on the dangers of fatigue and sleep deprivation. Such a program would be beneficial not just to the sleep schedules and patients of residents, as excessive fatigue can also cause physician burnout. Physician burnout is characterized by "fatigue, exhaustion, inability to concentrate, depression, anxiety, insomnia, irritability, and sometimes increased use of alcohol or drugs." However, the most distinct characteristic "is a loss of interest in one's work or personal life, a feeling of 'just going through the motions'" (Gunderson, 2001, p. 145). The Accreditation Council for Graduate Medical Education issued updated guidelines that took these issues into account; the maximum number of hours that a resident could be on shift was lowered from 30 consecutive hours to 16 for a student in his or her first year following medical school (PGY-1), and the maximum number of in-hospital consecutive night floats was set at six (night floats are when interns are placed totally in charge of patients during an overnight shift) (Desselle & Dawkins, date unknown, "Overview of the New ACGME Duty Hour Regulations").

Procedure Complexity

The level of complexity of a medical procedure also plays a huge part in the number and severity of PMEs. Based upon intuition alone, it should be obvious that more complex, multistep processes allow more chances for a physician to inadvertently cause a patient harm. No matter how much time and effort a surgeon invests into memorizing the steps of a particular surgery, there is always the risk that he or she will inadvertently miss a minor step that, when left unchecked, could threaten the patient's life. To illustrate this complexity, Dr. Gawande uses the case of a three-year-old girl who fell into a frozen Alpine lake and was, for all intents and purposes, dead (2009, pp. 15-17). Her symptoms included no pulse, lack of respiration, body temperature of 66 degrees Fahrenheit, and unreactive pupils. By working together across multiple specialties and multiple surgical teams, the girl's doctors were able to perform the thousands of steps necessary to bring her back to life.

In order to ease the burden of complexity on physicians, the World Health Organization (WHO) developed the "Surgical Safety Checklist," a three part checklist divided into three sections: Sign In (before induction of anesthesia), Time Out (before skin incision), and Sign Out (before patient leaves the Operating Room). Before delving into deeper discussion on the WHO's checklist, it is necessary to stress the fact that it is not designed to be a comprehensive checklist; too many variations exist between the hundreds of different surgical procedures for it to even attempt to be such a guide. Instead, the checklist is designed "to provide reminders of only the most critical and important steps—the ones that even the highly skilled professionals using them could miss"; simply put, the checklist is not meant to be the definitive guide to a surgery (Gawande, 2009, 120). These critical steps can be forecasted by using a Failure Modes and Effects Analysis (Gudewicz). This process (normally used in manufacturing) involves breaking a procedure down into smaller components. Each component is then analyzed for potential failures, and the magnitude of each failure is assessed. Contingency plans are developed based upon the results of this analysis and the likelihood and severity of each outcome.

Another key feature of the Surgical Safety Checklist is that users are encouraged to adapt it to their own needs, so long as the product remains in line with its original goal. While it is not enough on its own to stop Preventable Medical Errors, the checklist can be used as part of a larger "Swiss Cheese" model of error mitigation. The reasoning behind this idea is that each layer of defense against errors is like a slice of Swiss cheese: mostly solid, but with a few holes or gaps where errors can get through. By stacking multiple layers of defense together, a single impenetrable layer of defense can be created out of individual, permeable layers (Collins, Newhouse, Porter, & Talsma, 2014, p. 67).

Inexperience

Another cause of PMEs arises from inexperienced physicians. No matter how thorough medical schools attempt to be, they cannot hope to cover every possible scenario that a physician will encounter. As a result, residents will meet patients that they are not fully prepared to treat, even with the supervision of an attending physician, leading to the "July Effect." All graduates from medical schools in the United States begin their respective residencies in the month of July, which apparently correlates and coincides with the number of some adverse events (including deaths) at teaching hospitals in July. For example, one study found that there was, on average, a 10% increase in fatalities in July attributable to medication errors in teaching hospitals (Philips and Barker, 2010, p. 774). While there is no direct evidence linking the residents to the increased fatalities, it is worth noting that no other month had any significant statistical differences.

Overcoming physician inexperience is probably the hardest way to go about reducing error rates by virtue of the fact that the only way to overcome inexperience is with experience. Solutions like simulation labs, mock patients, and case studies would bear looking at, but none of them are as effective as real world experience.

Communication

Breakdowns in communication are yet another source of preventable medical errors. Miscommunications can occur between two physicians or healthcare providers during a patient handoff, between a physician and the patient (or patient's family), or even between a healthcare provider and the hospital's record keeping system. Like in the children's game "Telephone," "the more often information is transmitted or communicated, the more likely it is that there will be distortion or corruption of the original data" (Solet et al., 1094). The original data can include vital information like the patient's name, known allergies, or medication schedules; the effects of this information deterioration can range from minor administrative headaches to patient injury and even death. In order to minimize the number of patient handoffs that occur per patient, physicians work longer hours, leading to increased fatigue. As mentioned before, an increase in doctor fatigue can lead to a higher risk of PMEs, which may very well cancel out any benefit that having fewer patient handoffs would have provided, while still increasing the possibility of physician burnout. Instead, standardization of handoff procedures seems to be critical to reducing these types of errors. Currently, there are no nationwide standards for how patient handoffs should be managed. This lack of standardization means that relevant patient information that is exchanged during patient handoffs can vary among hospitals and even among physicians in the same hospital. One system that is gaining traction among some hospitals is the I-PASS System. Standing for **I**llness severity, **P**atient summary, **A**ction list, **S**ituation awareness and contingency planning, and **S**ynthesis by receiver, I-PASS aims to provide a framework within which transfer can take place more effectively. A brief outline of how a patient handoff would occur using the I-PASS system is that two physicians would meet prior one physician's leaving at the end of his shift. Going patient by patient, they would first discuss a given patient's symptoms and diagnosis (illness severity). Next the first physician would give a brief summary of the patient's history, including age, allergies, and any other conditions that the second physician should be aware of (patient summary). The action list involves suggested actions that the first physician recommends, while the situation awareness and contingency planning requires both physicians to plan for potential complications that the patient might face. In the last stage, the second physician repeats the information relayed to him or her back to the first physician, ensuring that all important details have been shared (Gudewicz). Starmer et al. found that the use of the I-PASS system resulted in a 30% decrease in preventable medical errors over 10,740 hospital admissions without a significant negative effect on hospital workflow (2014, "Results"). Essentially, this handoff standardization allows doctors to handoff patients in a way that reduces errors without creating delays in patient care.

Included in the issue of standardization of communication is how the patient data are transferred. Common methods include print-offs from an electronic patient database, word processing templates, and handwritten forms. Each system has its own advantages and disadvantages, but the handwritten forms tend to be the least informative; oftentimes, they only include a "single fragmented statement such as '50ish yo M with [chronic obstructive pulmonary disease] – stable,'" if the writing is even legible enough to read (Solet et. al, 1095). The templates tend to convey more information than handwritten forms because they have spots for certain necessary information that prompt healthcare providers to ask certain questions. Still, information can be left out, or typos can occur. Furthermore, unless additional physical or digital copies are made, there is no backup if the original is lost. The best method, albeit the most time consuming and expensive, is one based on a digital database. Once patient information has been stored in the database, it can be used during subsequent visits to avoid having to retake a patient history every time. If the hospital is using PDAs instead of physical copies of the data, patient information can be updated in real time, eliminating the need to track down and destroy out-of-date copies.

With regard to patient-to-physician and patient's family-to-physician communication, communication can go awry in a variety of ways, from linguistic barriers to knowledge barriers. With the changing demographics of the United States, it is becoming more and more important for medical doctors to be able to converse in languages other than English. While most hospitals do offer translation services, either in person or over the phone, the very act of adding an intermediary can introduce new areas where errors can occur. Obviously, the risks associated with having no method of translation far outweigh the risks associated with having even an imperfect one.

Even if both the physician and the patient speak the same language, patients might not be familiar with the reasoning behind a doctor's line of questioning. For example, in order to prevent dangerous interactions between prescription medicines, it is vitally important for a patient to notify his physician of what prescriptions he currently takes. The Agency for Healthcare Research and Quality (AHRQ, 2014, "Five Steps to Safer Healthcare") recommends that patients bring all of their medicines and supplements to their doctor visits so that the physician can ensure that no dangerous drug interactions can occur. Another area where it is important for patients and physicians to have open dialogue is allergies. A patient with no knowledge of his or her own allergies places himself or herself in a position of undue risk, as many common items in the medical field can trigger allergic reactions.

Possible Solutions from Aviation

<u>Checklists</u>

Medicine and aviation share several similarities: both industries require years of training, both involve huge life risks, and both can have cultures characterized by individual heroism. It is important to note that in many situations, individual heroism should be welcomed. As noted in Lewis, et al., in the medical field (and primarily with surgeons) a proclivity towards "[responding] to system deficiencies by finding ways around each problem" is common. For example, "when items of surgical equipment were missing, surgeons modified, reshaped, or adjusted equipment designed for other uses," describing this behavior as " ' adventurous,' 'daring,' and necessary for 'getting the job done'" (Lewis, Vaithianathan, Hockey, Hirst, & Bagian, 2011, p. 21). While these on-the-fly modifications show strong problem solving skills, in a perfect world, they would be totally unnecessary because system deficiencies would be nonexistent.

In the aviation industry, similar behaviors were once common (probably because of the prevalence of 'hot shot' former military pilots) but have largely been extinguished via "codification and other measures that downplay the role of individuals in ensuring safety." The goal of these efforts is to train pilots and mechanics "to follow set procedures and to report the problem through official channels" (Lewis et al., 2011, p. 21). One of the primary ways that this was accomplished was through the use of extensive checklists. In Gawande's *The Checklist Manifesto,* he discusses these checklists: contained in "spiral bound, about two hundred pages long, with numerous yellow tabs," they were short ("usually just a few lines on a page") but thorough enough that they could collectively account for almost any scenario that a pilot could face. Usually, when checklists are mentioned, we tend to think of long lists with each step in a process listed out; like a recipe, but without the anticipation of a cake at the end. These checklists are suboptimal checklists: they tend to be overly specific, "[turning] people's brains off rather than [turning] them on" (Gawande, 2009, p. 115). Instead, they should be focused on reminding users of the main steps in a process.

In 2008, the World Health Organization published the "Surgical Safety Checklist," a 19-item checklist that is designed to be used in almost any surgery. At first, it seems ridiculous that all potential complications of all potential surgeries could be held in check by the information contained on a single sheet of paper. However, its goal is not to replace a surgeon's knowledge; rather, the Surgical Safety Checklist aims to "reinforce accepted safety practices and foster better communication and teamwork between clinical disciplines." Each of the 19 items has a firm basis in "clinical evidence or expert opinion" and has been specifically chosen to "reduce the likelihood of serious, avoidable surgical harm and that adherence to it is unlikely to introduce injury or unmanageable cost" (WHO Surgical Safety Checklist Manual, 2008, p. 2). It is also important to note that the checklist should not be used as a replacement for existing pre-operation procedures; it should be integrated with existing procedures so as to provide the best fit for a given organization and a given surgery. In fact, the checklist itself has a note on the bottom which encourages its users to add to it and to modify it as needed.

Crew Resource Management

Another very successful method used in aviation to counter individual heroism is Crew Resource Management Training (formerly Cockpit Resource Management; both abbreviated CRM). The primary goal of CRM is to allow crew members to function "as an intact team, not simply as a collection of technically competent individuals" (Civil Aviation Authority, 2002, Chapter 2 page 1). While in normal flight operations, it is not necessarily important that crew members act as a team; however, the UK's Civil Aviation

Authority points out that “behaviour during normal, routine circumstances can have a powerful impact on how well the crew as a whole functions during high-workload, stressful situations” (CAA, 2002, Ch. 2, p. 1). As such, Crew Resource Management focuses on six distinct areas for crew members (pilots and otherwise) to improve upon.

The first area involves communication and interpersonal skills: those skills “associated with good communication practices [including] such items as polite assertiveness and participation, active listening and feedback” (CAA, 2002, Ch. 2, p. 9). This area focuses on recognizing barriers to communication which can include “rank, age, and crew position.” By acknowledging and working to minimize the effects of these barriers, crew members are more able to exercise “polite assertiveness,” allowing them to feel more confident in their ability to communicate important information, as “a single hesitant attempt to communicate important data constitutes a failure to discharge individual responsibility” (CAA, 2002, Ch. 2 p. 9). Carrying this idea over to medicine, if flight captains are analogous to surgeons, then the remaining crew members (co-pilots and flight attendants) are roughly equivalent to other operating room personnel (residents and nurses). Just as it is important for a junior pilot to speak up when he realizes that the senior pilot has committed a mistake, it is also important for a junior physician (resident) to speak up when he realizes the surgeon has erred. Not mentioned in the CRM manual is the significance of mutual respect: an individual who does not feel respected will be less likely to speak up.

Another area of Crew Resource Management is situation awareness, referring to "one's ability to accurately perceive what is going on in the cockpit and outside the aircraft. It further extends to the planning of several solutions for any emergency situation which could occur in the immediate future" (CAA, 2002, Ch. 2, p. 9). By maintaining this awareness at all times, crew members can not only anticipate what can go wrong but can also have one or more plans to deal with issues. Adapting situation awareness to medicine would require little to no change; each surgery has known inherent risks (some more than others), so it would be a simple matter of recognizing what tools and equipment are needed as each potential risk approaches. Risks could be predicted and evaluated using the aforementioned Failure Modes and Effects Analysis.

The third area that Crew Resource Management focuses on is problem-solving/decision-making/judgement. Although it is a broad topic that easily can be related to the other five, it primarily focuses on how a crew member processes information into a decision. As information can come from different (potentially conflicting) sources, it is important that crew members (especially the captain, from whom all major decisions come) have skills in conflict resolution (CAA, 2002, Ch. 2, p. 9). Similarly, surgeons must be able to make on-the-spot decisions given conflicting information. In the case of the 40-year-old surgery patient mentioned above, the initial concerns of a stopped heart were waved off by the anesthesiologist, who insisted that a lead for the cardiac monitor must have fallen off. In reality, the patient's heart had actually stopped (Gawande, pp. 4-6). The decision on how to process these two conflicting choices falls to the surgeon, who was able to arrive at a course of action by integrating contradictory information from his operating room personnel.

Another vital part of Crew Resource Management is the idea of leadership/followership. There needs to be “clear recognition that the command role carries a special responsibility.” While the goal of CRM is to have the crew members function as a single unit, they must never forget that the captain is the one who must make the final decision. However, “the credibility of a leader is built over time and must be accomplished through conscious effort” (CAA, 2002, Ch. 2, p. 9). Just as with the other principles of CRM, this one can be transferred to medicine with very little effort: while input is necessary and valuable from other members of the operating team, it is the surgeon’s responsibility to make the best decision for the patient. As surgery cannot be performed quickly and smoothly if a subordinate is always challenging the decisions of the senior surgeon, it is important that the surgeon be recognized as the ultimate decision maker.

Stress management is an area of CRM that is especially applicable to medicine, given the issue of physician burnout. Stress management with regard to Crew Resource Management “[refers] not only to one's ability to perceive and accommodate to stress in others but primarily to anticipate, recognize and cope with one's own stress as well” (CRM, 2002, Ch. 2 p. 9). Being able to recognize stress in oneself is arguably more important than recognizing it in others, as stress may be impossible to detect in others. In aviation, individuals who experience a decrease in their ability to perform as a result of stress or fatigue should be considered incapacitated and unfit-to-fly. A similar system should be in place in medicine. Doctors who are exhibiting poor performance because of stress or fatigue should be relieved of duty until they are back to full strength.

Aviation Safety Reporting System

In the aviation industry, the Aviation Safety Reporting System is a method for analyzing pilot's errors in order to see what actions the pilot could have taken to avoid making the mistake. By being "voluntary, confidential, and non-punitive," the ASRS encourages pilots to self-report so that data can be collated in order to "enhance the basis for human factors research & recommendations for future aviation procedures, operations, facilities, and equipment. Data from this system has been used in 64 published research studies and special papers; additionally, all reports are published (with identifying information removed) for review by any interested parties. Finally, analysis of data can reveal problems with equipment or procedures that can be addressed immediately via monthly "Alert Bulletins" (ASRS Program Overview, date unkown, pp. 5, 23).

It is safe to say that a similar system would be met with resistance, if not open hostility, if it was introduced into the medical industry. Doctors would perceive it as nothing more than a way to open themselves up to more opportunities for litigation. In order to make it acceptable to them, all possible identifying information would have to be scrubbed from the reports; additionally, it would be necessary to assure them that any reports that they submitted would be exempt from use in a court case. I would also recommend adding some sort of financial incentive to make usage more attractive. Dr. M. Bing and I decided that the most logical method would be to have malpractice insurers reduce their premiums for all doctors participating in the program. Doing so would require participation on the part of the insurance companies responsible for providing malpractice insurance to physicians. In order to accomplish this goal, it would be necessary to prove (using statistical analyses) that doctors' participation in an anonymous reporting system would help lower malpractice lawsuits.

Other Solutions

<u>Medicare and Preventable Medical Errors</u>

In 2009, the Center for Medicare and Medicaid Services (CMS) began refusing to reimburse hospitals for costs associated with "conditions that could reasonably have been prevented and serious preventable events." These events and conditions included three types of hospital acquired infections, as well as complications arising from objects being left in the patient during surgery and pressure ulcers (Wachter, Foster, & Dudley, 2008, pp. 116 and 120). Prior to this decision, Medicare reimbursed hospitals for the cost of patient care, regardless of whether or not any errors had occurred that would increase that cost: essentially, hospitals were receiving larger payments for procedures that involved errors than for procedures that were error free. While the "regulation's effect on these events has not been well studied," there is evidence that it was successful in reducing central line–associated bloodstream infections by 11% and catheter-associated urinary tract infections by 10%. Rates of injurious falls and hospital-acquired pressure ulcers showed no significant changes (Waters et al., 2015, pp. 347-348).

While Medicare's nonpayment system does show improvements in some areas, it faces several challenges. First and foremost, in order for Medicare to justify nonpayment, the preventable medical error must be one that was actually preventable. Infections seem to be fairly easy to prevent, with a 66% reduction in catheter-related bloodstream infections reported when medical personnel strictly adhered to a series of best practices. However, there is little evidence to indicate that rates of pressure ulcers, injurious falls, blood-type mismatches, and air embolisms decrease when similar prevention strategies are used (Wachter, Foster, & Dudley, 2008, pp. 119). Another issue that the system faces is event severity. Currently, "the policy makes no distinction between trivial and significant harm." Because there is no defined difference between a small slip-and-fall injury and a large one, there is the possibility of reduced payments for a supposed injury that required little more than a band aid. The final problem that the new Medicare system faces is that some conditions might be present prior to admission to the hospital. Preexisting conditions are especially a concern for catheter-related bloodstream infections, as they can be caused by urinary tract infections that the patient acquired prior to his or her admission to the hospital (Wachter, Foster, & Dudley, 2008, pp. 120).

The Patient Protection and Affordable Care Act

Another way that preventable medical errors might be reduced is through the Patient Protection and Affordable Care Act (ACA). While the effectiveness of the ACA is a hotly debated issue, Section 10607 does require that the U.S. Secretary of Health and Human Services give preference in awarding demonstration grants to states that make proposals "that are likely to enhance patient safety by detecting, analyzing, and helping to reduce medical errors and adverse events." The Act also requires states that receive grant money to submit "an annual report evaluating the effectiveness of activities funded with grants awarded" by the HHS Secretary (ACA, 2015, pp. 867-868). However, as these stipulations were enacted so recently (April of 2015), no efforts have been made to assess their projected effectiveness.

Section IV

Real World Anecdotes

Dr. Tom Gudewicz, MD

In the course of my research, I was privileged to be able to interview Dr. Tom Gudewicz, former Force Medical Officer of the Submarine Pacific Fleet and current surgical pathologist at Massachusetts General Hospital in Boston, MA. He not only provided me with advice and direction for my thesis but also gave me insight into how preventable medical errors affect real people.

While serving as a surgical pathologist in the US Navy, Dr. Gudewicz was placed in charge of the pathology department at a Navy hospital. For those unfamiliar with the field of surgical pathology, a physician in this field normally does not deal with patients face-to-face; rather, his "patients" are tissue samples and specimens taken from individuals undergoing surgery. The pathologist's job is to diagnose a patient based solely upon these samples. However, when Dr. Gudewicz first arrived at the hospital, he was greeted by a "bucket of surgical and cytological specimens that were not accessioned [recorded] for processing"; a number of samples were without any form of labelling, despite explicit instructions set forth in the department's manual (in some cases, the specimen containers had labels that were completely blank). This situation presented a very obvious problem: even if he was able to diagnose a sample's disease, how was he supposed to notify the patient?

As the problem was caused by the clinics and offices that were sending him the samples (entities outside of his direct control), he had to approach the problem with an unorthodox solution. After determining that the lack of labelling was caused by a lack of training, a lack of experience, and a lack of follow-up (on the status of the samples by clinics), he developed a database to document the specimens that allowed him to "collect data to analyze and generate real time 'report cards' by clinics/providers"; he was subsequently able to use these report cards "to convince senior leadership to institute system changes and training to address the issue" (Gudewicz). Although he met with some resistance from individuals who wanted to invest in a high-tech system involving automated labelling with database support, he was eventually able to convince the clinics to train their personnel better: a much simpler and more effective solution.

Another area that Dr. Gudewicz was able to provide insight on was how doctors deal with the outcomes of preventable medical errors. Simply put, he believes that the best course of action is to tell the truth. Patient safety is taken very seriously, and they are always looking for ways to increase it; medicine cannot advance in this goal if doctors attempt to cover up their mistakes. Additionally, full disclosure of any medical errors has more immediate benefits, including "salvaging trust, decreasing the likelihood of litigation and facilitating the healing of both the patient and the provider." However, owning up to mistakes (especially ones that result in the loss of life or limb) is an incredibly difficult task. Massachusetts General Hospital works to solve this problem by having physicians in every department who are trained to coach others through the process of disclosure, as well as additional resources on an intranet website (Harris et al. 1955).

Dr. Paul Bing, MD

Another excellent source of information was an interview with my thesis adviser's younger brother, Dr. Paul Bing, MD. As a physician specializing in emergency medicine, he has more face-to-face interactions with patients and was able to give me an exact breakdown of how patient handoffs occur at his Nashville hospital. Earlier, I discussed the I-PASS system, a standardized method that some hospitals use during patient handoff. One major drawback to it, however, as pointed out by Dr. P. Bing was that there is often too much going on in the hospital for two doctors to sit down and meet face-to-face about every patient; additionally, he mentioned that for some patients there is too much information to be written down, so some of it can get lost. Although there is no standardized method in place at his hospital, Dr. P. Bing focuses on standardizing his patient handoffs as much as possible: he covers the patient's history, current treatment, and recommendations for future actions. One thing that he mentioned that I had not heard of anywhere else was a "bedside handoff." As the name implies, a bedside handoff is one that takes place at the patient's bedside, allowing him to stay in the loop regarding his treatment. While no research has been done regarding them, Dr. P. Bing believes that they increase patient satisfaction and have the potential to reduce preventable medical errors.

Section V

Conclusion

Preventable medical errors are a very tricky topic to study: hospitals are generally opposed to researchers coming into their halls to document every mistake made. Consequently, hard data about error rates can often be hard to come by, especially on a national scale. Regardless, efforts must be made to analyze existing data as best as possible in order to decrease preventable medical errors and increase patient safety.

PMEs can be divided up into two general categories: structural errors and process errors. Structural errors are those errors that result from defects in the overall structure of a hospital; these can include things like scheduling and hospital capacity. These errors are generally hard to correct, as they require large sums of money to either hire new employees or expand current facilities. Process errors involve either an action or an inaction on the part of hospital personnel (errors of commission and omission, respectively). These mistakes are generally harder to spot, but once they have been recognized, they can be addressed more easily than structural errors.

While preventable medical errors can be caused my patients, I chose to focus on those errors caused by physicians and other medical personnel. Causes for PMEs by physicians include doctor inattentiveness, procedure complexity, inexperienced personnel, and failures in communication. Doctor attentiveness is primarily caused by lack of sleep or poor scheduling. Procedure complexity is a characteristic that all surgeries share; complexity can be mitigated by standardization using the WHO Surgical Safety Checklist. Inexperienced doctors (like the residents who might be responsible for the July Effect) are very hard to overcome without hands on practice; simulation dummies can be used to provide a somewhat realistic preview. Failures in communication were the last major causes of preventable medical errors and primarily occurred during patient handoffs. Standardization in handoffs using the verbal I-PASS system or digital database software can help ensure effective handoffs. Additional ways to improve patient safety include the use of an anonymous reporting system for errors, similar to the ASRS used in the aviation industry, as well as Crew Resource Management to better deal with a variety of factors.

Recommendations

Preventable medical errors create a huge cost for the American people, one that can be measured both in lives and dollars. While the Institute of Medicine's report has done much to alter the world of medicine, research and analysis can only do so much. Based upon the above discussions, I have chosen to highlight the areas that I believe would be the most beneficial in improving patient care.

First and foremost, medicine must become more standardized across all hospitals. While each patient needs and deserves to be treated as a person, there are many aspects of patient care that should be standardized. As mentioned above, many hospitals lack systematic methods for collecting and logging patient data. This situation wastes time, as patients must be asked to repeat their histories multiple times; more importantly, it risks patient safety. Without an organized way to collect data, healthcare professionals could potentially miss vital information that could result in patient harm or death. Imagine if a doctor taking a patient history forgets to ask about any allergies, but the patient has a severe allergy to penicillin. No allergies would be noted on the patient's record, so anyone who subsequently dealt with him might assume that the patient had no allergies. Another area that requires additional standardization is surgery. Undoubtedly, each case is unique and presents difficulties that might vary wildly, but these situations are generally the exception and not the norm. Increased use of the World Health Organization's Surgical Safety Checklist could reduce preventable medical errors associated with surgery; a 2012 Johns Hopkins study found that, on average, American surgeons "[leave] foreign object such as a sponge or a towel inside a patient's body after an operation 39 times a week, [perform] the wrong procedure on a patient 20 times a week, and [operate] on the wrong body site 20 times a week." These exact mistakes are dealt with in the WHO's checklist: the very first step involves patient confirmation of the surgical site and procedure, while one of the last is an instrument, sponge, and needle count. By taking the extra time to use the checklist, approximately 4,000 of these preventable medical errors could be avoided every year (Johns Hopkins, 2012).

Another endeavor that I believe would contribute greatly to patient safety would be a nationwide error reporting system, analogous to Aviation Safety Reporting System. Undoubtedly, implementing such a system would create a firestorm of conflict among healthcare providers, as its stated goal would be to track the very errors that cost them millions of dollars in malpractice suits. Therefore, efforts must be made to strip the results of any type of identifying information as thoroughly as possible, while still retaining the data necessary for performing useful analyses. In order to make the deal more attractive to physicians, I would also propose tying participation in the program to a tangible benefit, like discounted malpractice insurance. While initial participation in the system would be low, if tangible improvements to patient safety can be made, doctors would be going against their very jobs by refusing to participate. By collating information from the system, researchers could attempt to find patterns in the breakdown of patient care. For example, if structural errors (those errors associated with availability of staff and equipment) were found to occur at similar times every week, hospital administrators could be advised to increase the number of doctors or nurses on staff at those hours.

A third area that should be developed to increase patient safety is education of healthcare providers on the topics of preventable medical errors and their causes. Doctors and nurses can hardly be expected to work to correct an issue that they know nothing about. This method, too, would meet with pushback from the medical community. Mistakes are a hard topic to talk about; mistakes involving the loss of human life are even harder. Education would also help to improve the problem of doctor fatigue: by showing doctors how detrimental their exhaustion is to patient safety, the culture of indoctrination via overwork can be dismantled.

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