Medical Errors

"First, do no harm"

Internal Medicine Grand Rounds

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Medical Errors

Introduction

The frequency and outcome of medical errors has been a topic of much discussion in the medical and lay press for the past several years. The public debate on this topic started in earnest after the publication of *To Error is Human* by the Institute of Medicine in 2000[1]. More recently, the debate on the financing of healthcare reform has heightened the awareness of cost attributable to iatrogenic misadventures and injury in the current system. The uncertainty of outcomes in sick patients due to complexity and unpredictable physiologic responses, the assumption that many procedures have inherent risks that cannot be mitigated by the quality of medical care, and the hierarchical culture of medicine have hampered the study of medical errors in the medical field despite mountains of literature regarding human error in other professions and industries. Today, public opinion has definitely shifted away from the acceptance of a poor outcome as an inherent risk of being ill, and medicine must take the lead in reducing medical errors and mishaps to avoid the imposition of even more outside influences on the way we practice. This review will attempt to summarize our current knowledge of medical errors and suggest some methods to reduce them.

Definitions of Medical Errors

Although the definition of a medical error seems obvious to most lay persons and professionals, study of these errors requires we have exact definitions to prevent confusion and misinterpretation of data and situations. The Institute of Medicine[1] defines several terms that make important distinctions among the many possible causes and situations that might be considered a medical error.

Error: the failure of a planned action to be completed as intended (error of execution) or the wrong plan to achieve an aim (error of planning).

Adverse event: an injury caused by medical management rather than the underlying condition of the patient.

Preventable adverse event: an adverse event attributable to error.

Negligent adverse event: a subset of preventable adverse events that satisfy legal criteria used in determining negligence, i.e., whether the care provided failed to meet the standard of care reasonably expected by a similar physician in a similar situation.

As will be discussed in detail below, errors are an inevitable part of any system that depends on humans to make and execute decisions. Unfortunately, the culture of medical practice has evolved into a system that depends on near perfection in decision-making and execution by highly trained and competent individuals who exert much authority over what happens in practice and hospitals. This culture and dependence on human perfection is responsible for many of the errors in the health care system that we see today.

Magnitude of the Problem of Medical Errors

The number of deaths that result from medical error has been vigorously debated. The debate has focused not so much on whether the causes of medical errors should be studied and eliminated but on the magnitude of the problem. Various groups have estimated that between 44,000 and 120,000 patients die prematurely each year from preventable adverse events related to their medical care. This means that more patients die from preventable adverse events due to medical care than die from automobile accidents or breast cancer.

The original estimates of the number of deaths in the United States attributable to medical errors came from two large studies in the 1990s that examined the incidence of preventable medical errors in hospitalized patients. In one large study of hospital admissions in Utah and Colorado, it was determined that adverse events occurred in 2.9% of hospitalizations and 6.6% of the adverse events results in death[2]. Another large study in New York found that adverse events occurred in 3.7% of hospitalizations and of these 13.6% resulted in death[3]. When extrapolated to the 33.6 million hospitalizations per year in 1997 in the U.S, the Institute of Medicine estimated that 44,000 (Utah/Colorado Study) to 98,000 (New York Study) patients per year die each year due to preventable medical errors. Of these deaths, medication errors accounted for the largest subgroup of 9,000 deaths.

Some have argued that the magnitude of the problem has been exaggerated due to the definition of a preventable adverse event that results in premature death. Patients admitted to a hospital are at high risk for complications and death whether medical mistakes are made or not, and small deviations from "best practices" may not contribute to the death or disability. Since there are no controls in these studies to account for inevitable death due to disease, the deviations from best practice could have been interpreted as an error leading to premature death in the two studies noted above[4]. Also, most studies on medical errors consider a death premature even if the error hastens an already expected imminent demise, and determining if the deviation from standard practice contributed to the death is sometimes impossible in an individual patient. While the study authors carefully tried to control for these biases in the interpretation of the definition of a medical error and whether such an error hastened death, many fail to convince those who argue these biases have overestimated the number of preventable deaths and exaggerated the magnitude of the problem.

However, compared to other health care systems of the world, the U.S. does not fare well when quality of care and medical errors are reported. The Commonwealth Fund has reported national surveys ranking health care in various countries in several categories. Figure 1 compares the U.S. with several other countries when outpatient medical errors are reported by patients. Figure 2 compares the death rate for medical and surgical errors for several countries. It contains the median for all countries (OECD Median). It is clear that the U.S. does not rank in the upper tier of health care systems in the area of safety.

Figure 1. Percent of patients saying medical error occurred outside hospital, Sicker Adults, 2007 (2005 Commonwealth Fund International Health Policy Survey of Sicker Adults)

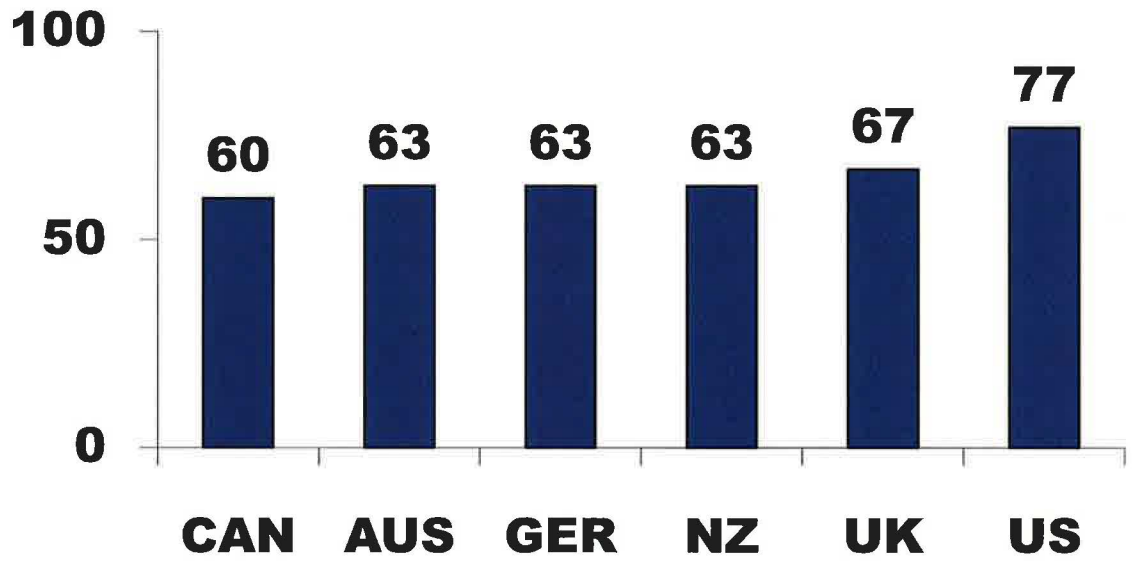
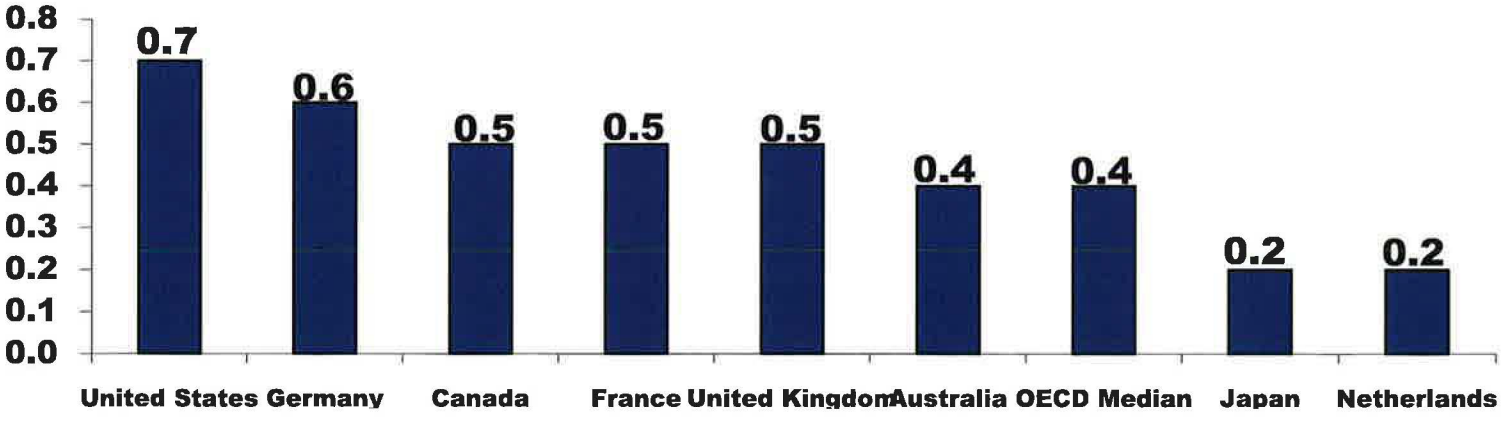


Figure 2. Deaths due to surgical or medical mishaps per 100,00 population in 2004 (J Cylus and GF Anderson, *Multinational Comparisons of Health Systems Data, 2006 (New York:* Commonwealth Fund, Apr, 2007)



Even if the number of deaths due to medical errors is overestimated, most would agree that errors do occur in health care at an alarming rate and that some of these errors cause significant disability and death in patients[5,6,7,8]. Reducing the number and impact of medical errors on patients is a moral imperative for the medical profession if we believe the admonition to "first, do no harm" is still pertinent today.

Causes and Types of Medical Errors

The Institute of Medicine in its report of 2000 made a strong recommendation for medicine to develop mechanisms to identify and report medical errors, evaluate the causes of medical errors and develop systems to prevent them. Unfortunately, the practice of medicine in the United States has not developed in such a way to make the identification of errors easy. Many believe the biggest impediment to the developing of such a system is the "culture of blame" that pervades our health care system. Medical-legal issues, the medical education system and the American news media all contribute to a tendency for our healthcare system to identify and punish or retrain anyone that makes a mistake. Also, hindsight bias, the tendency to attribute actions to circumstances that are not noticed at the time of an error and become obvious in retrospect, promotes the tendency to find a single cause of an accident which usually points to the human element.

Errors will occur in any system that involves human interaction with other humans or machines. Studies investigating the underlying cause of accidents in many industries, including medicine, indicate that 60-80% are caused by human error[9,11]. Consequently, the involvement of people in any system guarantees that a certain number of miscues will occur. However, attributing accidents to human error is not the same as assigning blame to the person making the error. James Reason makes a distinction between slips or lapses and mistakes[11]. In his model, a slip or lapse is when the action performed is not what was intended (an error of execution). For example, writing for one dose of a drug when the intention was to write another would be a slip. On the other hand, a mistake is when the action proceeds as planned but the result is not what was intended because the plan was incorrect (an error of planning), e.g., a wrong drug given because the wrong diagnosis was made. Both types of errors can have serious consequences and harm patients, but most studies in medicine have emphasized the prevention of errors of execution (lapses).

Active and Latent Errors

Another important concept in error prevention is the concept of latent and active errors[11]. Active errors are often referred to as "the sharp end" and are errors that occur at the interface of the frontline worker and the patient[12]. They are often felt immediately. Latent errors, referred to

as "the blunt end", are generally removed from the control of the front line worker and are flaws in the system that contribute to an error. Flaws in design, hospital administration, maintenance, procedures, equipment, are all examples of latent errors that can contribute to medical errors. While both active and latent errors can contribute to the harm of patients, latent errors are usually considered the most dangerous in complex systems such as health care since they are frequently out of the sight and control of the front-line worker or provider. Although the front-line worker may know about some of these latent errors and work around them, the most dangerous are those that are unknown to the operator.

The discussion of active and latent errors brings up the issue of "work-arounds", which are very prominent in health care. These work-arounds are usually compensations for latent errors in the system. When the work-around becomes the norm or accepted behavior ("normalization of deviance")[13], the system is much more dangerous and likely to fail due to important steps in a process that are overlooked or missed opportunities for the system to detect an error before it reaches the patient.

In the health care world, we frequently focus on active errors contributing to the culture of blame described above. Focusing on active errors generally leads to a false sense of security and justice in that it results in the discovery of a human error as the cause of a mishap and punishment, retraining, firing, etc. is falsely determined to be the best way to prevent the same error in the future. Focusing on active errors allows the latent errors to remain, thereby making the system more likely to fail in the future, sometimes in a catastrophic manner. Finding and repairing latent errors is a much more effective method of preventing future errors of any system than looking for and fixing active errors.

SRK classification of errors

Multiple factors are involved that predispose one to making errors. In general terms, errors can be divided into three types depending on underlying conscious engagement and competence (SRK classification)[10].

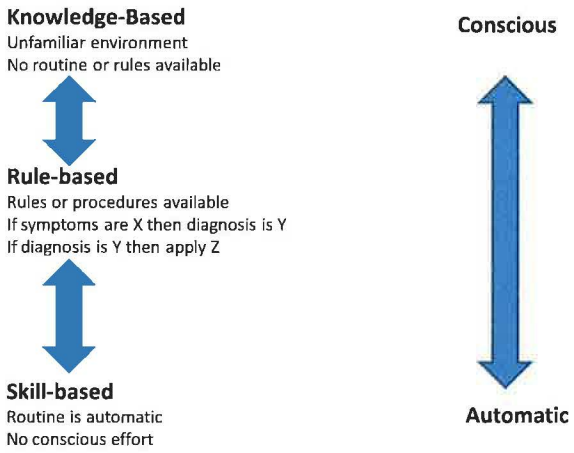
Skill-based Errors. Skill-based responses involve little conscious thought, are highly practiced and technical, and frequently involve motor activity. Skill-based errors occur when these subconscious actions fail. Generally, skill based errors have feedback loops that result in quick feedback. An example of a skill response might be a procedure done repetitively until little if any thought is consciously required to complete it.

Rule-based Errors. Rule-based responses are between skill and knowledge responses, and the level of conscious control is intermediate between them. They require more mental exertion than skill based responses and apply rules to situations that cannot be handled with skill responses. Rule-based errors are a failure of expertise when the wrong rule is applied either because the analysis of the situation is incorrect or the wrong rule is chosen for the situation.

Knowledge-based Errors. Knowledge-based responses require concentration or conscious thought to carry out the task. This might be when one is learning to do something new or when a person with experience faces an unusual situation. In these cases, one must expend a considerable amount of mental effort to complete the task.

A graphic representation of the SRK classification system is shown in the following figure.

Figure 3 The Continuum between Conscious and Automatic Behavior (based on Reason[10])

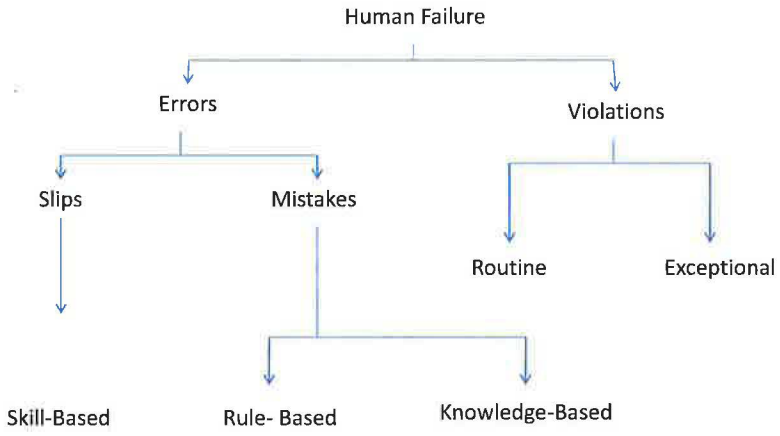


Using this model, a classification system of human errors was developed by Reason. A slip results when a failure occurs while someone is in the skill-based mode. For example, a task may be so simple or has been performed so many times that no conscious thought is required to execute the steps of the task. Fortunately, the feedback loop in skill based situations is usually quick so that corrections can be made. Unfortunately, a slip may result in a catastrophic situation that cannot be corrected. The fact it is called a slip does not imply that a failure in this mode is not serious. An example might be an experienced surgeon who cuts a vital structure during a procedure that he/she has performed so many times, it is automatic and done without conscious thought.

Using this model, a mistake is made when one is operating in the rule-based or knowledge-based mode. A mistake is rule-based when there is a failure of expertise. In this situation, one may make the wrong diagnosis of the situation and, consequently, apply the wrong rule to correct it (failure of diagnosis) or make the correct diagnosis of the problem and fail to apply the correct rule or plan (failure of execution). Conversely, a mistake is knowledge-based if there is a lack of expertise. In this case, despite adequate conscious effort, the wrong diagnosis or plan is made and executed because of some reason such as time pressure, inadequate instruction or study, fatigue, etc.

Finally, this model also describes two types of human failure called violations, both routine and exceptional. A routine violation is when one fails to use establish rules because they are interpreted as irrelevant. For example, a procedure in a policy may be routinely ignored, although known, because it is not thought to be important in a particular situation. An exceptional violation occurs when a rule or procedure is not used in one situation for any reason, time pressure, fatigue, pressure from superior, etc.

Figure 4. Classification of Errors[10]

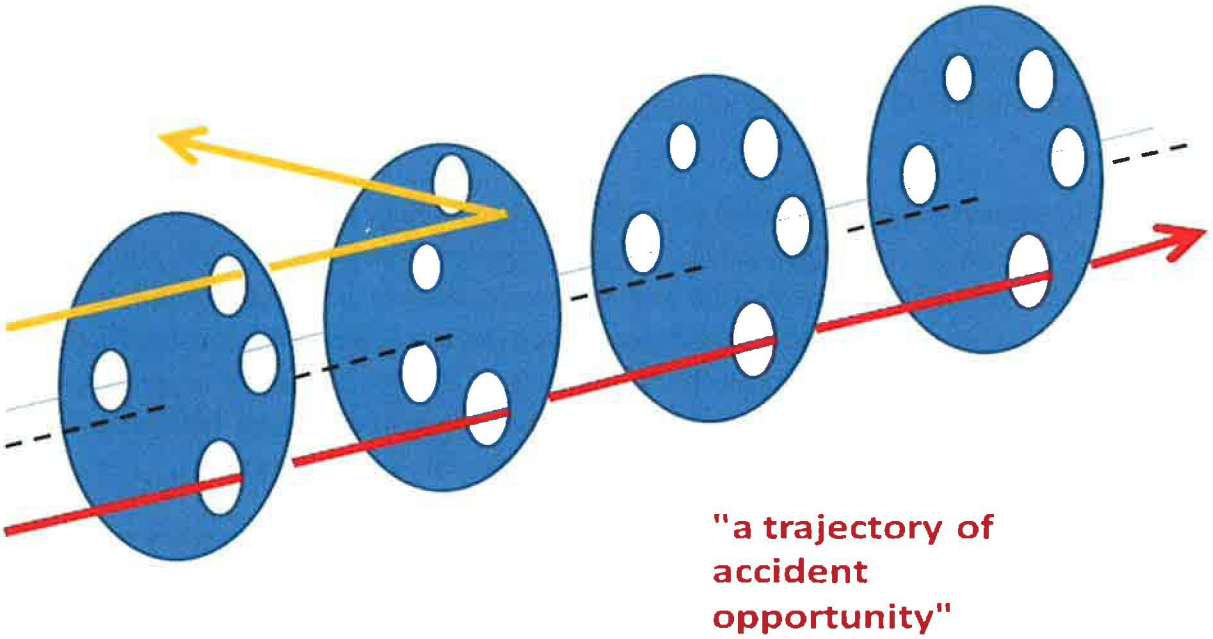


Many industries have developed methods to prevent errors in the various classes describe above, and many have been and/or are being tried in medical practice. Exceptional violations in general should be handled by evaluation of the reasons the proper procedure was not followed, and, if none is found, disciplinary action is usually indicated. If systemic reasons for the exception are

found, they clearly should be corrected. Routine violations usually are considered a systemic problem, and the procedure should be formally abandoned or reinforced if the procedure is important to the task. Finally, some interventions reinforce the importance of operating in the right mode when a task is being performed. For example, the mandatory use of time outs and check lists reinforces the importance of being in rule-based or knowledge-based mode instead of a skill-based mode before a procedure is performed on a patient. The removal of unnecessary distractions, which generally pushes one to a more subconscious level of performance, has been used very successfully in aviation in the form of the "sterile cockpit". In this situation, no unnecessary personnel can be present in the cockpit and no idle conversation may occur when the plan is below a certain altitude.

Another important concept in the study of medical errors involves the "chain of errors" and Reason's "Swiss cheese" model of errors. Most errors in medicine do not involve a single mistake that leads directly to the harm of a patient. Due to the complexity of the medical system of hospitals and clinics, several persons and processes are involved in the commission or omission of an action that could lead to a patient being hurt. This holds true for any health care practitioner be they physician, nurse, mid-level practitioner, etc. When an initial error is made, usually several other people or processes touch that error and could potentially stop it under the right circumstances. This has led to a model of errors illustrated in the following figure:

Figure 5. Reason's Swiss Cheese Model of Errors



Each time a person or process touches the original error, there is an opportunity to deflect the arrow away from the patient. Ideally each opportunity would prevent the error from reaching the patient, but individual and process errors along the way give rise to an opportunity for the original mistake to reach the patient. This "chain of errors" required for an action to reach an individual patient gives opportunity for feedback loops to notify the person making the error that one has occurred and system process refinement to close the holes to prevent similar errors in the future from reaching the patient.

Are Some Systems More Prone to Errors than Others?

This question has been examined in detail by Perrow[9], who characterized the risk of accidents in systems using two dimensions, complexity and coupling.

Complexity: Using the first dimension of complexity, systems can be linear or complex. Linear systems follow a predictable pattern of interactions where one step only interacts with the one before and after it such as an assembly line. These systems tend to be arranged in subsets with little interaction, contain few feedback loops and easy substitution. On the contrary, complex systems, of which health care is one, are characterized by having individual processes that can interact with many other processes, and the results of these interactions are frequently unpredictable and even invisible. When one process fails in this situation, frequently other dependent processes fail leading to major dysfunction of the entire system. In these complex systems, there are frequently many feedback loops, and each process is often so specialized that substitution of personnel is impossible.

One must be very careful making changes in complex systems because the effects of tasks on other parts of the system are frequently unknown or are not appreciated until the change is made. Change in linear systems is usually easier since the downstream effect of those changes is more predictable.

Coupling: The second dimension described by Perrow is coupling, which refers to the slack or buffering between two parts of the system. Tightly coupled systems have little ability to be flexible when the output of a process varies and, frequently, there is only one way to achieve the goal. In these systems, one process is very dependent on the one before it working correctly and predictably. When that does not happen, problems arise. Conversely, loosely coupled systems have individual processes that tolerate variability in the output of processes before them, can reorder the sequence of the processes and are much more flexible and resilient.

Although containing some linear processes, health care can be described as a complex, tightly coupled system. Unfortunately, systems with these characteristics are most prone to accidents and errors because they tend to become dysfunctional when individual functions do not operate predictably and efficiently. Also, in this type of system, small mistakes tend to result in a

snowball effect and result in large errors as the initial mistake is magnified through the complex system.

Unfortunately, we have been slow to adopt procedures used in other complex, tightly couple industries that have markedly reduced the incidents of catastrophic mistakes.

Evaluation of Medical Errors

Studies evaluating the prevalence and incidence of medical errors have used traditional research methodology of epidemiology. However, the evaluation of individual errors or those in hospitals or practice require the use of tools used in the evaluation of systems and process analysis. Probably the most commonly used tools to evaluate individual or small clusters of errors are root cause analysis, common cause analysis and some method to determine individual culpability when an error occurs.

Root Cause Analysis (RCA). Root cause analysis is probably the most common method used in the serious evaluation of a medical error. It is a very effective method of determining the "root cause" of an incident or error. However, it does require strict adherence to a defined methodology if the correct cause(s) of the error is(are) to be identified.

The first step in an RCA is to collect complete and comprehensive data regarding the incident. Data are generally collected in three ways. First, detailed and objective interviews of all persons involved in the incident should be conducted to document exactly the sequence and details of events and situations around the time and place the error occurred. Ideally, these interviews should be conducted within hours of the occurrence while facts are fresh in everyone's memories. It is critical that these interviews be objective, legally protected from discovery and without any implication of blame or conclusion at this point. Second, documentation from the medical record should be reviewed, again only looking for facts surrounding the error or injury. Finally, the location and equipment should be examined looking for environmental reasons a mistake could have been made. For example, investigation of a medication error should involve looking at the containers or locations containing the medication to look for confusing labels, vials, drawer locations, etc. All three methods of data collection should be evaluated in every RCA to avoid bias created by premature conclusions or inadequate data

The next phase of the RCA is to gather a group of experts to review the data. The group of experts should include a member from any group involved in the situation. For example, if a nurse is involved, one member of the group should be someone with intimate knowledge of the work of nurses in the area. A frequent mistake in RCAs in medicine is to just include physicians, nurses, and/or administrators in these groups when they may have little knowledge of many systems involved in the incident, e.g. pharmacy, scheduling, residents, dietary, housekeeping, etc.

This group will then go through a formal process of evaluating the available data, brainstorming to come up with all possible causes of the error and finally determining the primary cause or causes of the mishap, frequently using a fishbone or Ishikawa diagram. Typically, a facilitator familiar with these techniques should lead these meetings to avoid inadequate evaluation, jumping to conclusions and common biases which occur frequently in this type of meeting, e.g., hindsight bias.

Finally, the group will then make recommendations regarding individual culpability or correction of identified flawed system processes.

Two common mistakes are made in root cause analyses. The first, mentioned above, is the jumping to conclusions based on predetermined conceptions of what did or could have happened. The second is to assign blame to an individual who made the error without consideration of flawed system processes which allowed the error to reach the patient.

Common Cause Analysis. This type of analysis is useful when evaluating the total of a certain type of errors occurring in a system or if there is a cluster of errors. Evaluation of falls and adverse drug events in a hospital are common problems that can be effectively reduced using this method of evaluation. While root cause analysis tries to glean as much information as possible regarding human and system risk from a single significant incident, common cause analysis uses many incidents, sometimes less severe in outcome, to identify the most common problems that should be corrected. It requires less manpower per incident to find commonality between errors with shared characteristics and, therefore, this method is more cost efficient in evaluating problems or errors that occur frequently in a health system.

The basic methodology of common cause analysis involves evaluating a series of events looking for common characteristics that, if corrected, make the error less likely to occur in the future. Like root cause analysis, data should be collected from documented cases involving the incident type in question in an objective review of cases and a predetermined method of classifying problems or errors in the system should be used. Depending on the sample size of the problem being investigated, common themes and hypotheses to correct them are developed using stream analysis (<10 cases), change analysis (10-25 cases) or Pareto analysis (>25 cases).

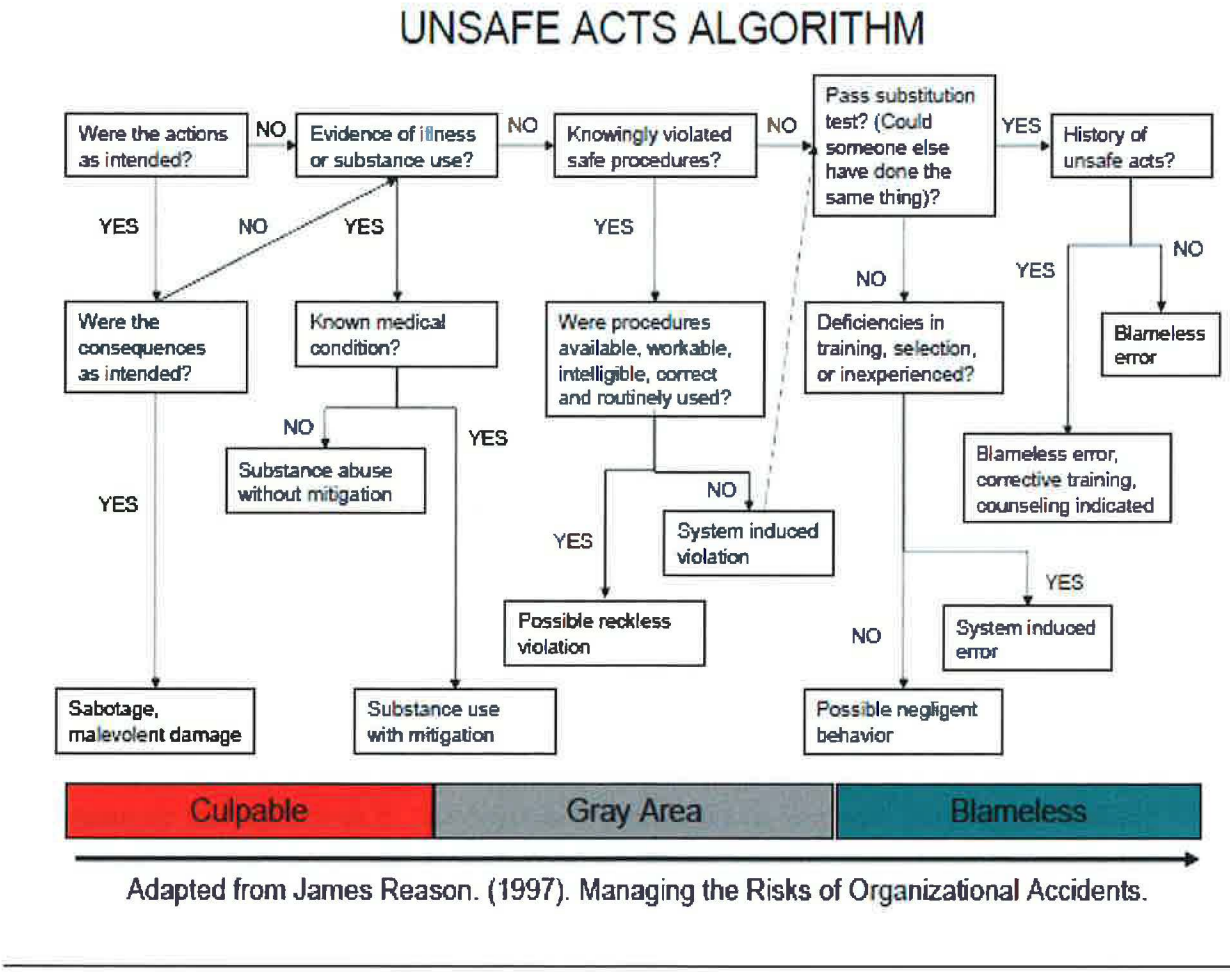
OhioHealth, a not-for-profit system of 18 hospitals, reported using this methodology to reduce the number of adverse drug events with certain classes of medications in their system by 45% in one year.

Determining Culpability in a Human Error. Our natural tendency in evaluating human errors in medicine is to attach blame to the person making the error. This "blame culture" is deeply imbedded in the practice of medicine and is reinforced by the medical legal system, our traditional methods of teaching, the "captain of the ship" philosophy, the hierarchical structure of medical practice and the obsession of the lay press for publicizing the human factors involved in medical errors. However, human errors are inevitable. Some high reliability organizations have

developed systematic methods for preventing these errors from being realized, but we cannot get past the fact that 60-80% of all errors will be traced back to some level of personal responsibility by an individual. When the error caused or had the potential to cause significant injury to a patient, we frequently are put in the situation of having to determine the degree of culpability of the individual for the outcome.

Probably the best algorithm for determining the level of culpability by an individual is that described by Reason[14]. This method (Figure 6) takes into account various characteristics of the error, such as intent, and goes through several mitigating circumstances of the error to finally assign a level of culpability by the individual.

Figure 6[14]. Algorithm to Determine Individual Culpability in an Error



This algorithm is particularly useful in determining how human or system errors contributed to an adverse event. The algorithm should be applied to each individual involved in an error and questions should be addressed in order. If the actions and consequences were as intended in the adverse event, then obviously criminal action should be sought. The questions regarding substance use differentiates medication taken for a known medical condition from recreational or illegal substance use. If safe procedures were violated, then one must determine if the violation was reckless or if the violation was due to the procedure being unknown, unworkable or not routinely used. Procedures that are not known or workable due to other circumstances indicate system or organization problems that are frequently out of the control of the individual making the error. However, if the procedure is routine and deliberately violated, recklessness is usually the cause and disciplinary action is indicated. The substitution test determines if similar errors have been or could be committed by competent individuals. Finally, a history of committing unsafe acts, even if blameless, could indicate an individual is prone to slips or is careless, in which case counseling is indicated. In summary, once the substitution test is passed, the error should be considered blameless and process or system improvements should be made to prevent further adverse events. In industry, 90% of errors are in the blameless and system-induced category.

Reducing Errors in Medicine

As noted above, past efforts to reduce medical errors in healthcare have focused on identifying those making the errors and punishing or retraining them. While retraining may be appropriate for some skill and knowledge-based errors, it is not appropriate to reduce the majority of errors committed. Humans will make errors at a finite rate in any system no matter how educated and competent they become. Any system dependent on human perfection as the major error reducing effort will fail and, frequently, will fail in a catastrophic manner. We must develop systems that reduce the chances of making errors and catch those errors that are made through feed-back loops and redundancy. These safe systems should be developed at all levels of responsibility. Below is a summary of this author's recommendations to reduce the number of errors reaching patients in the medical field.

Medical Education Level

1. Continue intense knowledge and skill-based mode training. Medical education is the foundation of medical practice. The education and training of our next generation of practitioners should continue to be intense and rigorous. Knowledge and experience is not sufficient but is critically necessary for practice in a low error medical environment. The dumbing-down of basic science and clinical medical education and training should be vigorously opposed. While clinical pathways and artificial (computer) intelligence may give us the right answer 99% of the time in routine clinical situations, only a trained

practitioner can analyze and make the complex decisions necessary when unusual or out-of-the ordinary situations arise.

2. Teach science of human error reduction. As noted in this presentation, much can be learned by the medical field from the study of human error in other industries. While the situations encountered in medicine are certainly unique, the human factors involved in making decisions in those situations are similar in most instances.
3. Teach team management. Medicine in our era is practiced as a team, and management of the efficiency and safety of that team should be taught at all levels of training.

Individual Practitioner Level

1. Life-long learner philosophy. This ethical commitment to our patients is hardly debatable. In our time, this includes knowledge of best practices in the areas in which we practice.
2. Use of computer-based decision support. Knowledge can come in many forms and, given the vast amount of new medical knowledge generated in our time, the use of computers to assist in decision-making should be considered whenever possible. With the current doubling time of medical knowledge being about every 10 years based on number of publish medical articles, it is obvious that no one can be current on everything. Computer programs can be a critical help with routine issues of ordering and management. They should not be used to make complex decisions in critical situations although they can provide calculations of critical components in such situations. A couple of the many ways computers can be used in decision support are alerts (feedback loops) and clinical pathways (best practices).
3. Individual responsibility for managing personal risk for error.
4. Standardization and customization to reduce variation in practice.

System Level

1. Get rid of "culture of blame" and replace with "culture of safety" systems approach to error reduction. This is a major change in focus of medicine as it has been practice in the United States. This change of culture requires the adoption of new principles and rules by practitioners, the institutions in which they practice, payors and society, including the legal system and public media. In this new system, individuals and the systems in which they work realize that errors are inevitable and that reporting those errors when they occur will not automatically result in recrimination. This will allow health systems to focus on why the error occurred and preventing its recurrence[18,21] in the future instead of focusing primarily on the person who committed the error and how to punish or rehabilitate them. This does not mean all who make errors necessarily will be held harmless if they report them, although some visionary organizations have done so.
2. Focus on units and teams in addition to individual responsibility. As mentioned above, medicine is a team activity and should be treated as such. All individuals, especially

medical and nursing staff, should be trained in error reduction methodology and techniques at the system and individual level, effective communication skills in hierarchical organizations and quality improvement technology. One method some health care organizations have used is to adopt characteristics of High Reliability Organizations (HRO)[17] such as aviation, nuclear power and flight deck operations. Certain characteristics are noteworthy in these organizations and can be found in Table 1.

Table 1. Characteristics of High Reliability Organizations[22]

Preoccupation with failure
Reluctance to simplify interpretations
Sensitivity to operations
Commitment to resilience
Deference to expertise

These organizations treat every small failure or near-failure as a catastrophic event requiring serious investigation and correction of the system causes identified. As a result, catastrophic accidents in many of these organizations are very rare. One methodology used by many of these organizations is Crew Resource Management[16] (CRM). CRM was developed and used effectively in aviation after that industry's crisis in safety noted in the 1970s, which is similar to that which medicine is experiencing now. This is a very effective tool for groups that work in small units which depend heavily on effective communication and teamwork to work safely and efficiently (operating rooms and emergency departments). Although some have questioned their effectiveness in medical practice[18], others have supported continued evaluation and use[20].

3. Accountability for quality and safety at organization and Board level, including management of individual risk factors that are influenced by organization actions such as scheduling, work load, work hours and work flow.
4. Ability to measure practice variation at individual practitioner level. This is critical to ensure each patient is receiving at least best practice treatment.
5. Expand use of time outs and check lists where procedures should be highly structured and standardized.
6. Use of Electronic Health Record (EHR)
7. Expand use of <u>functional</u> electronic decision support. Functional is the key word here. Effective clinical decision support <u>must</u> save time and be efficient as well as effective.

8. Voluntary reporting of quality metrics and improvement efforts. This has been used effectively by some organizations such as Cincinnati Children's[15] where adverse events and quality metrics are publically reported to patients, families and the public. However, the risk management and efficacy of this open strategy is still being debated.

Summary

In summary, medical errors account for an unacceptable number of deaths each year in the United States. The medical community should take the lead in developing systems and processes of care that drastically reduce the number of these errors because it is our moral responsibility to do so. If we fail to take the initiative in preventing these errors, the probable result will be unacceptable intrusion on our ability to practice by public and payor organizations. A study of methods to reduce human error in other industries where errors can lead to catastrophic results is one method to rapidly reduce the number of errors in medicine. The study of these methods should occur in conjunction with robust quality improvement efforts overall.

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