Chapter

Keeping Patients Safe: The Critical Role of Medical Error Recovery

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Abstract

Two decades after the Institute of Medicine Report, To Err is Human: Building a Safer Health System illuminated the high number of preventable deaths and adverse events associated with health care, medical errors remain a top global concern. To date, resources have been focused on preventing medical errors; however, the importance of error recovery must not be overlooked. Medical errors cannot be fully eliminated from our health care system, yet many errors can be recovered thus preventing patient harm. This chapter will (1) define and describe the error recovery process, (2) discuss the role of health care providers in error recovery, (3) explore strategies that enhance and prohibit error recovery, and (4) analyze characteristics that influence error recovery. Given the importance of patient safety within the health care industry, health care professionals and organizations must focus on both error prevention and error recovery as a key strategy in keeping patients safe.

Keywords: medical errors, error recovery, near miss, patient safety, expertise, culture, leadership, workload, high reliability

1. Introduction

Four out of every 10 patients are harmed while receiving care; costing payers an average of $8000 per admission [1, 2]. Errors related to diagnosis, medication errors, and unsafe surgical procedures are most frequently reported [1]. Over the past two decades, numerous resources and attention have been devoted to preventing medical errors and adverse events. Yet, in complex, high-risk systems, eliminating errors is unrealistic [3]. Safety practices must incorporate both error prevention and error recovery strategies.

This chapter will focus on error recovery as a critical safety strategy. Topics discussed in this chapter include (1) the error recovery process, (2) the role of health care providers in error recovery, (3) strategies that enhance and prohibit error recovery, and (4) individual and organizational characteristics that influence error recovery.

2. Magnitude of medical errors

Health care harm is a top safety concern globally. Medical errors occur when actions (intended or unintended) fail to meet their desired outcome, an action is not completed as intended, or the wrong action is taken to achieve an aim [4, 5]. In other words, errors result from unintended consequences as well as when health care providers make the wrong decision. The Institute of Medicine's (IOM) seminal

report *To Err is Human*, first alerted the health care community and the public to the widespread nature of deaths attributed to medical errors [6]. According to the IOM, 44,000 to 98,000 patient deaths were attributed to medical errors in the United States annually [4]. A decade later, Classen et al. estimated that the medical error rate among hospitalized Medicare beneficiaries was nearly four times that of the IOM estimate [7]. Over the past two decades, national efforts to reduce medical errors have led to some improvement. For example, hospital-acquired conditions (HACs) declined by nearly 1 million instances from 2014 to 2017 [8]. Despite these efforts, in 2019, the World Health Organization (WHO) reported that globally, four out of every 10 patients are harmed while receiving care and at least five patients die every minute as a result of medical errors [1]. Although the exact number of patient deaths attributed to medical errors remains debatable, preventable deaths and adverse events are a significant safety issue.

Research investigating the nature and impact of medical errors within the health care system began in earnest in the 1990s. Initially, human behavior, such as carelessness, poor motivation, and inattention, was blamed as the source of medical errors [6]. However, a shift away from the physiological and psychological limitations of humans and toward system error introduced new safety lessons from areas outside of the traditional health care arena [3, 6, 9]. Strategies adapted from safety-critical industries such as transportation, manufacturing, and aviation brought forward important gains in the fight to improve patient safety.

Aviation safety, for example, depends on managing errors, both through prevention and recovery [9]. In 1995, the US Secretary of Transportation challenged the aviation industry to meet the goal of zero accidents [10]. Interventions such as crew resource management training, checklists, and new technologies were introduced to address attitudes, behavior, and performance with the goal of improving aviation safety. Considerable efforts and resources were invested in the industry to limit opportunities for human error. However, human error is inevitable, particularly in complex, high-hazard organizations, and the goal of zero errors was unrealistic [3]. As a result, the aviation industry recognized the importance of error recovery and began training pilots to identify and remediate errors when they occurred [11].

Still, health care is focused on preventing medical errors, leaving behind important lessons in correcting errors to reduce adverse events. Health care historically equates errors with failure, and failure is unacceptable [12]. Thus, the notion of error management is not easily embraced. Error management involves understanding the nature and extent of errors, changing the conditions that create errors, identifying behaviors and actions that mitigate damage from errors, and training personnel in their use [9]. Error management incorporates two unique aspects [6]. The first aspect is prevention or limiting the incidence of errors. The second aspect is containing the damaging effects of errors, also referred to as error recovery. Error recovery is a highly valued strategy in safety programs outside of health care and is emerging as an important safety strategy in keeping patients safe [13].

3. Complexity

Health care systems are highly complex organizations, consisting of numerous interconnected components including the patients and their condition, the procedure, the team's expertise, the equipment design and use, and the workload [4]. Communication and the urgency in which decisions are made add further complexity to the system. Finally, these complex systems operate in highly variable environments that are impacted by regulatory, fiscal and social considerations.

High-reliability organizations (HROs) are organizations that operate in complex, high-hazard domains for extended periods without serious accidents or catastrophic failures [14]. HROs are not immune to errors and adverse events, instead, they are preoccupied with failure. Defining features of HROs include their heightened sense of vigilance and ability to anticipate and detect problems early in order to prevent adverse events. HROs have learned to make systems as tolerant as possible toward error [6]. Understanding error recovery can support health care organizations on the journey toward high reliability.

In safety-critical systems, error recovery is equally as important as error prevention, as it is often the last barrier of defense before a near miss becomes an adverse event [15]. Error recovery is highly valued in other industries outside of health care, yet it is just beginning to be recognized as an important safety strategy in health care [16]. Both error prevention and error recovery strategies are needed to make greater strides in improving patient safety.

4. Error recovery model

The Eindhoven Model of Near Miss Reporting has been used to explore and define error recovery in safety-critical industries [17]. Errors stem from technical, organizational or human factors that set off a chain reaction that could result in adverse events. When dangerous situations develop, systems are designed with automatic safety mechanisms to prevent negative consequences. In the case of high-risk situations however, automatic safety mechanisms are not always enough to resolve errors. In these instances, human intuition, expertise, and flexibility are needed to intervene and recover the error before harm occurs. If the error is recovered before harm occurs, this is defined as a near miss.

The Eindhoven model offers insight into error recovery processes in health care settings [15]. Henneman and Gawlinski adapted the Eindhoven model to create the Nursing Near-Miss model to better understand the mechanisms nurses use to recover errors at the point of care. In this model, bedside nurses are the final line of defense between a near miss and an adverse event. The researchers pointed out that surveillance is a key strategy nurses use to prevent developing incidents from becoming adverse events. A growing body of literature describes the ingenuity and adaptability of health care providers in recovering errors.

5. Error recovery process

Error recovery is a three-step sequential process incorporating (1) identification, (2) interruption and (3) correction [17–19]. First, an error must be detected. Error identification or detection is the process of knowing that an error occurred and may be triggered by a mismatch in an expected outcome. This step is aimed at making errors quickly apparent, thereby enabling recovery. Factors such as knowing the patient, players, plan of care, and the environment aid in identifying medical errors [16, 20, 21].

Interrupting an error is the second step in the error recovery process. In this step, participants attempt to understand how the error occurred, the level of importance, and potential countermeasures that may be necessary to return the situation to normal [20–23]. Health care providers interrupt errors using actions such as offering assistance, clarifying orders, and even verbally interrupting [16].

Perseverance is key to correcting errors, particularly when error identification or interruption was not successful [16]. In this step, the focus is on deploying

countermeasures to avert the error and reducing patient harm [20–23]. Being physically present, reviewing or confirming the plan of care, and involving other experts or leaders are successful strategies in correcting errors [16]. The system returns to its' safe state and patient harm is averted when errors are successfully recovered [19]. If errors are not successfully recovered, adverse events and potentially catastrophic consequences may occur.

Health care providers rely on flexibility, ingenuity, surveillance, and clinical judgment in recovering errors [16]. Henneman et al. first recognized the importance of surveillance in the error recovery process [15, 20, 21, 24]. Surveillance involves the continuous acquisition, analysis, and synthesis of information from both an individual and organizational perspective. Surveilling the patient and the environment enables providers to recognize developing complications and intervene appropriately. In contrast, when surveillance is lacking dangerous events may develop. Clinical judgment integrates knowledge, skills, expertise, and reasoning to recognize and address potentially dangerous situations [16]. Finally, providers use creativity and flexibility when devising and choosing appropriate strategies to interrupt and correct errors.

Researchers have attempted to quantify the number of errors recovered by health care providers. An integrated review of the literature noted that the magnitude of error recovery among nurses varies from as much as 18 times per 1000 patient days among medical-surgical nurses to as many as two errors per shift among critical care nurses [16]. Perioperative nurses have been known to recover as many as 11 errors per surgical case [22]. Nurses commonly recover errors related to medication errors, mismanagement of aversive systems, mismanagement of coexisting health issues, and improper use of precaution techniques in invasive monitoring [25]. Nurses accept that errors occur and see error recovery as an ongoing part of their job [15]. They regularly identify, interrupt, and correct errors, yet this information is rarely collected and analyzed. Thus, the important role that nurses contribute to patient safety is often invisible [16].

In addition to nurses, others play key roles in error recovery. A growing body of literature has explored strategies pharmacists employ to recover errors [23, 26]. Emergency department pharmacists were found to recover, on average, 7.8 medication errors per 100 patients [26]. A study of error recovery in community pharmacies found that pharmacists recovered numerous e-prescribing errors daily [23]. Most errors were caught at the identification stage of the error recovery process by pharmacists and technicians using strategies such as double checks and highlighting information on the printed e-prescription. Consulting with other pharmacy team members, reviewing the patient's history, and consulting with patients were strategies used to interrupt medication errors. Finally, pharmacists and technicians contacted prescribers to correct medication errors.

Patients and families also contribute to identifying and interrupting medical errors. A study of families of hospitalized children attempted to quantify the number of errors recovered by families. Benjamin et al. reported that 8% more medical errors were identified and interrupted when families were actively engaged with the health care team during family-centered rounds [27]. Families questioned medication changes, scheduling issues, and adverse drug reactions. The literature supports the notion that patients and families are increasingly involved in early error detection [28]. An analysis of near misses in the National Health Service found many instances of family members reminding staff about lapsed arrangements, pointing out overlooked care plans, and insisting on tests. The literature indicates that patients frequently identify communication and coordination related problems that may lead to adverse events [29]. Key strategies enabling them to prevent adverse events were knowing the patient and plan of care. Patients and families should be encouraged to actively engage in the care process and speak up when concerns arise [28].

While there is no standardized approach to capturing the magnitude of medical errors, front-line providers, as well as patients and families, play critical roles in recovering errors. Patients and families contribute to ongoing surveillance through active engagement in the care process. Effective communication between health care team members, patients and families aids in identifying and interrupting medical errors. Flexibility, creativity, clinical judgment, and surveillance are key strategies enabling health care providers to correct errors.

6. Characteristics influencing error recovery

Health care organizations are striving toward resilience during turbulent times in which they continue to struggle with access, cost and quality issues. Providers are challenged to make intricate decisions in dynamic, fast-paced, complex environments under tight time constraints. Errors are likely to occur under such conditions. Individual characteristics and organizational structures and processes can either help or hinder error recovery.

6.1 Individual characteristics

Individual characteristics that influence error recovery include expertise and workload [16]. Experts, like non-experts, are not immune to errors. However, what is unique about experts, is that they can recover errors more quickly than non-experts [12]. Experts unconsciously organize knowledge into manageable chunks that allow them to access and use critical information when necessary [12, 16, 30–32]. Experts rely on past experiences to help them identify cues and recognize patterns. They are better able to synthesize explicit and tacit knowledge in meaningful ways as compared to non-experts. Experts separate critical and relevant information from irrelevant information. In the end, experts develop what is known as deep smarts, a special form of wisdom that incorporates social, emotional, formal, and experiential knowledge [32]. As clinicians develop deep smarts, they exhibit greater confidence, perform more efficiently, and achieve higher levels of performance.

In the health care arena, experts use a multi-dimensional approach to integrate clinical judgment with knowledge of the patient, environment, and plan of care that allows them to more readily recover errors [16, 20, 21, 31]. A laboratory study of attending critical care physicians, residents, and medical students exploring the relationship between expertise and error recovery found that experts (physicians) recovered more (75%) errors than residents (61%) [33]. A study exploring the ability of dialysis nurses to recover errors determined that expert nurses detected more errors than non-expert nurses [34]. A study exploring error recovery among medical-surgical nurses found that expert nurses were four times more likely to recover medical errors than non-expert nurses [31].

Another hallmark of expertise is knowing when to deviate from standard protocols and employ shortcuts [35]. The ability to gauge tolerable risk in clinical situations is acquired over time and can only reside within experts. A study of trauma physicians and residents found that expert physicians made fewer errors when deviating from standard protocols than first- and second-year residents [31]. When deviations from standards or countermeasures are required to prevent adverse events the role of expertise should not be underestimated.

Workload is also associated with error recovery. When workload increases, nurses' ability to recover errors decreases [13, 31]. The notion of workload incorporates the demand placed on one's cognitive function, physical energy and the

work pace itself [36]. Acute care settings are fast-paced, complex environments in which health care providers are constantly combining complex thinking processes with psychomotor and affective skills to deliver appropriate care and interventions [37]. Nurses, in particular, spend a great deal of time providing direct patient care and communicating with patients, families, and team members [38]. Patient care involves nursing process activities such as assessing patients' clinical conditions, judging the need for nursing care intervention, implementing nursing care measures, and evaluating the effects of therapy. Communication involves consulting with team members, delegating to others, and patient education. Nurses are forced to cognitively shifting between patients based on their condition, medications, therapies, and requests within tight timeframes. As stressors and demands build, the nurse's thought processes and attention are negatively affected. Error identification and interruption is a complex process that requires significant cognitive resources [39]. Consequently, when nurses are experiencing high cognitive loads, due to heavy patient assignments or workload, their cognitive defenses and capacity to recovery errors are diminished.

6.2 Organizational characteristics

In addition to individual characteristics that influence error recovery, there are organizational characteristics as well. These characteristics include a culture of safety and leadership.

A culture of safety is the most important organizational factor contributing to successful error recovery. Organizations with a strong culture of safety recover errors more readily [13, 16]. On average, there are 2.4 recovery opportunities per error [13]. When a recovery opportunity is missed, individuals and organizations have another opportunity to identify, interrupt and correct the error before harm occurs. Organizations that prioritize safety engage in practices and behaviors that enable ongoing surveillance and ultimately error recovery. Practices such as interdisciplinary bedside rounds, effective handoffs, reducing interruptions and facilitating open and ongoing communication enhance early identification and resolution of errors [20, 21, 27–29].

When organizations do not prioritize safety, errors are more likely to occur, and error recovery opportunities are missed. In this case, important safety checks are skipped, shortcomings in protocols and procedures are noted, and critical knowledge is not transferred between providers making it difficult for errors to be identified [13].

Supportive leadership is also an important organizational characteristic influencing error recovery. Studies noted that when all else fails, involving leadership in the final stage of error recovery is an effective countermeasure to prevent patient harm [20, 21, 31]. But the role of leadership goes well beyond stepping in as the voice of authority to recover errors. Financial constraints, time pressures, and performance constraints put additional strain on organizations and impact error recovery processes [36, 37]. Leadership must develop a portfolio of strategies aimed at managing errors that are coordinated between executives, middle management and frontline staff [40]. Middle managers can act as a buffer for front-line providers and negotiate for solutions to alleviate heavy workloads. Executives can ensure a culture of safety and prioritize safety over other domains when faced with competing pressures. Leadership decisions, at all levels, contribute to creating an environment that either facilitates or hinders error recovery at the point of care.

Organizations striving to consistently provide excellence in quality and safety for every patient, every time must make safety a priority. A key safety strategy in resilient organizations is early error detection and mitigation of medical errors [6].

This strategy must be embraced by the health care industry. Today, health care providers are making critical decisions in complex situations within tight time constraints which contribute to medical errors. When errors occur, expertise and workload are individual characteristics that enhance error recovery. Expertise must be retained and redeployed across the staff. Strategies to facilitate the transfer of expert knowledge or deep smarts to non-experts should be harnessed. Workload and staffing levels must facilitate error recovery. Thus, workload or care models that leverage expertise should be explored. Finally, systems and processes must be adapted to address the strengths and weaknesses of human cognitive functions, particularly as health care becomes more complex.

7. Conclusion

This chapter described the error recovery process, highlighted the role of health care providers in error recovery, identified strategies that enhance and prohibit error, and explored individual and organizational characteristics that influence error recovery. Health care providers, patients, and families demonstrated ingenuity and adaptability when recovering errors. Flexibility, creativity, surveillance, and clinical judgment of health care providers are key strategies in identifying, interrupting and correcting medical errors. Characteristics that enhance error recovery include individual provider expertise and organizational culture of safety. A burdensome workload is an organizational characteristic that inhibits error recovery.

The value of error recovery in keeping patients safe is clear, although undervalued in health care. Safety-critical industries recognize that errors cannot be fully eliminated and have embraced error recovery as a critical safety strategy. Health care must do the same.

8. Case study

Delivering chemotherapy to cancer patients is a high-risk activity with numerous opportunities for patient harm [41]. Although the incidence of medication errors in chemotherapy is low, the margin of error for administering toxic chemotherapeutic agents to cancer patients is very small. Memorial Sloan Kettering Cancer Center noticed that as the number of chemotherapy orders increased so too did the number of near-miss medication errors. To minimize medication errors, the hospital implemented the new role of a verification nurse (VN) to review all chemotherapy orders. If a discrepancy is noted in the chemotherapy order, VNs investigate the incident by referring to protocols, contacting the health care provider for clarification, referring to the patient's plan of care for updates or changes and maintaining open and ongoing communication with the team members. Evaluation of the new role noted a direct correlation between an increase in chemotherapy orders and patient volume with error recovery by VNs. While additional complexity added to an increased number of medical errors, the organization embraced the concept of error recovery. This is an example of how one hospital heightened their sense of vigilance and supported strategies to enable health care providers to anticipate and detect problems early to prevent adverse events.

Conflict of interest

The author has no real or perceived conflicts of interest.

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