COMMENTARY

Health care system vulnerabilities: Understanding the root causes of patient harm

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Adverse drug events (ADEs) are any injuries resulting from the use of a drug and can be broken down into two categories: adverse drug reactions (ADRs) and medication errors. ADRs are any undesirable experiences associated with the use of a medicine in a patient, whereas medication errors are defined as any preventable events that may cause or lead to inappropriate medication use or patient harm.[1,2] Medication errors are the most common type of error affecting patient safety in hospitals[3] and occur most often at points in transfer of care—at admission, transfer between hospital units, or at discharge.[4] There is an abundance of literature evaluating ADEs at various points of a patient's transition across the health care continuum; however, literature surveying the prevalence of ADEs across the full spectrum of care is lacking. This article explores potential vulnerabilities of the health care system as we track a patient's movement from his arrival at the emergency department (ED) through admission and transfer to the intensive and acute care units and to the patient's hospital discharge.

Arrival at the ED. *An elderly man arrives at a hospital's ED with chest pain and shortness of breath. He is diagnosed with a non-ST-segment elevation myocardial infarction.*

Imagine for a moment that *you* are the elderly patient suffering from a multitude of chronic conditions, working diligently to hold onto a semblance of your previous state of healthy living. Suddenly, your health takes a turn for the worse and the health care system, which includes everyone from the admitting physician to the imaging technician in the magnetic resonance imaging suite, from the clinical pharmacist to the bedside nurse, becomes your refuge. All you want to know is what is going to happen, who is going to help you in your time of need. As you gasp for breath in the triage area of the ED, a pharmacist approaches and informs you that there is a two-thirds chance that a potentially serious medication error may affect your prognosis before you are even admitted to the hospital.[5] What would happen to your trust in future care at that institution?

Of course, patients are not informed of such staggering, pessimistic statistics when they are in a time of crisis. As health care professionals, we are aware that such statistics are clinically important. Medication reconciliation on admission is one of the most evaluated areas of study for medication errors, and justly so. A physician may have difficulty diagnosing heart failure without basic laboratory test results, imaging, and a stethoscope. It would be equally difficult to determine the etiology of a heart failure exacerbation without knowing what medications the patient is taking or about recent changes to therapy. Compounding these difficulties is the fact that 11–22% of hospitalizations for exacerbations of chronic disease (e.g., chronic obstructive pulmonary disease, seizure disorders, heart failure) are a direct result of medication noncompliance.[6,7] The Joint Commission has underscored the importance of accurate medication reconciliation by including it as one of its National Patient Safety Goals.[8]

The Centers for Medicaid and Medicare Services reported that 52.4 prescriptions were filled per enrollee for the 2006 calendar year.[9] In a separate analysis, Peterson et al.[10] found that patients obtained prescriptions from up to seven different providers. Polypharmacy and

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multiple outpatient care providers contribute to the disparity between documented medication lists and what the patient may actually be taking. A meta-analysis of 22 studies found that errors in prescription medication histories occurred in 67% of patients at arrival to the hospital, with up to 59% of these errors deemed to be clinically relevant.[5] The most common form of unintended discrepancy is omission of a long-term medication the patient uses on a regular basis.[5,11] Anyone who has spent time in an ED has likely seen patients arrive with "brown bagged" medication bottles. Many of the medications are duplicate drugs, from different pharmacies, with different dates and dosing instructions. Other times, a patient may have a pillbox full of tablets and capsules filled by someone else, completely unaware of what they are. While this may be frustrating, having all medications in our physical possession is one of the most accurate ways of ascertaining a correct history. The Agency for Healthcare Research and Quality encourages patients to bring all medications to every health care visit.[12]

With recent attention focused on medication reconciliation and efforts to improve the quality of medication histories, some hospitals have enlisted support from companies that electronically query patients' outpatient medication refill history and claims databases.[13,14] While very useful for obtaining an initial medication list or as a starting point for a medication history for unresponsive patients, the list that is returned by the query may not be accurate.[10,15] Recent medication changes or instructions provided to patients that are not included in the electronically obtained query (e.g., halving tablets to make a certain dose) may not be available in the report. An outside institution's medication list is similarly error prone. During an interinstitution transfer, you may receive an accurate history of what the patient is receiving as an inpatient from that facility; however, the initial pitfalls of accurate medication reconciliation on admission may have already occurred.

A trained, competent pharmacist is the ideal health care professional to perform accurate home medication reconciliation. Pharmacists have demonstrated higher accuracy in both error detection and obtaining complete medication histories compared with nonpharmacy personnel.[16,17] A study performed by Nester and Hale[18] demonstrated a significant increase in identified discrepancies necessitating clinical intervention, including those that could result in significant harm, when a pharmacist obtained medication histories at admission instead of nursing staff (37% versus 16%, $p < 0.001$). In addition, data analyzed from the National Clinical Pharmacy Services database revealed that hospitals in which pharmacy personnel obtain medication histories had a 50% reduction in medication errors compared with hospitals that use nonpharmacy personnel to obtain this information.[19]

Admission to the hospital. *In addition to routine medications for hypertension, a query of the patient's recent prescription refills at local pharmacies revealed that he was taking amitriptyline as an outpatient medication. After the patient is stabilized, he is transferred to an observation unit, where the admitting physician writes orders to "continue home medications." On transfer, he is subsequently prescribed amitriptyline, a contraindicated therapy after an ischemic cardiovascular event.*[20]

Correctly documenting all medications on admission cannot be stressed enough, as it will contribute to the patient's safety and outcomes throughout the hospital stay and at discharge.[21,22] Once an accurate medication history is obtained, proper evaluation of these agents is required. An order to continue home medications without critical appraisal of the need to continue each agent is an unacceptable practice. Computerized prescriber order entry is an evolving and valuable tool used to decrease ADEs across the spectrum of care; however, accurate use of this system is a safety-limiting factor that may introduce opportunities for errors not previously realized.[23,24]

The reported incidence of inpatient medication errors varies widely, depending on the detection method used, but is estimated to range from 0.012 to 1.4 errors per patient admission.[25-29] A recent prospective study found that 524 (15.8%) of 3322 patients who were followed through their hospitalization had at least 1 ADR.[30] Initiation of the causative drug as a new inpatient therapy was responsible for 602 (82.1%) of the ADRs that occurred. The strongest predictor of a patient experiencing an ADR was the number of medications received, with the hazard ratio increasing by 1.14 with each medication added. Additional risk factors for ADRs included older age and female sex. The fact that 53.3% of these ADRs were deemed to be preventable (consistent with the definition of medication errors) highlights the importance of clinical pharmacists' vigilance in monitoring patients, especially elderly patients taking multiple drugs, for the development of ADRs.

Handoff to imaging. *The patient's cardiac function prompts an order for additional diagnostic testing with an echocardiogram. The nurse provides a brief, verbal handoff report to the courier transporting the patient to the imaging department. The patient has a continuous infusion of nitroglycerin running; as the echocardiogram begins, the infusion pump alarm sounds, signifying that the infusion has been depleted. The technician, perhaps unfamiliar with the device, the medication, or the patient's status, silences the alarm so that the test can proceed. Fifteen minutes later, during*

the echocardiogram, the patient's respiratory and cardiovascular statuses deteriorate.

Leape et al.[31] identified "proximal causes of adverse drug events," such as lack of knowledge about the drug, lack of knowledge about the patient, and lack of standardized processes. Lack of knowledge does not necessarily imply negligence or ignorance; it may reflect unfamiliarity with drugs or devices outside the employee's field of expertise. Understandably, a radiology technician cannot be presumed capable of performing the work of a nurse or pharmacist or vice versa. In cases such as this, it is the system that fails both the health care worker and the patient. Education and standardized practices are key factors in preventing serious ADEs. To create standardization in our health care systems and minimize ADEs, high-risk situations and opportunities for error must first be identified through an ADE identification and reporting system at the institution. After initiating a medication safety program centered around internal event reporting, education, and interventions, a 489-bed community hospital reported a threefold reduction in ADEs, with the median number of ADEs per 100 patient-days significantly declining from 5.07 to 1.30 ($p < 0.001$), and a reduction in ADE severity.[32]

A root-cause analysis of the patient's ADE may identify the lack of a proper, informative handoff during the patient's transition as a contributing factor. The importance of communicating complete and accurate information during patient handoffs cannot be overemphasized. Like aviation, health care is considered a complex industry rife with high-risk situations. Handoff strategies used in space shuttle mission control have been applied to health care, identifying potential consequences of a failed handoff during critical transitions (appendix).[33] If it had been noted that a continuous infusion of nitroglycerin was running, this event may have been prevented before the patient left the unit.

Transfer to acute care. *After the patient has spent several days recovering in the intensive care unit, the physician writes orders for him to be transferred to an acute care unit. The patient has been receiving continuous infusions of nitroglycerin and dobutamine, but his dosages were successfully adjusted downward, and the physician orders the dobutamine to be discontinued when the patient is transferred to the acute care unit. However, the receiving nurse does not realize that the dobutamine has been discontinued from the medication administration record; because there is sufficient quantity to deliver the medication for another 12 hours, the medication is continued.*

Lee et al.[34] conducted a study involving tertiary care hospitals to prospectively evaluate the occurrence of medication errors in 129 patients transferred between inpatient units. The authors found that on internal hospital transfer, there was a 62% chance that a patient would experience at least one medication error; over half of these errors were omissions, and over a third had the potential to cause discomfort or clinical deterioration. The Joint Commission evaluated sentinel events occurring during hospitalization and reported that 70% of events resulted from a breakdown in communication, with over 50% occurring during patient handoffs, including between-unit handoffs and surgery or procedural department handoffs.[35] In light of this, the Joint Commission recommends the use of a standardized patient handoff form as a National Patient Safety Goal.[36] Unfortunately, there are no clinically validated methodologies to improve handoffs in the health care setting. When evaluating common handoff tools, such as the Situation–Background–Assessment–Recommendation, the portion of the handoff dedicated to medication therapy is small (Figure 1). The medication section, from the perspective of a pharmacist, is disproportionate to the possible harm incurred from medication errors.

Recent nursing shortages have decreased the nurse:patient ratio,[37,38] and this issue is expected to worsen, as registered nurse positions constitute the largest portion of projected growth in any industry, and enrollment and graduation in nursing education programs will not satisfy the industry's demand.[39-41] Increased staffing requirements have been correlated with increased nursing errors, including those involving medications.[42] These hazards can be minimized through the development and implementation of thorough, standardized, and consistent requirements for handoff strategies.

Nursing staff do not contribute to handoff errors implicitly. Just as important are the professional handoffs among attending and resident physicians and other care providers, including pharmacists. In a survey of internal medicine and surgical residents at a large, academic, tertiary care hospital, 59% of respondents reported that during their previous rotation, at least one patient had experienced harm because of problematic handoffs, with 12% of residents categorizing the harm done as major. The overall quality of handoffs was judged to be fair or poor by 31% of residents. Factors most often cited by medical residents as contributing to the poor quality of handoffs included incomplete reports of all major active issues, handoffs not being face-to-face, frequent interruptions, and no opportunity for the recipient of the handoff to ask questions.[43] Maintaining the continuity of care and performing patient handoffs are necessary to patient safety, and the responsibility is shared among all health care workers.

Discharge. *The patient has recovered from his cardiovascular event and resulting complications and is*

Figure 1. Example of a patient reporting form for care transitions. BUN = blood urea nitrogen, A&O = alert and oriented, NG = nasogastric, NPO = nothing by mouth.

S **Situation**	Name Age Diagnosis Surgical treatment/interventions Code status Procedure to be done	
B **Background**	Allergies/any problems with contrast? Pertinent history—does patient have a history of Heart disease? Kidney disease? Multiple myeloma? Lupus? Diabetes? Is patient taking metformin? Current BUN and creatinine Prep given: time, type Transportation needs: stretcher, wheelchair Communication: hearing, vision, language Mental status: anxiety?	
A **Assessment**	**Neurologic status**—A&O, confused, cannot be left alone, understands instructions **Cardiovascular**—pacemaker **Pulmonary**—oxygen requirements **Abdomen**—NG tube **Bowel**—continence? **Bladder**—Foley, urgency, continence? **Muscle/skeletal**—weakness: can stand, sit, walk, implants, special positioning needs **I.V.**—gauge: date started, fluid running **Skin**—open wounds, dressings **Pain**—location, last pain medication **Nutrition**—NPO, last contrast **Equipment**—pumps, suction **Precautions**—Contact, standard, isolation	
R **Recommendation**	Special treatments? Special needs when off unit? Needs nurse for procedure or transport?	

scheduled to be discharged home. During his hospitalization, several of his medication dosages were increased, and new agents were added to his medication regimen. An angiotensin-converting-enzyme inhibitor and spironolactone therapy were added for heart failure treatment. Potassium chloride was ordered, as his serum potassium concentration on the morning before discharge was 3.2 meq/L. The potassium chloride was inadvertently prescribed as a discharge medication. The patient is told to schedule a follow-up appointment with a cardiologist.

According to a recent study, the chance of a patient continuing the same medication regimen at discharge as the regimen taken on admission is less than 10%.[44] On average, 28–40% of a patient's medications are discontinued during hospitalization, and 45% of medications prescribed at discharge are new medications initiated during the hospital stay.[45,46] In another study, more than 60% of patients had three or more changes in their drug regimen during their hospital stay.[47] Of particular concern to the authors was the large number of drug changes for conditions other than the disease that precipitated the hospital admission. The error rate for medication reconciliation at discharge is unacceptably high, ranging from 25% to 70%.[21,48] The most common types of discrepancies are the omission of medications and incomplete or inaccurate prescriptions, 30% of which are likely to cause potential patient harm or discomfort.[49] In addition, medications started as inpatient therapy, such as proton pump inhibitors for stress-ulcer prophylaxis or hypnotics for insomnia, are many times continued inappropriately at

discharge, adding to the patient's medication burden.[50,51]

Readmission. *Two weeks after discharge, the patient develops extreme weakness and anorexia and is readmitted to the ED. Laboratory test results reveal an elevated serum potassium concentration of 7.5 mg/dL, necessitating medical intervention and admission to the cardiology observation unit.*

ADEs are the most common adverse event experienced by patients after hospital discharge, occurring in approximately 10–20% of patients.[52,53] The overall risk for an ADE postdischarge in one analysis was 4.4% for every drug alteration or change.[53] Nearly half of the ADEs found in another analysis resulted in an office visit, ED visit, or hospitalization, and 60% of these ADEs were preventable.[52] Surveillance studies found that 2.5–6.5% of all ED visits are the result of an ADE.[54,55] This problem is often unrecognized; in a prospective study by Dormann et al.,[56] 57% of ED visits secondary to an ADE were not detected upon admission by the attending physician. Complicating this process further are issues surrounding patient noncompliance, which increases with patient age and the number of medications prescribed.[53] One intervention proven to reduce ADEs is discharge reconciliation and patient education by a pharmacist. This intervention has been shown to positively affect predischarge and postdischarge medication errors and adverse events, resulting in decreased hospital readmissions and increased patient satisfaction.[57-59]

Conclusion. Patients no longer have one physician, hospital, or pharmacist; their movement through different health care entities is as dynamic as the constant refinements to our own systems. Lack of communication and consistent methodologies for tracking patients, their health status, and all medications are root causes for many adverse events and medication errors that jeopardize patients' health. Despite the existence of National Patient Safety Goals for proper medication reconciliation, transfer documentation, discharge, and follow-up, there are no universally recommended standards for these tasks. Computerized prescribing, documentation, medication review, and reconciliation carry with them the potential to increase patient safety across the continuum of care. However, there is a learning curve for all processes and a time period for transition, during which increased harm may be realized. Structuring and standardization of systems to ensure continuity of care are needed to optimize health care and to improve quality of life for our patients.

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Appendix—Hazards of poor or incomplete patient handoffs[32]

Possessing an incorrect or incomplete status of the patient's state

Being unaware of significant data or events

Being unprepared to deal with impacts from previous events

Failing to anticipate future events

Lacking knowledge that is necessary to perform tasks

Creating an unwarranted shift in goals, decisions, priorities, or plans