Abstract:
Medical errors are a leading cause of morbidity and mortality in healthcare. Pediatric patients receiving care in the acute or emergency setting may be especially susceptible to medical error and subsequent harm. Here we review the most common types of medical errors in pediatric emergency medicine – those related to medication, laboratory evaluation, communication, and diagnosis. Diagnostic errors are perhaps the most common but least studied type of error, though there has been recent interest in further quantifying, characterizing and preventing such error. Active research focuses on the systems issues and cognitive biases that likely play a role in this process.

Keywords:
Medical error; Patient safety; Diagnostic error; Pediatric emergency medicine

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Common Medical Errors in Pediatric Emergency Medicine ,

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Medical errors have been identified as a leading cause of patient harm and death.[1,2] Error in medicine has been defined as an unintended act (of omission or commission) or one that does not achieve its intended outcome.[1] Since the 1999 publication of the National Academies of Science Engineering and Medicine's (NASEM—previously called the Institute of Medicine) report on healthcare safety,[3] great efforts have been made to identify, characterize, and reduce various kinds of medical error, with particular attention paid to medication errors and a more recent report on improving diagnosis, specifically focusing on diagnostic errors.[4] There has been in an increased focus in the last decade on patient safety in the field of pediatric emergency medicine.

The inherent nature of the emergency department (ED) makes it a particularly vulnerable setting for medical error.[5] The ED environment is unpredictable and often chaotic. Medical providers are tasked with caring for multiple patients simultaneously – each with a unique medical history, chief complaint, and acuity level. Medical decisions must often be made in time- and information-constrained settings, interventions must be implemented quickly, and providers must prioritize the sickest patients while also managing those with lower acuity problems.[6] Additionally, the ED is a 24-hour operation where transitions of care occur frequently and staff are prone to sleep deprivation. These factors all increase the risk of medical error,[7,8] which in turn contributes to both

increased risk of patient harm[9,10] and increased costs to the healthcare system.[11,12]

Caring for children in the ED presents additional unique challenges. Younger pediatric patients are developmentally unable to communicate their symptoms and thus the medical team must depend on third-parties, e.g., reliable caregivers, to obtain information. Furthermore, caring for children of all ages necessitates appropriately-sized equipment and general knowledge of weight-based dosing and age-specific norms in vital signs and physiology and typical age-ranges for disease presentation.[13] These additional considerations may make pediatric patients even more susceptible to medical error.[14,15]

MEDICATION ERROR

Case 1

A healthy 2-year-old girl presents with a large full thickness burn after pulling a pot of boiling water off the stove. Her mother reports a recent weight of 25 pounds, which is incorrectly charted as 25 kilograms. The physician gives a verbal order for morphine based on the erroneous weight in kilograms and the nurse administers the dose. The patient suffers unanticipated respiratory depression as a result.

Errors related to medication have been well-studied and are common to pediatric emergency medicine.[16] Even in dedicated pediatric EDs, where staff are presumably familiar with the nuances of weight-based dosing and pediatric prescribing guidelines, reported rates of medication error range from 10–30%.[16,17] A review of incident reports from 18 EDs within the Pediatric Emergency Care Applied Research Network (PECARN) demonstrated that medication errors accounted for 19% of all such events.[18] The most common causes of medication error included incorrect dose (due to calculation error, incorrect weight, duplicate dosing, etc.), incorrect medication, and delayed or missed doses.[18]

A 2018 policy statement from the American Academy of Pediatrics focused on decreasing errors in both prescribing and administering medications in the pediatric ED setting.[15] Computerized physician order entry with automatic dose calculation is one suggested strategy; however, the system must address pediatric-specific needs and is only accurate if the patient's weight is entered correctly.[15] Other strategies include utilization of a standardized pediatric formulary and implementation of on-site ED pharmacists for dosing verification, medication reconciliation, and preparation of high-risk drugs.[15] With regard to medication administration, the policy recommends using premixed intravenous preparations when feasible, use of automated barcoded medication and automated dispensing cabinets, and using standardized concentrations for a given drug.[15] Implementation of these recommendations can improve pediatric medication safety while the process continues to be studied and refined.

LABORATORY ERROR

Case 2

Two ill patients are being evaluated in the ED—a febrile 3-week-old and a 14-year-old with diabetes and dehydration. A urine sample is obtained from both patients but the technician, who is caring for both patients, mislabels the specimens. The samples are processed in the point-of-care lab in the ED. Error is suspected when the infant's urine test results with ketonuria and glucosuria and the teen's urine demonstrates large nitrites. Both patients must undergo repeat testing with a delay in further management.

Laboratory errors are a common but less studied cause of safety events and medical error in the pediatric emergency department.[19] ED providers rely on efficient and accurate laboratory testing to diagnose and treat a variety of conditions, but the process of obtaining results is a complicated one with many opportunities for error. Errors may be classified based on the phase of testing in which they occur. Pre-analytic errors occur before the specimen reaches the laboratory or before the analysis has begun.[20] These are errors in the processing or handling of the specimen and include incorrect specimen labeling, incorrect patient, insufficient sample size, or improper collection or transport.[20] Post-analytic errors occur after sample processing with the communication of test results.[20] Additionally, errors may occur during the analysis or testing phase within the confines of the laboratory.

A recent review of incident reports from EDs within PECARN demonstrated that laboratory errors were second only to medication errors and that the majority of these errors occurred in the pre-analytic phase.[19] Certain technological interventions, such as bar coding patient identifiers and specimens, have proven to reduce error.[21] The majority of errors, however, are due to human factors and failure to adhere to standard procedures[19,22] and as such require behavioral interventions. More investigation is needed to better determine the incidence of laboratory

error in pediatric emergency care and identify additional strategies to prevent error.

COMMUNICATION ERROR

Case 3

It is change of shift for the intern covering the Pediatric ED, and he has four patients to handoff to the oncoming resident. He discusses the case of an 18-month-old presenting with cough and advises that the oncoming resident follow-up on a chest x-ray that had been ordered. He neglects to mention that the patient has sickle cell disease. The new resident takes over and the patient subsequently develops fever; the resident attributes this to a viral syndrome and discharges the patient without any further work-up or treatment.

Handoff of patient care occurs regularly in the ED setting and is known to be a high-risk event with implications for patient safety.[23] Miscommunication is a leading cause of medical error and contributes to two-thirds of sentinel events reported to the Joint Commission.[24] Consequently, there has been an increased focus on improving the handoff process in recent years, and residency programs are increasingly implementing formal handoff training and evaluation of trainee handoff.[25]

One proposed solution to improve transition of care has been the implementation of standardized handoff tools or checklists, which have been shown to improve communication and reduce medical errors in both the ED and inpatient settings.[26,27] There is no consensus on the optimal tool for inter-shift handoffs in the ED, however, it is an area of active investigation.[23] Additional areas of research include assessment and optimization of handoff location (patient's bedside vs provider workstation), handoff team (provider-to-provider vs multidisciplinary) and handoff mechanism (computer-based vs written vs verbal).[28] Suggested practical strategies to improve transitions of care include limiting the number of unnecessary handoffs, reducing interruptions and distractions during the sign-out period, and encouraging questioning and an open dialogue during the handoff communication.[28]

DIAGNOSTIC ERROR

Case 4

A fully-immunized, previously healthy 10-month-old presents to the ED in January with fever and increased work of breathing. Vital signs demonstrate fever, tachypnea, and tachycardia. He is given an antipyretic and his fever improves, however his heart rate remains elevated. He is discharged and his father is given instructions for supportive care for presumed viral bronchiolitis. He presents to the ED again several hours later with signs and symptoms of heart failure that are ultimately attributed to myocarditis.

The emerging field of diagnostic error research has been called the "next frontier" for patient safety.[29] Multiple definitions of diagnostic error have been proposed, with NASEM describing it as "a failure to establish an accurate and timely explanation of the patient's health problem(s) or communicate that explanation to the patient."[4] Diagnostic errors have been challenging to study as they are difficult to define in practice and are often unreported by both patients and medical providers.[29-31] This may be even more common in the ED setting, where providers care for patients they are unlikely to encounter again and typically receive little formal feedback or follow-up about missed or incorrect diagnoses.[32]

Diagnostic uncertainty is intrinsic to the ED, making it an appropriate environment in which to study error. Yet there remains a paucity of data related to the incidence of diagnostic error in pediatric emergency medicine. Recent efforts have been made to quantify it in subsets of the population; Warrick found an incidence of 5% misdiagnosis in children presenting with acute illness to a community hospital in the United Kingdom.[33] Based on an assumed 5% error rate and 25 million annual pediatric ED visits, it has been suggested that at least 1 million children experience diagnostic error each year.[30] Though not specific to pediatric emergency medicine, a recent survey of US academic and community pediatricians, including subspecialists, found that over half (54%) self-reported making a diagnostic error at least once or twice per month.[34]

Review of pediatric malpractice cases from the previous decade reveals diagnostic error to be the most common cause of litigation.[35,36] A 2018 study by Glerum offered insight into the leading diagnoses associated with medical error, citing cardiorespiratory conditions, appendicitis, and disorders of the male genital organs (testicular torsion) as the most common conditions in pediatric emergency malpractice suits.[35]

In order to prevent such diagnostic errors, it is important to understand why and how they occur. Graber classifies causes of diagnostic error into three major categories: no-fault errors, systems errors, and cognitive errors.[37] No-fault errors are those in which the disease has an unusual

presentation or where patient-related behaviors (cooperation, truthfulness) limit the diagnostic process.[37,38] Systems-related errors result from technical or organizational factors – inefficient processes or difficulties with teamwork or communication.[37,38] The third type of error is cognitive error, that is, error inherently related to the faulty knowledge, data gathering, or synthesis by the physician.[38]

Cognitive biases are suspected to play a major role in cognitive errors, which in turn cause diagnostic errors.[37] While cognitive biases may be related to faulty knowledge or skills, they are more commonly related to errors in data gathering and synthesis.[37-39] Biases common to clinical medicine are summarized in Table 1.

Cognitive biases are often unrecognized by medical providers, making them difficult to correct or address.[39] Proposed solutions aim to improve providers' metacognitive skills or situational awareness, that is, training physicians to recognize their cognitive biases along with strategies to correct them.[40] Methods for identifying and overcoming cognitive bias and reducing diagnostic errors are active areas of research. Croskerry notes "exploring and cultivating debiasing initiatives should be seen as the next major research area in clinical decision making."[41]

The field of diagnostic error research is still in its infancy. Such research is complicated by the fact that the causes of diagnostic error are multifactorial. Cognitive error is perhaps the most common but least studied cause of diagnostic error. One promising approach to understanding and correcting cognitive error is through the lens of cognitive biases. Approaches to better understand the epidemiology of diagnostic errors in the pediatric ED setting, contributory factors that predispose to diagnostic mishaps, harm from such events, and indeed mapping the entire diagnostic process need to be undertaken. Such efforts will require a multidisciplinary approach with involvement of ED clinicians, human factor engineers, data scientists, safety experts, and patients. Importantly, such approaches need to be contextualized to the care setting because the diagnostic process varies by the care setting and the system vulnerabilities are likely to vary as well. Recent literature in the field of diagnostic error describes the first conceptual model of the diagnostic process in the ED and highlights its unique characteristics that might give future investigators a basis for conducting more rigorous research in emergency and acute care for adult and pediatric patients.[42]

TABLE 1 Common cognitive biases.

Common cognitive biases	
Affective bias	Allowing emotions or stereotypes to interfere with a diagnosis
Anchoring bias	Making a diagnosis based on initial presenting features and failing to reconsider the diagnostic impression when more information is presented
Availability bias	Making a diagnosis based on cases most recently encountered; preferentially recalling recent diagnoses and diseases
Confirmation bias	Accepting only evidence that supports the suspected diagnosis and ignoring data that contradict it
Overconfidence bias	Tendency to remain confident in the diagnosis regardless of accuracy; believing no one knows more than one does
Premature closure	Narrowing the differential diagnosis before considering all evidence and failing to consider alternative diagnoses before the evaluation is complete

SUMMARY

Medical errors are a leading cause of patient morbidity and mortality. Errors in pediatric emergency medicine care include those related to medication dosing and administration, laboratory evaluation, communication, and diagnosis. Diagnostic errors are perhaps the most common but least studied type of error. Continued research is needed to better quantify, characterize, and prevent medical errors.

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