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Don’t Wait to Collect an Accurate Weight: A Case of Subtherapeutic Insulin Therapy

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The Case

A 16-year-old girl with type 1 diabetes presented to the emergency department (ED) complaining of dizziness, fatigue and a “high” reading on her home blood glucose monitor. Initial laboratory tests suggested diabetic ketoacidosis (DKA), consistent with the clinician’s impression that the patient's insulin pump was malfunctioning. Despite aggressive treatment with insulin drip at a basal rate of 0.1 unit/kg, her blood glucose remained high and the anion gap closed much slower than expected, given that this patient had a history of DKA episodes that had previously responded rapidly to insulin infusion.

Late on day 2 of the admission, it was discovered that the admitting nurse and resident in the pediatric intensive care unit (PICU) had used the patient weight recorded in the ED to calculate and verify the insulin drip rate. Their rationale was that it was late, and the patient was tired when she arrived to the PICU. Her actual weight was 30 kg more than the weight documented in two different electronic health record (EHR) systems. Root cause analysis revealed that the weight in the ED had been marked as "stated" by the patient, which the patient verified when asked, but she had simply guessed at what she might weigh. Once the patient's weight was corrected and her insulin dose was adjusted, she improved quickly and her DKA resolved within 12 hours.

The Commentary

By Brittany Newton, PharmD, and Roslyn Seitz, MPH, MSN

Treatment of DKA is characterized by aggressive administration of intravenous fluids, replacement of electrolytes, identification of an underlying cause, and treatment with insulin.[1] Insulin is commonly administered as a continuous intravenous infusion based on patient weight measured in kilograms (kg). The National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) recommends a documented metric weight of each patient at admission, and during outpatient and ED

encounters, and to avoid the use of stated, estimated or historical weights.[2] However, estimated weights are not unusual in the ED where quick, actionable data are highly valued and often considered acceptable. In this patient's care, the failure of the ED to obtain an accurate weight led to underdosing the insulin infusion and suboptimal fluid resuscitation. This error carried over to the PICU resulting in delayed resolution of DKA, increased PICU length of stay, and potential long-term sequelae of severe hyperglycemia.

EDs are high-risk environments prone to medication errors, particularly for pediatric patients. Factors such as weight-based dosing, a hectic and distracting environment, and frequent transitions of care contribute to this issue.[3] A study from one children's hospital ED and two general hospitals found that pediatric weight errors were rare (0.63% of encounters); however, approximately one third (34%) of these weight inaccuracies led to medication dosing errors.[4] Although weight errors may be rare, they have a high potential for causing significant harm and often persist into the inpatient setting.[5] In a study of 326 pediatric dose-related safety events from Pennsylvania, 15% involved using wrong information in the dose calculation, as in this case. This study noted that technology optimization had the potential to address 82% of the dose calculation issues, suggesting that weight-based errors are preventable.[6]

For this patient, the transfer between care settings (ED to PICU) also necessitated a transition between two EHR systems, creating an opportunity for communication errors. A common reason for supporting dual EHRs within an organization is the ability to tailor the display of data for inpatient care versus outpatient care, but these displays are vendor-specific, so clinicians who work in one setting may not be familiar with displays used in the other setting.[7] There is a paucity of literature on the implications of dual EHRs on rates of medication errors, but authors with this experience report that any benefits must be weighed against the risk of missing information and any corresponding patient safety decision support (e.g., alerts, dosing guidance, documentation templates, etc.)[7] It was not apparent until this medication error was investigated that the weight for the patient was documented as "stated" by the patient rather than an actual weight, potentially due to lack of interoperability between the EHRs.

A nationwide survey identified that most physicians do not have accessible scales for patients with chronic, significant mobility limitations, placing this population at increased risk of weight-related medication errors.[8] Although this patient's body mass index and/or body habitus were not reported, patients with higher weights have been observed to be at increased risk for weight-based medication errors in the ED because clinicians either underestimated their patients' weights or were uncomfortable with very high weight-based doses.[9] Finally, it is important to note that disparities in safety events for Black and Hispanic children have been observed.[10] More research is needed examining whether weight errors and other dosing errors contribute to racial and ethnic disparities in pediatric patient safety.[11]

Approaches to Improving Safety

Optimize Human Factors Engineering

Clinicians in both the ICU and ED care settings failed to obtain an accurate patient weight indicating hospital-wide barriers to this technically simple but sometimes labor-intensive task. Designing a work environment that considers staff capabilities and limitations is key to occupational safety.[12] Structural barriers to obtaining an accurate weight are similar across ED and inpatient settings and include the

location and availability of functioning scales (stretcher or standing) and sufficient nursing support staff.[5,13] Obtaining weights in the ED and ICU can also pose significant safety risks as patients may have multiple intravenous catheters, surgical drains, or ventilation tubes, or may require stabilization due to trauma or acute complications. The NCCMERP recommends having appropriate metric scales (standing, chair, beds/stretchers with scales, built in floor scales) available wherever patients are admitted or encountered.[2] Cost and space are important considerations to addressing structural barriers. Built-in bed scales are convenient but are also costly. Ground-based bed scales are an alternative but more time-intensive as staff must obtain a comparison weight with the bed and positioning elements.[14] This patient's late arrival to the PICU and their fatigue were cited as reasons for not obtaining an accurate weight. Addressing human factors engineering by having appropriate support staff and accessible, functioning scales should facilitate obtaining accurate weights.

EHR Optimization

Consider EHR Forcing Functions and Standardization to Eliminate Estimated and Self-reported Weights

Forcing functions can prevent a user from performing an undesired or unsafe function, such asentering a self-reported weight. A forcing function to eliminate self-reported weights can be employed at two decision points within the EHR, at triage or hospital admission and when ordering high alert weight-based medications, such as insulin. Forcing functions are considered a highly effective strategy in creating change, although they may also have unintended consequences when workarounds become necessary (e.g., when the available scale(s) are broken).[15] A 2017 study found that pairing forcing functions with improved availability and maintenance of scales, along with ongoing nursing education and leadership, increased the percentage of patients with actual documented weights from 19% to 91%.[5] Notably, forcing functions were deemed necessary to achieve the final improvement step, from 60% to 91%.[5]

Lastly, standardization of the nursing workflow has proven to be a strong intervention to improve quality in certain settings.[15] Adding an actual weight (and disallowing estimated weights) to the process of triage and PICU admission is an example of standardization intended to improve the consistency and reliability of data collection. An experienced pediatric nurse, clinician, or medical assistant may also recognize when a weight seems inconsistent with the appearance of the patient, as in this case.

Address Limitations Associated with Dual EHRs

The primary challenge of utilizing more than one EHR is mitigating patient safety risks while balancing institutional costs, optimizing user experience, and appropriately integrating data. In this case, dual EHRs may have played a role in facilitating this weight-based dosing error when the patient moved from an outpatient to inpatient care setting.

Potential solutions to mitigate risk include a web view of data in all EHRs (e.g., a graphical front-end interface) accessible from whichever EHR is being utilized.[7] Automatic transmission of data from one EHR to another can also be implemented; however, considerable information technology work is necessary to ensure that all data flow appropriately, with correct labeling. Lastly, some dual EHR institutions have policies requiring that providers consult both EHRs for patient data, but it is unclear if this redundant expectation is actually feasible in clinical practice.[7] An intimate understanding of the challenges posed by

using dual EHRs is a critical first step in preventing errors during transitions of care.

Incorporate Clinical Pharmacists in the ED

The Joint Commission Standard for Medication Management states that all medication orders should undergo prospective order verification review by a pharmacist prior to dispensing and administering, with limited exceptions.[16] For example, “if waiting for pharmacy review would create a delay that could result in patient harm” or “a licensed practitioner (LP) controls the ordering, preparation, and administration of a medication,” then autoverification technology within the EHR may be used instead to verify the accuracy of the order. About three-quarters of hospitals report utilizing EHR-based autoverification tools to obviate the need for pharmacist review of every medication order.[17]

Despite the widespread use of autoverification, little guidance exists on how best to tailor it to the needs of the institution while maintaining high standards for medication safety. The Institute for Safe Medication Practices (ISMP) has expressed support for autoverification as long as the EHR algorithms account for allergies, interactions, high-alert medications, and patient weight, and as long as autoverification is used for specific medications or order sets, such as ED triage orders, not to all orders in those locations.[17] Pharmacists’ presence in the ED to review medication orders in real time was shown to reduce medication errors by about two-thirds in one hospital.[18] The American College of Emergency Physicians (ACEP) advocates for the addition of pharmacists within the ED, recognizing that high-risk groups such as children may benefit from their expertise.[19] Children are especially susceptible to medication errors given their constant growth; pharmacists are encouraged to obtain an actual weight during every visit for accurate dosing calculations.[20]

In this case, it is not clear whether a pharmacist was present in the ED to perform prospective order verification. However, it is plausible that a pharmacist would have intercepted this medication error involving a patient-reported weight rather than actual weight. Recognizing the inherent risks of medication errors in the ED setting, hospitals should consider restricting which orders qualify for autoverification, and requiring pharmacists to review orders for all high alert medications, such as insulin, in non-crash situations.

Identify and Combat Automation Complacency

Cognitive biases are implicated in errors across the clinical spectrum.[21] The tendency to over-rely on automated functions, known as automation complacency, is a form of cognitive bias that will likely play an increasingly important role as healthcare systems continue to integrate clinical decision support (CDS) into day-to-day tasks. Although CDS initiatives eliminate some opportunities for error, they also create an environment prone to automation complacency. The admission process involves a mix of automatized and manual tasks during a time of high task load.[22] CDS automates the multistep process of insulin ordering by calculating the infusion rate based on documented weight. In this patient’s case, an inpatient insulin infusion order was created utilizing a self-reported weight that was 30 kg less than the patient's actual weight. Notably, CDS is unable to audit the accuracy or quality of the weight input in the system, so the CDS fails when the input data are incorrect.

One intervention described in the literature (and consistent with NCCMERP recommendations[2]) is an interruptive alert that is triggered when there is a difference greater than 10% between a newly recorded weight and historical weights, or if more than 7 days have lapsed since the last weight entry. By utilizing this intervention, one study found that the frequency of medication orders for which the dosing weight differed significantly (>10%) from the recorded weight decreased from 13.1% to 9.5%.[23] Automation complacency can also be addressed with teaching to help clinicians become aware of the risks associated with automation and to appreciate the benefits of slowing down to reflect on medical decision-making.[22]

Take-Home Points

- Minimize barriers to obtaining an actual weight during patient encounters. This includes ensuring that appropriate metric scales (standing or weighted stretcher scales) are readily available and accessible in most patient care areas, including outpatient clinics, EDs, and inpatient units.
- Optimize EHR functionalities by employing “forcing functions” to eliminate the use of self-reported weights and standardize processes for obtaining weight during triage and admission.
- Consider information technology enhancements to ensure that clinical data translate and display correctly when using dual EHR systems within a hospital.
- Utilize clinical pharmacists in the ED to provide an additional layer of medication safety by prospective order verification. Use of autoverification should be minimized for the pediatric population and high-alert medications.
- Address automation complacency through education, double checks, and interruptive alerts to notify practitioners of large variances from historically documented weights.

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