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Accurate Dosing Weight: When the 10% Really Matters

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Abstract. Introduction: Children are at increased risk of medication-associated adverse events, often due to weight-based dosing errors. We aimed to reduce the proportion of medications that were administered where the dosing weight was ≥ 10% different from the recorded weight. Methods: We adopted in-situ usability testing to iteratively improve design of clinical decision support that would enable accurate dosing weight documentation by prompting clinicians to update weight if recorded weight was > 10% different and it had been at least 7 days since the last dosing weight update. Results: The proportion of medication administrations with difference >10% between their recorded weight and dosing weight decreased from 13.1% (56,256/ 429,006) in the baseline period to 9.5% (35,560 / 372,443) in the intervention period ($P < 0.001$). Discussion and Conclusion: User-centered design of an interruptive alert improved the accuracy of dosing weights during medication administrations without substantial alert burden. In-situ usability testing is an effective approach to rapidly obtain feedback from frontline users and iterate on the design to effect desired behavior changes

Keywords. Clinical decision support, medication safety

1. Introduction

Children are at increased risk of medication-associated adverse events, often due to weight-based dosing errors [1]. Many pediatric medications are dosed by weight (e.g. 10mg/kg/day divided two times a day), thus appropriate dosing requires multiplication by the correct patient weight. Certified pediatric electronic health records (EHRs) largely maintain separate fields for the "dosing weight" (what gets multiplied by the dose) and the most recently recorded weight because of physiologic situations in which the current weight and dosing weight are appropriately different – for example newborn infants generally lose weight in the first 1-2 weeks of life, but the volume of distribution for medications at that age is based on the birth weight. Similarly, fluid overload, dehydration, obesity, and other clinical situations can lead to clinically appropriate discrepancies between dosing and current weights.

However, separating fields for dosing and current weight can lead to inappropriate discrepancies due to data entry issues, forgetting to update, or other workflow difficulties. Inaccurate dosing weights are a source of medication dosing errors and even when the overall incidence of inaccurate dosing weight is low; the incidence of potential harm from medication errors when dosing weight is inaccurate is higher [2]. The National Coordination Council for Medication Error Reporting and Prevention recommends

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automated clinical decision support (CDS) rules to alert practitioners to significant changes in patient weight. At our institution, we maintained system policies that directed when dosing weight should be updated, but there was no consistent practice of updating dosing weights. We also had no metrics to determine policy adherence or any prompts to address patients who had increases in weight over time that met the threshold for updating dosing weight.

In this study, we aimed to reduce the proportion of medications that were administered where the dosing weight was > 10% different from the recorded weight through an interruptive alert that would fire upon chart open for hospitalized children when (1) the dosing weight and most recently recorded weight were > 10% different and (2) it had been at least 7 days since the last dosing weight update.

2. Methods

2.1. Setting

This study was conducted at a large pediatric health system in the greater Atlanta area with more than 2,600 pediatric providers and 638 licensed beds. This study was deemed Non-Human Subjects Research by the institutional review board as a quality improvement initiative.

2.2. Clinical Decision Support Design

We developed a candidate alert design to reduce weight discrepancies based on heuristic design [3]. We then adopted in situ usability testing to iteratively improve design of the alert [4,5]. We identified participants in real clinical settings who appeared not to be too busy and asked for 10 minutes of their time to improve EHR design. We then provided participants verbally with a realistic clinical scenario and observed how they interacted with the alert in a test EHR environment. We followed a think aloud protocol,[6] and at the end of each simulation, we debriefed to understand how we could improve the design of the alert. To allow for swiftness in participant recruitment, testing, and rapid improvement in design, we did not formally record conversations with participants. We adopted member checking notes at end of the testing sessions to validate insights we had gathered and inform design updates [7]. The alert ran in the background from Jul 5 2022 prior to go-live (Aug 23 2022) to verify functionality and accuracy while assessing for potential alert burden.

2.3. Evaluation

The CDS was evaluated using a pre-post design. Our ultimate outcome measure was medication errors of severity ≥E on the NCC MERP scale, however this was felt to be too rare for iterative improvement cycles. Instead, we focused on the process measure of medication administrations while the dosing and most recently recorded weight were >10% different. We also followed balancing measures including (1) number of alert firings per week and (2) alert acceptance rate (i.e., users acting on alert and changing dosing weight). Metrics were compared pre- vs. post-implementation using X^2 tests.

3. Results

3.1. Usability Testing

Six providers (1 Resident, 1 Advance Practice Provider, 4 Attendings) participated in in-situ usability testing. Five out of six participants liked the alert but had suggestions to improve it. These included (1) additional acknowledgement reasons for fluid overload and an option to indicate "will verify weight before changing", (2) reword acknowledgement for sensitive medications, and (3) link to growth chart to assist with alert interpretation in context. Prior to the simulations, none of the participants were aware of the policy asking to update dosing weight when the difference is >10%. In simulation, four of the six participants did not change the dosing weight. Of these, 3 wanted to suppress the alert temporarily to verify the new weight before making dosing weight changes, while the 4th participant worried about the effect of a dosing weight change on the need to recalculate dosing for all drips to keep the same volume, but they nonetheless felt the alert was helpful to remind them to think about adjusting dosing weights. The one participant who did not like the alert felt it was unnecessary as they always updated the dosing weight. The screen shot of the alert after redesign is shown in figure 1.

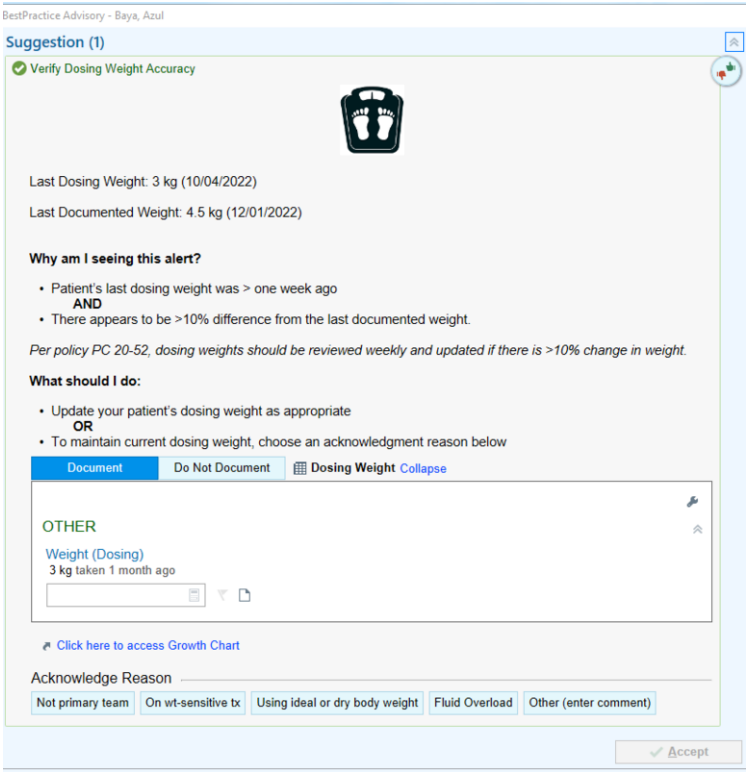

Figure 1. Redesign of the alert after formative testing.

3.2. Intervention Results

Process Measure: The proportion of medication administrations with difference > 10% between their recorded weight and dosing weight decreased from 13.1% (56,256/429,006) in the baseline period to 9.5% (35,560 / 372,443) in the intervention period (Figure 2, $P < 0.01$). Balancing Measures: Between 08/23/22 to 02/28/23 the alert fired 3,451 times on 1,378 unique patient encounters with alert acceptance rate of 15.4% (545/3,541). The most common alert override was the users indicated not being on the primary team 44% (1,558) of firings. Other reasons included using ideal body weight (7%; 243), on sensitive treatment (5%; 179) and fluid overload (5%; 168).

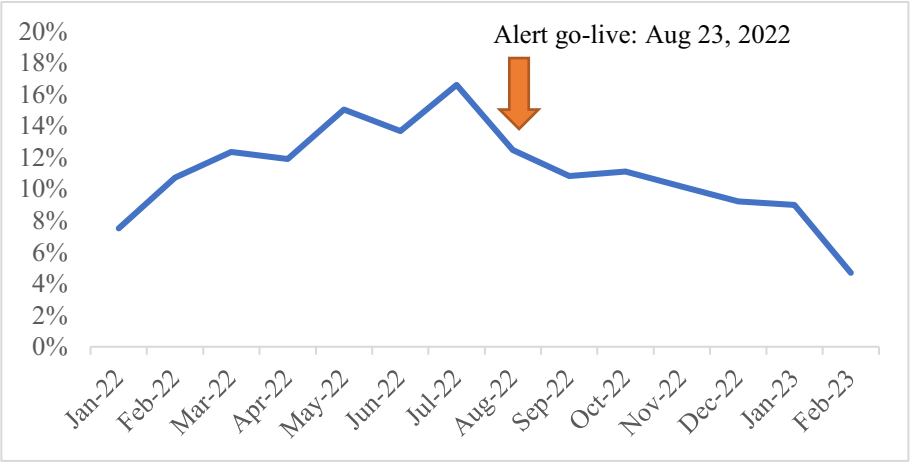

Figure 2. Percent medication administrations given while dosing weight > 10% different from recorded weight.

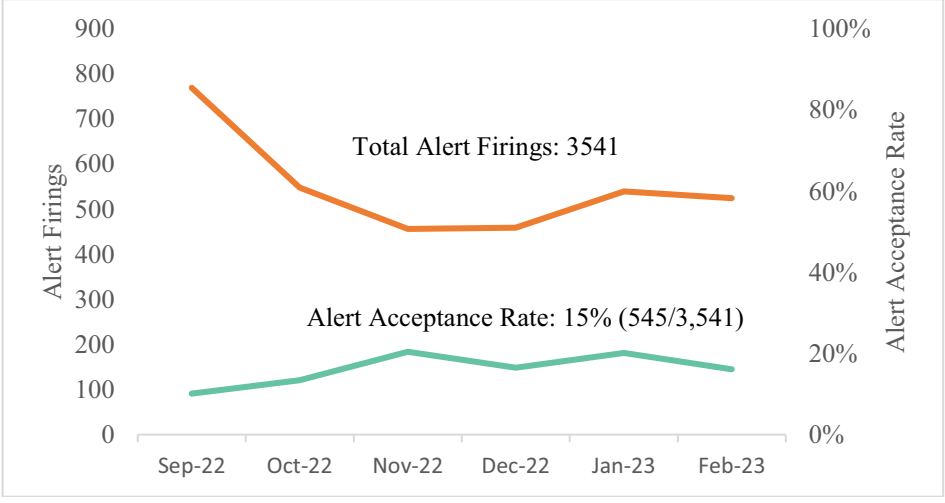

Figure 3. Alert Performance

4. Discussion

User-centered design of an interruptive alert improved the accuracy of dosing weights during medication administrations without substantial alert burden. In-situ usability testing incorporated frontline users who may otherwise be not available to provide feedback. It allowed us to rapidly iterate on the design to effect desired behavior changes. Running interruptive alerts in the background prior to implementation can ensure appropriate targeting as designed. Primary reasons for alert override and non-adherence to the recommendation included display of the alert to non-primary team, intentional use of ideal body weight, or when the patient is on weight sensitive titration or has fluid overload. The design elements identified for CDS in inpatient setting supplements existing recommendations on using CDS to address weight-based dosing errors.[8]

Limitations: This study was done at one health system. Further, it remains unknown if this reduction in medication administrations with discrepant weights affects the rate of serious medication errors, which are rare events.

5. Conclusions

The study showed improvement in accurate dosing weight documentation thus reducing potential medication errors. In-situ usability testing is an effective approach to rapidly obtain feedback from frontline users and iterate on design for improvement.

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