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# **Pediatric Health Assessment Tracker: A Quality Improvement Initiative to Obtain Weights Consistently and Appropriately in a Tertiary Pediatric Intensive Care Unit**

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#### ABSTRACT

Introduction: Weight is vital for tracking fluid status and nutrition and assuring patients have accurate dosing weights in the pediatric intensive care unit (PICU). Challenges in acquiring weights in critically ill patients include clinical instability, limited equipment, and lack of appropriate orders in the electronic medical record (EMR). Methods: We implemented interventions that targeted EMR weight orders and actual collection of weights in the 42-bed PICU of a children's hospital. Preintervention data were collected from February to March 2023 for all patients admitted to the PICU with a length of stay (LOS) ≥3 days. We surveyed PICU nurses to identify barriers to collecting weights. Interventions included a multidisciplinary team approach, safety checklist, nursing education, and automatization of weight orders. The study team monitored the number of patients with weight orders and weights obtained as ordered twice weekly from March 2023 to April 2024 using statistical process control charts. Results: There were 1728 patient instances of LOS ≥3 days. Preintervention data showed 70.4% of patients with appropriate weight orders and 35.5% with weights obtained. Implementing a safety checklist, nursing education, EMR changes, and automatizing weight orders, the centerline for weight orders shifted to 94.3% and for weights obtained to 69.5%. Reminder emails to all ICU providers and nursing check-ins maintained the centerline. No increase in unplanned extubations occurred. Conclusions: Through interventions involving rounding providers, nurses, and the EMR, the frequency of weights ordered and obtained in a busy PICU sustainably increased. (Pediatr Qual Saf 2025;10:e791; doi: 10.1097/pq9.0000000000000791; Published online January 16, 2025.)

## **INTRODUCTION**

Obtaining accurate weights in critically ill SAFETY pediatric patients is essential to patient care. Obtaining regular and accurate weights in the pediatric intensive care HEALTH . unit (PICU) is challenging, but the

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is a clinical marker of fluid overload, which is associated with increased mortality,4 and of nutritional status, which is especially important for critically ill children who are at high risk of entering a starvation state.5

cation dosing, and inaccurate weights place

patients at risk for both overdosing and

underdosing of medications.<sup>1</sup> Patient

weight also affects the tidal volume

selected on the ventilator.<sup>2</sup> An inappro-

priate tidal volume puts patients at risk

for volutrauma or the development of

microatelectasis, resulting in lung injury.<sup>3</sup>

Furthermore, change in weight over time

Surveys have demonstrated that obtaining weights is considered important by bedside staff and providers in the ICU, but multiple barriers exist to obtaining weights safely.<sup>6,7</sup> Additional investigations have evaluated weight estimation in the ICU setting, but this is a poor surrogate for obtaining a true weight.<sup>8</sup> However, advances in the tools currently available to obtain weights are promising. For example, data suggest that bed scales are as accurate as standing scales.<sup>9</sup> Despite the widespread recognition of the importance of obtaining weights and increasing availability of tools to obtain accurate weights, little published data exist describing successful projects to increase the frequency with which weights are obtained in the PICU.

Specifically in our ICU, obtaining weights beyond an initial weight on admission is challenging, causing delays in the assessment of fluid status and preventing dosing weights from being updated to reflect accurate changes in our patients. Using quality improvement (QI) methodology, a multidisciplinary group was formed to evaluate the barriers to obtaining weights and to implement strategies to increase the frequency with which weights were obtained safely. The overall goal was to build a sustainable strategy, with minimal cost to the unit, to weigh our patients as often as needed to better track their health status across time in the PICU. This goal was balanced with monitoring unplanned extubations to assure that the movement associated with obtaining weights did not lead to increased endotracheal tube dislodgement.

# MATERIALS AND METHODS

## Setting

This QI initiative occurred at the PICU of Monroe Carell Jr. Children's Hospital at Vanderbilt University Medical Center in Nashville, Tenn. The PICU is a 42-bed combined medical/surgical unit in a tertiary care pediatric hospital. The PICU receives approximately 3,000 admissions annually. The hospital primarily serves the wider central Tennessee area and is a large referral center for east Tennessee and southern parts of Kentucky.

# **Ethical Considerations**

This project was approved by the Vanderbilt University Medical Center institutional review board (230258).

## Multidisciplinary team

We created a multidisciplinary team composed of PICU providers and nursing leaders. PICU providers met at least every other month and nursing leaders joined quarterly. Nursing leaders helped reinforce bedside nursing-based interventions, whereas PICU providers reinforced providerbased interventions. At the start of the project, we sent surveys to bedside nurses to assess current barriers to obtaining weights in the PICU, the perceived level of importance in acquiring weights, and changes that would make weighing patients easier. We used QI methodology to design a key driver diagram (Fig. 1) and perform plan-do-study-act cycles based on analysis from the preintervention nursing surveys, discussions with nursing leadership, and published data on the subject.

## Project Name

Pediatric Health Assessment Tracker was chosen as the name for this project to ensure it would be memorable amid multiple ongoing quality projects. The name describes the importance of serial weights for PICU patients.

# Study of Interventions

We collected baseline data prospectively from February 2023 to the implementation of the first intervention in March 2023. Data were collected through April 2024.



**Key Driver Diagram** 

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All patients admitted to the PICU with a length of stay  $(LOS) \ge 3$  days were included for data analysis. Members of the study team gathered data twice weekly. We collected data from the electronic medical record (EMR), which included the number of patients admitted to the PICU with an LOS  $\geq$ 3 days, the number of patients with appropriate weight orders, and the number of patients with weights acquired and recorded as ordered. A weight order was defined as appropriate depending on the patient's age and diagnosis. For patients who were younger than 6 months of age, at high risk for fluid overload, admitted for failure to thrive, or who had received an organ transplant, weights should be ordered daily. If a patient was older than 6 months and on mechanical ventilation, then weights were routinely ordered and obtained on Monday, Wednesday, and Friday. For all other patients, weights were ordered at least once weekly. We considered a patient to have the weights obtained as ordered if the number of documented weights matched or exceeded the number in the weight order since the last data collection. If a patient did not have an appropriate weight order or had no weight order, then it was not considered possible for the weight to have been obtained as ordered. LOS of  $\geq 3$  days was chosen as all patients have a weight on hospital admission, and patients admitted for less than 3 days often do not have clinically significant changes in their weight. Given the nursing resources necessary to obtain weights, we prioritized obtaining weights in patients for whom it would be most clinically impactful. Preintervention and postintervention data were collected and recorded in a secure database. Statistical process control charts were used to track outcomes and balancing measures. Standard rules were used to evaluate for evidence of special cause variation.

## **MEASURES**

#### **Primary Outcomes**

Primary outcomes were the percentage of patients with a LOS  $\geq$ 3 days with weights ordered as per protocol in the EMR and the percentage of patients with a LOS  $\geq$ 3 days with weights obtained as ordered.

#### **Balancing Measure**

The rate of unplanned extubations was selected as a balancing measure and documented every month during the study period. Our preintervention period included February to March 2023, and postintervention included April 2023 to April 2024. We used a statistical process control chart to depict these data and standard rules to evaluate for special cause variation.

In initial nursing surveys, "patient too critically ill," "patient safety concerns," and "lack of staffing" were identified as perceived barriers to obtaining weights. Commonly, nursing staff cited an inability to safely obtain weights in high acuity mechanically ventilated patients due to concern for endotracheal tube dislodgement leading to an unplanned extubation, a significant complication and safety event. There was a perception that the consequences of an unplanned extubation while obtaining a weight was greater than the need to obtain a weight for clinical decision-making despite mechanically ventilated patients having a greater risk for fluid overload and malnutrition. We sought to show that weights could be obtained at a higher frequency without leading to an increase in safety events in the most critically ill patients.

#### Interventions

Interventions were determined from multidisciplinary discussions and based on nurse survey results, which specified barriers to obtaining weights and recommendations for obtaining them more consistently. Prioritization was given to interventions that did not require increased staffing or the purchase of new equipment because the goal was to intervene sustainably without a committed budget. Interventions of implementation are listed later. Plan-dostudy-act cycles began each set of interventions, during which the team tested new interventions via small tests of change-before adopting new practices. During these cycles, the safety checklist underwent multiple revisions, culminating with an EMR version of the checklist that could be filled out electronically and refreshed daily. The final safety checklist used is a universal list of precautions for ICU patients, including a review of indwelling lines, laboratory orders, need for IV medications, and assurance that weights are ordered and obtained appropriately. (See Figure 1, Supplemental Digital Content 1, which describes final safety checklist. http://links.lww.com/PQ9/A633.)

- We implemented the first iteration of the safety checklist in the PICU, which verified that the patient had up-to-date dosing weight.
- "Weights on Wednesdays" moniker was adopted, and educational flyers hung with this slogan throughout ICU.
- A second iteration of safety checklist was implemented, which included weight orders.
- Nursing educational huddle discussion of the importance of obtaining weights.
- First reminder email sent to providers with information about ordering weights appropriately.
- Second reminder email to providers.
- The admission order set changed to add an automatic weekly weight order and guidance on when to order more frequent weights; the weight order modifiable within the order set to fit patient needs.
- Safety checklist incorporated into PICU provider EMR.

# RESULTS

Table 1 describes the unit and demographic characteristics of the PICU during the study period. Patients were included if they met criteria by length of stay and were

# Table 1. Unit and Demographic Characteristics of the PICU, March 2023–April 2024

| Unit Characteristics                                       |                  |
|--|------------------|
| Total No. beds, n  | 42               |
| Total admissions, n  | 3,192            |
| Total admissions w/ LOS ≥3 d, n                            | 906              |
| Average daily census, $n \pm SD$                           | $34.8 \pm 5.9$   |
| Peak average daily census per month                        | 44               |
| Median length of stay, d, n [Interquartile<br>Range (IOR)] | 1.6 (0.9, 3.5)   |
| Median mechanical ventilation days per                     | 170 (154, 222)   |
| month, n (IQR)   |                  |
| Peak mechanical ventilation days per month                 | 395              |
| Median PICU Continuous Renal Replacement                   | 20 (16.5, 33.5)  |
| Therapy patient days per month, n (IQR)                    |                  |
| Total PICU Extracorporeal Membrane                         | 37               |
| Oxygenation (ECMO) runs                                    |                  |
| Unplanned extubations per 100 vent days,                   | $0.733 \pm 0.73$ |
| n ± SD   |                  |
| Demographic characteristics                                |                  |
| Median age, y, n (IQR)                                     | 4.8 (1.1, 12.8)  |
| Median weight, kg, n (IQR)                                 | 17.2 (9.1, 43.0) |
| Female, n (%)  | 1,412 (44.2%)    |
| Race, n (%)  |                  |
| American Indian or Alaska Native                           | 7 (0.2)          |
| Asian  | /1 (2.2)         |
| Black  | 496 (15.5)       |
| Native Hawalian or Other Pacific Islander                  | 15 (0.05)        |
| Uner/Mixed   | 437 (13.7)       |
| Unspecified  | 1 002 (62 4)     |
| VVIIILE  | 1,993 (02.4)     |

counted with each data collection if they remained in the ICU even if they had been included on previous data collection days. Thus, there were a total of 1,728 patient encounters evaluated from 906 unique patients. Preintervention data demonstrated that 70.4% of patients had an appropriate (as per protocol) weight order placed (Fig. 2) and that 35.5% of patients had an appropriate weight documented as ordered (Fig. 3). Through surveys, nurses reported that barriers to obtaining weights included insufficient equipment/staffing, high patient acuity, and lack of order for weights (Fig. 4). Survey results suggested that having a designated day and shift for weights and discussion of weights on rounds would increase the frequency with which weights were obtained (Fig. 4).

### **Intervention Steps**

Following the first 2 interventions of a safety checklist posted on doors and "Weights on Wednesday" signs in March and May of 2023, both interventions suggested from nursing surveys (Fig. 4), we detected special cause variation, and the centerline shifted upward in both weight orders placed (70.5%-81.2%) and weights obtained (39.8%-60.9%) (Figs. 2, 3).

Shortly after that, a second safety checklist was rolled out, which included a section detailing the presence of an appropriate weight order and if the weight was obtained. Nursing daily preshift huddles emphasized the concept of "Weights on Wednesdays" and the importance of obtaining weights. In the 2 months following these interventions, there was special cause variation with an upward shift in the centerline in weights obtained (60.8%–62.9%) (Fig. 3). No signal change occurred with weight orders placed at that time.

To help maintain appropriate weight orders and weights obtained, emails sent to PICU providers included



Fig. 2. .P chart displaying percentage of patients with appropriate weight orders.







reminders to complete the safety checklist with an emphasis on placing weight orders per protocol and assuring that nursing was recording the weights. Providers rounding at night were encouraged to verify these orders. Furthermore, nursing members of the team continued to work with nurses in acquiring patient weights, especially on Wednesdays-including reminders and help from out-of-staffing nurses. The percentage of weight orders placed maintained a mean centerline of 81.2% (Fig. 2). In December 2023, the percentage of weights obtained had a signal change with a downward shift in the centerline (62.9%–51.8%) (Fig. 3). During this time, there was an increase in daily census and ventilator days to 41 and

395, respectively (median during the study period of 34.8) patients and 170 ventilator days).

In January 2024, to encourage compliance, a reminder email went out to providers regarding the safety checklist. Additionally, new PICU resident orientation was updated to include instructions on how to place appropriate weight orders during all PICU admissions. Finally, the PICU admission order set was changed to include a preselected weight order. This defaulted to once a week on Wednesday, aligning it with the "Weights on Wednesdays" moniker, but guided providers on when to choose daily or Monday/Wednesday/Friday weights instead. Following these interventions, a signal change



Fig. 5. U chart showing unplanned extubations per 100 ventilator days per month from February 2023 to April 2024. Mean centerline is 0.7 and no special cause variation was detected. Preintervention period: February 2023–March 2023. Intervention period: April 2023–April 2024. LCL, lower control limit; UCL, upper control limit.

occurred in both weight orders placed (81.2%–90.2%) (Fig. 2) and weights obtained as ordered (51.8%–69.5%) (Fig. 3). The final intervention was making the safety checklist electronic and integrated into providers' EPIC workflows with a final signal change and upward shift in the weight orders placed centerline (90.2%–94.3%) (Fig. 2). No signal change for weights was obtained as ordered after this final intervention.

#### **Balancing Measure**

The team monitored unplanned extubations as a balancing measure due to the risk of displacement of tubes and lines when moving patients for weights. Figure 5 demonstrates that throughout the study period, the centerline for unplanned extubations remained unchanged at 0.7 unplanned extubations per 100 ventilator days per month.

# DISCUSSION

Over 14 months, the percentage of patients with an EMR weight order appropriate for their clinical condition and the percentage at which weights were obtained as ordered in the EMR increased safely and sustainably without an increase in unplanned extubations.

Streamlining the admission order set to include a prechecked weight order and frequent provider reminders helped to increase the percentage of appropriate weight orders, a barrier noted by our nurses. Accurate electronic orders are essential for many safety measures, such as reducing medication errors, improving communication, and standardizing practice.<sup>10,11</sup> It is, therefore, not surprising that when the rate of appropriate weight orders increased, so did the percentage of patients getting weighed.

Despite interventions to increase appropriate EMR weight orders, the rate at which weights were obtained continued to lag, so we designed interventions to address this. Most significantly, the multidisciplinary collaboration between providers and nurses was essential to increasing nursing buy-in to obtain weights when ordered. Nursing leadership on the team developed a system where most patients would be weighed on the night shift, with only the most critically ill or unstable patients weighed on the day shift. These same team members helped maintain progress by reminding nurses to obtain weights as ordered and to acquire weights on Wednesdays as a default while also focusing on nursing education about the importance of accurate weights. As seen in this initiative, nursing leadership collaboration has previously been shown to improve QI projects.<sup>12</sup> Nursing had also strongly indicated that barriers to obtaining weights in the PICU included a lack of staffing and insufficient equipment. Given that the goal of

this project was to increase weights without using monetary resources, these barriers were not addressed but could be an important intervention in future studies or in another institution if there was an ability to budget for this.

The safety checklist also improved weight orders placed per protocol and weights obtained. The safety checklist was part of a broader QI project to ensure key safety aspects on rounds. The checklist reminded providers to place appropriate weight orders and communicate with nurses about acquiring those weights, especially on Wednesdays. Safety checklists improve patient management plans regarding safety and quality metrics.<sup>13,14</sup>

There was a downward change in the centerline for weights obtained from December 2023 to January 2024 likely due to the higher census and number of mechanical ventilation days. The demographic and unit data in Table 1 demonstrate the high level of acuity within this PICU throughout this time period. Compared nationally, both our bed size and annual extracoporeal membrance oxygenation (ECMO) runs are significantly larger than national medians.<sup>15,16</sup> Specifically, the median number of pediatric and neonatal ECMO runs is 7 per year per center, whereas ours was 37. Due to higher census and higher acuity, nursing resources to weigh patients were likely stretched too thin to safely weigh patients consistently during these times. Barriers such as these have been noted in past studies. In a survey of ordering providers and nurses, 40% of providers and 80% of nurses indicated that mechanical ventilation and ECMO were barriers to obtaining weights in critically ill children.<sup>6</sup> Importantly, we observed no increase in unplanned extubations during times of high census or during times of higher compliance with obtaining weights.

There are limitations to this study. Although we measured weights twice weekly, variation was likely missed during some weeks. If recording had been daily, then we may have observed additional variation in the frequency with which weights were obtained. Additionally, we did not address the biggest barrier per our nursing survey: our beds cannot consistently weigh patients. Furthermore, dysfunctional scales may have led to variability in acquiring accurate weights. This was a logistically and financially challenging barrier to overcome, but future work should attempt to address it.

Additionally, despite significant improvements in weights ordered per protocol and weights obtained as ordered, nearly 30% of patients were not weighed as ordered. These patients remain at risk for inappropriately dose medications and unrecognized fluid overload. The room remains in need of ongoing improvement. Finally, we could not capture demographic or clinical characteristics of patients who were weighed versus patients who were not. This could have provided more information on the characteristics of patients who had regular weights obtained compared with patients who did not have regular weights obtained.

# **CONCLUSIONS**

Through interventions involving rounding providers, nurses, and the EMR, the frequency of weights ordered in a busy PICU increased from 70.4% to 94.3%, and weights obtained from 35.5% to 69.5% without an increase in safety incidents.

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