

Pediatric Medication Safety in Adult Community Hospital Settings: A Glimpse Into Nationwide Practice

Francisco Alvarez, MD, Lana Ismail, MD, Allison Markowsky, MD

BACKGROUND AND OBJECTIVES: Most children in the United States are treated in adult settings. Studies show that the pediatric population is vulnerable to medication errors. It can be extrapolated that children cared for in adult settings are at equal or higher risk for errors. The goal of this study was to assess the existing pediatric medication safety infrastructure within adult hospitals.

METHODS: Questionnaire developed through Research Electronic Data Capture (REDCap) and distributed to pediatric hospitalist programs listed on the American Academy of Pediatrics, Section on Hospital Medicine web site and members of the American Academy of Pediatrics Quality Improvement Innovation Networks listserv. There were >20 questions regarding the use of various safety measures and characteristics of the hospital.

RESULTS: Thirty-eight program staff and 26 Quality Improvement Innovation Networks listserv members completed the survey (total = 64). Of these, 90.6% use order sets or computerized provider order entry with pediatric weight-based dosing, 79.7% review pediatric medication safety events or concerns, 58.7% were aware that their hospital had defined or documented maximum doses on orders, and 50.0% had milligram-per-kilogram dosing required to be in the order. A majority of respondents document weights only in the metric system (kilograms or grams) in both the emergency department and the pediatric unit (84.4% and 92.1%, respectively). A total of 57.8% of hospitals had pharmacists trained in pediatrics, with hospitals with >300 beds more likely to have a pediatric pharmacist than those with <300 beds (75% vs 44%, $P \leq .05$).

CONCLUSIONS: Pediatric medication safety infrastructure shows variations within the sites surveyed. Our results indicate that certain deficiencies are more widespread than others, providing opportunities for targeted, but hospital-specific interventions.

ABSTRACT

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Address correspondence to Francisco Alvarez, MD, Division of Hospitalist Medicine, Children's National Medical Center, 111 Michigan Ave NW, Suite M-4800, Washington, DC 20010. E-mail: falvarez@childrensnational.org

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Dr Alvarez conceptualized and designed the study, performed the associated literature search, drafted the initial manuscript, reviewed and revised the manuscript, and approved the final manuscript; and Drs Ismail and Markowsky aided in the design of the study, performed the associated literature search, and wrote portions of the manuscript.

*Division of Hospitalist
Medicine, Children's
National Medical Center,
Washington, District of
Columbia; George
Washington University
School of Medicine,
Washington, District of
Columbia; and Mary
Washington Hospital,
Fredericksburg, Virginia*

Nationwide, pediatric medical care is predominantly done in adult hospitals where medication infrastructure is geared toward the adult population. This adult predominance adds risk when determining, calculating, and administering medications to pediatric patients. The Institute of Medicine noted that medication errors are the most common cause of harm in the pediatric population.¹ Various studies have looked at common pediatric medication errors, such as prescription dosage errors, preparation errors, and administration errors.^{2–17} Some of these studies found a rate of 1 in 10 hospitalized children who had some kind of medication error and others noted that as high as 35% of these were serious or life threatening.^{13–15} Currently, there is a lack of studies and understanding of the current pediatric medication safety infrastructure within adult settings that manage pediatric patients.

A recent survey by the Institute of Safe Medication Practices (ISMP) looked at common pediatric medication practices within pediatric and general hospitals. The study noted that there are gaps with following the most common pediatric medication safety practices.⁸ Developing a pediatric-specific safety infrastructure in adult settings is important to not only minimize safety events or near misses, but also for process improvements in the future.^{13,15,18,19} The limited understanding of some of the deficits within adult settings make it challenging to determine what the main focus or intervention should be (ie, education, weight-based prescribing tools, pharmacy oversight, etc). A better understanding could help prioritize resources to a specific concern and develop safety tools and structures. The goal of our study was to assess the existing pediatric medication safety infrastructure within adult hospitals to serve as a foundation for the development of safety tools and process improvement interventions.

METHODS

Study Design and Participants

An anonymous, electronic, cross-sectional survey was developed and distributed to

pediatric hospitalist program directors listed on the American Academy of Pediatrics (AAP), Section on Hospital Medicine web site in January to February 2015 and members of the AAP Quality Improvement Innovation Networks (QIINN) listserv in September 2015. An initial recruitment e-mail was sent describing the project with an e-mail link to the survey. Two subsequent e-mail requests for participation were sent during each survey period.

Inclusion criteria for participation in the survey were any individual who cares for pediatric patients within an adult hospital setting. No clarification was given if the pediatric care setting was a pediatric unit within an adult hospital, pediatric patients within an adult emergency department, or a pediatric hospital within an adult hospital. As of January 2015, there were 209 program directors listed on the Web site, and membership of the QIINN Listserv as of September 2015 consisted of >600 pediatric hospitalists and primary care physicians.

The Mary Washington Healthcare institutional review board approved this study.

Survey Design

Survey questions were determined based on studies within pediatric tertiary care centers, safety deficits within our community hospital programs, and questions within the ISMP survey. Survey data were collected and managed through the Web application, Research Electronic Data Capture (REDCap).

The survey consisted of >20 “yes,” “no,” or “I don’t know” questions regarding the use of various safety measures. The “I don’t know” option was placed in the survey to give responders the ability to not deny the existence of a safety practice (ie, answer “no”) if they were not aware of its presence. The survey also assessed characteristics of the hospital.

The survey sent out to AAP pediatric hospitalist directors stated: “This survey is intended for pediatric hospitalist directors who oversee pediatric hospitalist programs within adult institutions.” Two questions

were added to the QIINN listserv survey that screened for staff that do not manage pediatric patients within adult hospital settings and asked if they had previously filled out the survey.

Statistical Methods

For each question, the percentage of participants who answered “yes” was calculated. A Fisher’s exact test was used in the analysis. For each question, “yes” answers were compared with “no”/“I don’t know” answers and *P* values were calculated. “No” and “I don’t know” responses were grouped together to have a clearer comparison to the percentage of those who were aware of an existing safety practice (ie, “Yes”) versus the ones that did not have a specific safety practice (ie, “No”) or were not aware of it (ie, “I don’t know”).

RESULTS

A total of 38 pediatric hospitalist program staff and 26 QIINN listserv members completed the survey, for a total of 64 responses. Five geographic regions were represented: Northeast (33%), Southeast (17%), Southwest (6%), Midwest (28%), and West (16%). These regions included university- (39%) and non-university-affiliated (61%) hospitals. Hospitals varied in size with 7.8% having <100 beds, 48.4% having 100 to 300 beds, and 43.8% with >300 beds. A variety of providers cared for these patients, but they were predominantly managed by pediatric hospitalists (94%) with other providers being primary care physicians (42%), family medicine physicians (30%), adult surgeons (47%), pediatric residents (34%), and family medicine residents (33%).

Review of the data showed that 90.6% of hospitals use order sets or computerized provider order entry (CPOE) with pediatric weight-based dosing, and 79.7% review pediatric medication safety events or concerns. A majority of responders stated that they document weights only in the metric system (kilograms or grams) in both the emergency department (ED) and the pediatric unit (84.4% and 92.1%). Responders were aware of clearly defined or documented maximum doses on orders 58.7% of the time and specific

milligram-per-kilogram dosing was required to be in the order only 50% of the time. A total of 57.8% of responders had pharmacists specifically trained in pediatrics, with larger pediatric units (average daily census [ADC] >10) more likely to have a pediatric pharmacist than smaller units with an ADC ≤10 (68% vs 47%, *P* = .129).

Among statistically significant results (Table 1), those deemed to be clinically applicable are as follows. Hospitals with >300 beds were more likely to have a pediatric pharmacist than smaller hospitals (<300 beds) (75% vs 44%, *P* < .05). The use of smart pumps was more common in hospitals with an ADC ≤10 versus an ADC >10 (97% vs 76%, *P* < .05). University-affiliated programs were more likely to require specific milligram-per-kilogram dosing in the medication order (72% vs 36%, *P* < .05) and have a group or individual review pediatric medication safety events or concerns within their hospitals (96% vs 69%, *P* < .05).

Four of the sites were noted to have matching data for all demographic entries. Based on this, we assume that at most 6% (4/64) of survey responses may have been from the same site.

Our survey results demonstrated that the top 5 identified gaps included the following: documenting milligram-per-kilogram dosing, using a pediatric pharmacist, documenting maximum dosing, having a pediatric medication safety committee, and using CPOE weight-based dosing in the ED. Of the safety measures noted in Fig 1, an average of 6.5% (0%–17%) responded “I don’t know” to a particular practice.

DISCUSSION

Given the high risk of medication safety errors in hospitalized children in adult settings, our survey serves as a small glimpse into identifying possible areas for improvement. Based on our limited survey, the most common gaps identified among the sites surveyed were requiring milligram-per-kilogram dosing specifications and documentation of maximum doses. However, results from our survey also show that a majority of

TABLE 1 Survey Question Percentage of “Yes” Results

Questions	Overall Percent “Yes” (N = 64)	Overall Percent “I Don’t Know” (N = 49)	University Affiliated (N = 25)	Non-University Affiliated (N = 39)	<i>P</i>	<300 Beds (N = 36)	>300 Beds (N = 28)	<i>P</i>
Does your hospital require specific milligram-per-kilogram dosing to be documented in the order for pediatric medications?	50	2	72	36	<.05	42	61	.207
Does your hospital have a pharmacist specifically trained in pediatrics?	58	17	72	49	.076	44	75	<.05
Does your hospital have maximum doses clearly defined and/or documented on orders for hospitalized pediatric patients?	59	2	68	51	.207	56	61	.800
Does your hospital have a designated committee that addresses pediatric medication safety events or concerns?	60	11	68	54	.305	56	64	.609
Does your ED use order sets or CPOE with pediatric weight-based dosing?	73	9	80	69	.397	81	64	.165
Does someone routinely review pediatric medication safety events or concerns within your hospital?	80	11	96	69	<.05	78	82	.761
Are weights measured in kilograms per grams in the emergency department?	84	0	76	90	.170	81	89	.492
Does your hospital use standard pediatric concentrations for intravenous and oral pediatric medications?	86	9	92	82	.463	83	89	.720
Does your hospital use “smart pumps” for medication administration?	86	9	88	85	.991	81	93	.278
Does your pediatric unit use order sets or CPOE with pediatric weight-based dosing?	91	0	88	92	.671	89	93	.688
Are weights measured in kilograms per grams in the pediatric unit?	92	2	92	90	.763	86	96	.219
Does your hospital use a bar-code administration system?	92	5	84	92	.417	86	93	.454

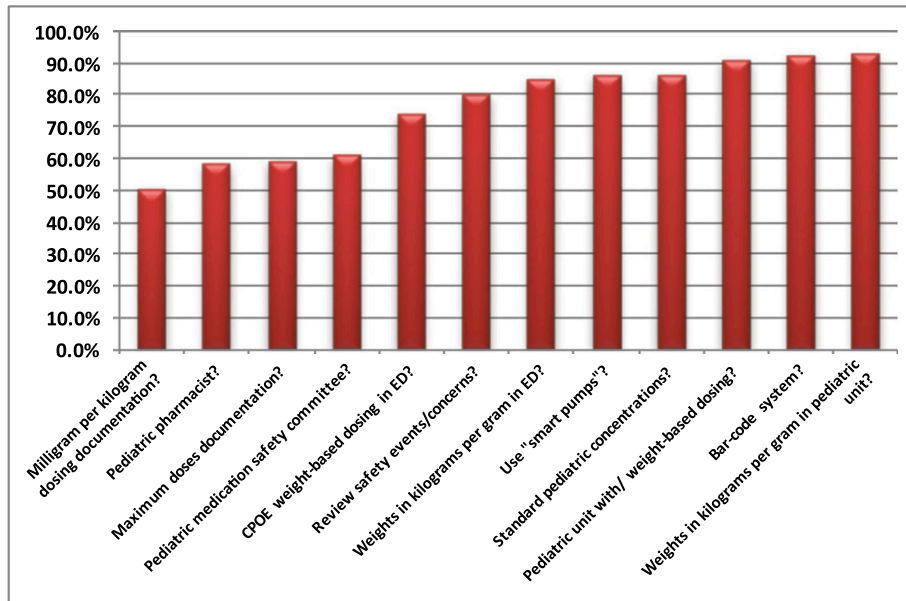


FIGURE 1 Percentage of hospitals with pediatric safety measures.

programs surveyed use order sets or CPOE with weight-based dosing. This means that some CPOE orders contain a suggested dose in milligrams per kilogram, but when the final calculated dose is entered, it may not have to specify which milligram-per-kilogram dosing was used. Fortescue et al¹⁸ found in a 2003 study on reducing medication errors that basic CPOE can reduce potentially harmful errors by 60%, but CPOE with clinical decision support systems, such as alerts for maximum and milligram-per-kilogram dosing, can reduce them further by a total of 76%. Having the hospitals that already have CPOE include a requirement of maximum and milligram-per-kilogram dosing could potentially reduce errors by an extra 16%.

Although it can be costly, a pediatric unit-based pharmacist has been shown to reduce medication safety errors, intercepting as much as 78% of prescribing errors.⁶ Interestingly, over half of the responders had pharmacists specifically trained in pediatrics, with larger hospitals (>300 beds) more likely to have a pediatric pharmacist than smaller hospitals (<300 beds). Results were similar in hospitals with larger ADCs (>10) versus smaller ADCs (≤10). This still leaves 42% of hospitals surveyed without a pediatric-

trained pharmacist to intercept these potential errors. Although a majority of responding hospitals document weights exclusively in the metric system in both the ED and the pediatric unit, the 16% of EDs not implementing metric weight-only recordings could find medication safety improvements by addressing this practice.

The most commonly identified gaps found in this survey could be improved on by 5 interventions: implementing maximum and milligram-per-kilogram dosing, using a pediatric pharmacist, implementing CPOE weight-based orders in the ED, and using a committee to review pediatric safety events. Although this is not necessarily proportional to the percent of medication safety events that would be prevented, each of these interventions have been recommended in various studies.^{2,3,6-8,10,15,18-23} Starting with these 5 goals, each hospital can identify their primary areas for improvement. Additional studies are needed to see if implementing these interventions would improve patient safety or decrease error rates.

We acknowledge that there are significant limitations to this study. Although our survey was sent to the entire AAP Section on Hospital Medicine's list of pediatric hospitalist programs of North America and members of the QuIN listserv, we only

received 64 responses. Therefore, our results can only speak to the medication safety practices within the hospitals surveyed. Also, despite having a question asking if the responder had previously completed the survey, some responses could be duplicates, with calculated estimate of duplication being at most 6%. Overall, our results are similar to the ISMP survey with regards to the lack of use of a pediatric unit-based pharmacist and CPOE with alerts about exceeding maximum or weight-based dosing. However, unlike the ISMP survey, we looked at how specific deficits vary based on ADC, university affiliation, region of the country, and overall hospital bed count.^{24,25}

As in any survey, results may be limited by the awareness of a surveyor as to the current practices at their site. We acknowledge that the "I don't know" responses could have been "yes," although even if the highest "I don't know" responses (ie, pediatric-trained pharmacist [17%] and pediatric safety committee [11%]) were "Yes," the top 5 identified gaps would remain the same. In addition, the areas identified as the most common gaps in medication safety could have less of an impact on reducing medication error rates than other, less widespread

medication safety issues not highlighted in this survey. Despite these limitations, our study was able to demonstrate the significant variation in pediatric medication safety practices within the adult settings surveyed. Due to the low response rate, our survey findings can only speak for the sites that responded; however, it does give us a general idea of which changes may have the highest potential of minimizing safety events if implemented within the settings surveyed, and possibly be extrapolated to other institutions.

CONCLUSIONS

Pediatric medication safety infrastructure in the adult settings surveyed varies significantly. Our results indicate that certain deficiencies are more widespread than others. The most common gaps found in our survey included implementation of maximum and milligram-per-kilogram dosing, use of a pediatric pharmacist, use of CPOE weight-based orders in the ED, and presence of a pediatric safety event review committee. As a next step, adult hospitals that care for pediatric patients can focus on which of these are their own most important hospital-specific interventions. This survey can be used as a starting point for institutions that may have similar deficits to assess what resources and tools may be needed to implement these pediatric medication safety practices. Using this foundation, a stepwise approach can be created for settings lacking a pediatric-specific infrastructure to optimize pediatric medication safety practices and ideally work toward making all hospitals as safe as possible for children.

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