

Comparison of Two Methods of Pediatric Resuscitation and Critical Care Management

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Study objective: We compare time to drug delivery and the incidence of dosage error between 2 different systems of medication administration: The Broselow Pediatric Emergency Tape and a standardized volume/weight-based dose reformulation of resuscitation and critical care medications (reformulated to 0.1 mL/kg).

Methods: This was a randomized crossover trial, in which volunteers ($n=16$) from emergency department (ED) pediatric resuscitation teams from the ED of a large, urban, teaching hospital in Australia were assigned to manage simulated (Advanced Pediatric Life Support scenario) patients. The volunteers were each presented with 3 case scenarios (brady-asystolic arrest, status epilepticus, and rapid sequence intubation requiring administration of 4, 5, and 4 medications, respectively). The order of presentation was randomized for the 2 methods. The volunteers were then asked to manage 3 case scenarios using one and then the other method (resulting in a total of 6 cases managed per participant). The dosage of each medication ordered, as well as the time to the simulated administration of that medication, was recorded for all scenarios. The expected dosages were compared with the actual dosages delivered to determine which system provided greater accuracy in medication administration. Statistical analysis was undertaken using the Wilcoxon signed rank test and McNemars test for paired proportions.

Results: Compared with the Broselow tape, the standardized volume/weight-based dose reformulation significantly reduced median time to medication delivery for all clinical scenarios (147 versus 72 seconds; 197 versus 87 seconds; 146 versus 64 seconds; $P<.001$). The proportion of dosing errors with Broselow tape across the 3 scenarios was greater than with volume/weight-based dosing (0.08 versus 0, 0 versus 0, and 0.08 versus 0.02, respectively).

Conclusion: Use of a standardized volume/weight-based dose reformulation method is a simple, fast, and accurate method of medication delivery for the pediatric patient that eliminates the need for memorization and/or calculation. The standardized volume/weight-based dose reformulation method performs better than the Broselow tape in speed of delivery of medications used for pediatric resuscitation and critical care without any reduction in dosing accuracy. [Ann Emerg Med. 2008;52:35-40.]

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INTRODUCTION

In 1999, the Institute of Medicine reported that medical errors kill between 44,000 and 98,000 people in US hospitals each year and that more than 7000 of these deaths are attributable to medication errors.¹ In recent years, much attention has also been brought to the incidence of errors during the provision of medical care to children and the potential impact that these errors may have.²⁻¹⁰

Traditionally the medications that have been used during adult resuscitation and critical care management have also

been used for children, with the same formulations and concentrations being administered to both pediatric and adult patients.¹¹⁻¹⁵ However, whereas the dose of many medications used for adults remains relatively constant across the spectrum of adult weights, the dose can differ substantially between pediatric patients as a result of the relatively wide variation in weight. As a consequence, medication administration in the pediatric patient commonly requires both an estimate of patient weight and a calculation for each dose of medication to be administered, practices that

Editor's Capsule Summary*What is already known on this topic*

Variations in children's weight make the rapid delivery of appropriate doses of medications a challenge during pediatric resuscitation. The Broselow system is one of several methods used to assist in accuracy of weight-based dosing.

What question this study addressed

Does volume/weight-based dose reformulation of resuscitation drugs improve speed and accuracy of drug delivery in children?

What this study adds to our knowledge

In a simulation study involving 16 physicians and nurses, volume/weight dosing, as compared to the Broselow tape, significantly reduced drug preparation time without loss of accuracy.

How this might change clinical practice

This exploratory work suggests an alternative way to prepare medications for rapid and safe dosing in pediatric resuscitation situations. Although intriguing, widespread implementation would require a multidisciplinary effort to redesign medication packaging and reeducate staff on the use of the new dose formulations.

have been shown to be independently associated with high rates of error.^{6-10,16-19}

Throughout the years, health care providers have developed various devices or memory aids to assist them in determining the correct dose(s) of medication necessary for administration in the pediatric critical care setting. The Broselow Pediatric Emergency Tape (Vital Signs, Inc., Totowa, NJ) is one such tool. The Broselow tape has been previously demonstrated to provide health care practitioners with a simple and accurate means for estimating patient weight and determining medication dosage for children, based on length to weight correlations that exist in the pediatric population.¹⁸⁻²⁷ However, not only have recent studies shown that the Broselow tape may actually underestimate patient weight (resulting in underdosing of medications) but also it has been demonstrated to accurately predict medication dosages in only 55% to 60% of the cases in which it is used.^{21,28} In addition, the Broselow tape lists dosages in milligrams, requiring the practitioner to calculate the volume of solution to be administered, a calculation that depends on and varies with individual medication concentration.

A theoretical alternative that would overcome the need to make this calculation would be to reformulate all pediatric resuscitation medications in such a way that the concentration of the drug in mg/mL enables the health care provider to avoid having to make this calculation. Hence, a drug is formulated in whatever concentration is needed such that the provider can

directly calculate the volume of drug to be administered from the patient's weight without having to calculate this volume from a milligram quantity. Furthermore, all medications used for pediatric resuscitation or critical care can be similarly reformulated so that they yield an identical volume of medication per kilogram of body weight, thereby effectively standardizing the dosage (volume) of all medications.

In this study, we proposed a standardized volume/weight-based dose reformulation of resuscitation and critical care medications (reformulated to 0.1 mL/kg) and compared it with the Broselow Pediatric Resuscitation Tape with respect to time to drug delivery and the incidence of dosage error.

MATERIALS AND METHODS

We compare time to drug delivery and the incidence of dosage error between 2 different systems of medication administration: Broselow tape and a standardized volume/weight-based dose reformulation of resuscitation and critical care medications (reformulated to 0.1 mL/kg).

The study was a randomized, 2-treatment, 2-period, crossover trial, in which individual physician or nurse volunteers from emergency department (ED) pediatric resuscitation teams were assigned to manage 3 simulated pediatric patients (Pediatric Advanced Life Support scenarios) using both the Broselow method and standardized volume weight method to calculate drug doses. For each of the 3 scenarios, the study subjects were randomly assigned to use either the Broselow method (control) or the standardized volume-weight method (intervention) during their first attempt at the scenario and the other method during the second attempt. Data were collected between November 20 and December 10, 2006.

Selection of Participants

All nursing and medical staff from the ED of a large, urban, teaching hospital in Australia were invited to participate in the study (St. George Hospital in the South Eastern Sydney and Illawarra Area Health Service, located in New South Wales, Australia). A brief description of the study was provided, along with the request for participation. Participation was voluntary and written informed consent was obtained from all participants. The study received previous approval from the hospital ethics committee.

Interventions

Study participants were provided with and asked to review tutorials on the appropriate use of each of the 2 systems before initiation of the study (Appendixes E1 and E2, available online at <http://www.annemergmed.com>). On arrival to the location of the study, the participants were given a brief, interactive presentation of each system. Participants were queried as to their understanding of the tutorials and systems, and all questions were answered to the satisfaction of each participant.

Participants were then presented with 3 simulated pediatric critical care case scenarios (brady-asystolic arrest in a 19-kg

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