



## Original Contributions



### USE OF THE BROSELOW TAPE IN A MEXICAN EMERGENCY DEPARTMENT

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**Abstract—Background:** The Broselow tape is one method for rapid weight estimation in pediatric patients undergoing resuscitation, but it does not perform equally in all populations. To date, we are unaware of any study evaluating its use in a Latin American population. **Objective:** To investigate the accuracy of the Broselow tape in a Mexican emergency department (ED). **Methods:** We conducted a prospective, observational study of children presenting to a Mexican ED. Patient weight was estimated using the Broselow tape and the estimate compared to their weight measured on a scale. Researchers were blinded to scale weight and Broselow categories. For analysis, the Broselow tape's nine color zones were divided into three weight categories. **Results:** Of 815 subjects, 356 (43.7%) were female. In children weighing <10 kg, the tape tended to underestimate weight, whereas it overestimated weight in the other two weight categories. The mean percentage difference between the actual weight and the Broselow tape-predicted weight was <3% in each category, although it differed significantly across the three weight categories. Accuracy of the predicted weight to within 10% of actual weight was lowest for children weighing <10 kg, at 46.2% (confidence interval [CI] ± 6.4%), and greatest for those in the 10–18-kg weight category, at 64.1% (CI ± 5.1%). However, the correlation of color zones predicted by both methods was highest for subjects <10 kg at 64.4% (CI ± 6.1%). It was significantly lower in the other weight categories at 54.5% (CI ± 5.3) for subjects weighing 10–18 kg, and 50.1% (CI ± 6.4%) for subjects weighing >18 kg. The percentage of children for whom the color code differed by two or

more categories was <4% overall and for each weight category. **Conclusion:** The Broselow tape-estimated weight was different from the scale weight by more than 10% in a substantial percentage of Mexican children. Nevertheless, the mean percentage difference was <3%, and Broselow tape color zone estimation was accurate in the majority of subjects, suggesting its use would result in clinically appropriate dosing and equipment estimations. Further research is needed to validate its use in this clinical setting. © 2015 Elsevier Inc.

**Keywords—**Broselow tape; pediatric resuscitation; weight estimation

### INTRODUCTION

Rapid and accurate estimation of patient weight is crucial during emergency resuscitation of pediatric patients. Without an accurate weight, physicians cannot determine correct medication doses, equipment sizes, ventilator settings, energy for defibrillation, or intravenous fluid volumes. Delaying resuscitation efforts to weigh patients is both impractical and potentially detrimental. One method commonly utilized for rapid pediatric weight estimation in the emergency department (ED) is the Broselow tape, which translates patient height into corresponding weight categories. Derived from data from the U.S. Census and the National Center for Health Statistics, the Broselow

tape was first developed by John Broselow and Robert Luten in 1986 and validated shortly thereafter (1). It has performed well when compared to provider estimation and to a variety of mathematical formulas for weight estimation (1–3). In addition to estimating weight, the Broselow tape provides medication doses and equipment sizes for a variety of common resuscitative adjuncts that can reduce cognitive load during already stressful resuscitations, and can potentially prevent medical errors secondary to inaccurate calculations (4,5). Since its introduction, the Broselow tape has become a standard resuscitation tool, endorsed by the American Heart Association Pediatric Advanced Life Support guidelines (6).

However, the Broselow tape may not perform equally well across all types of pediatric patients. Despite periodic revisions to the tape based on updated census data, there is evidence that as obesity rates increase, the Broselow tape may increasingly underestimate weights (7,8). Conversely, malnutrition or endemic disease burdens in certain populations may result in overestimation of weight by using the Broselow tape. Several studies have investigated the accuracy of the Broselow tape in a variety of international settings, with varying results (9–13). The purpose of this study was to investigate the accuracy of the Broselow tape in Mexican pediatric patients for use in a Mexican ED.

## MATERIALS AND METHODS

A prospective, observational study was performed in children presenting to the ED of Hospital del Niño DIF in Pachuca, Hidalgo, México from May 2012 to January 2013. Consent was obtained from the guardians of the study participants. The study was approved by both the Indiana University Institutional Review Board and the Ethics Committee at Hospital del Niño. Hospital del Niño is the primary pediatric referral center for Pachuca, the capital of Hidalgo state in central Mexico, which has a population of over 250,000. The ED had an annual census of 18,089 in 2012. The majority of patients came from the state of Hidalgo, although approximately 5% were residents of one of the five surrounding states. Children between the ages of 1 day and 12 years presenting to the ED were included in the study. Similar to previous research studies on this topic, patients were excluded if they had a height <46 cm or more than 143 cm (i.e., outside the limits of the tape length) or had any medical condition directly affecting the ability to allow their height to be accurately measured (e.g., cerebral palsy, microcephaly, limb amputations, severe muscle contractures, congenital malformations). Children were also excluded if critically ill at the time of presentation to the ED and therefore unable to be weighed.

Data were collected by the local nurse or clinician on call. By having actual medical providers measure patients with the Broselow tape for the study, we attempted to estimate its accuracy in a natural clinical setting and minimize any bias that might result from using researchers to take the measurements. At the time of presentation to triage, each subject was first measured by the provider with a Broselow tape. For the purposes of blinding, the tape's color-coded categories were covered with labels printed with letters in place of the usual weight categories. Medical providers using the tape were blinded to the relationship between the letters and the weight categories. After measuring supine subjects from crown to heel, this letter category was recorded. Once measured with the blinded tape, subjects were then weighed per standard ED protocol with a standardized, calibrated scale to the nearest 0.01 kg. Shoes and heavy outerwear were removed prior to weighing subjects. Height was measured per standard ED protocols. Patient age in months and basic demographic information were also recorded. The data sheets were then collected. The recorded letter labels were translated back into the corresponding kilogram weight on the Broselow tape by study investigators.

In keeping with previous literature, a Bland-Altman analysis was performed to assess agreement between the recorded Broselow weight and the actual weight for the overall sample. The Bland-Altman analysis assesses agreement by looking at two graphs. The first is a simple scatter plot of the two weights. The second graph consists of a scatter plot showing the difference in weights against the mean of the weights. In addition, a line for the mean difference and lines defining the range of agreement are included. The limits for the level of agreement were calculated as the mean difference  $\pm$  two standard deviations from the mean difference. In addition to the Bland-Altman analysis, we assessed bias by looking at the average percentage difference between the average weight and the Broselow-measured weight. Based on findings from previous literature, our hypothesis was that the Broselow weight would be equivalent to the scale weight if the mean percentage difference were within 3%. We would reject the null hypothesis if the mean percentage difference was significantly >3%.

We also calculated the accuracy of the Broselow weight because an item can have little bias but still not be accurate. For this analysis, we calculated the percentage of children whose calculated weight was within 10% of their actual weight. We similarly calculated percentage agreement between the color-coded zone of the Broselow and the scale weight.

In addition to evaluating the overall sample, we also looked at agreement within weight categories. For the purposes of analysis, the Broselow tape's nine color zones were divided into three weight categories:

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