

## How reliable is length-based determination of body weight and tracheal tube size in the paediatric age group? The Broselow tape reconsidered

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**Background.** The Broselow tape was designed to estimate body weight and tracheal tube size on the basis of the body length of emergency paediatric patients. The tape was validated previously in US populations. We assessed its accuracy in a sample of European children by reviewing paediatric anaesthetic charts at the Triemli City Hospital for 1999.

**Methods.** Age, body length and body weight measured before surgery as well as the size of the tracheal tube used were recorded. The body weight was estimated on the basis of body length using the Broselow tape and was compared with the measured weight. Tracheal tube size selections using the Broselow tape and an age-based formula were compared with the size of the tube used.

**Results.** A good correlation was found between the Broselow weight and the measured weight ( $r^2=0.88$ ). Bland–Altman analysis revealed a mean bias of  $-0.52$  kg for the entire study population. For children  $\leq 20$  kg the mean bias was  $-0.05$  kg, and for children  $>20$  kg was  $-1.05$  kg. The Broselow weight was found to be within a 10% error of the measured weight in 65% of children. Tracheal tube selection by the Broselow tape method was adequate in 55% but underestimated the actual tube size in 39%. The age-based formula matched the actual tracheal tube size in 41% of children but overestimated it in 57%.

**Conclusions.** The Broselow tape is an accurate means to assess body weight from length in smaller children; in older children it underestimated body weight. Endotracheal tube size selection by the Broselow tape appears to match the size of the tube used better than the age-based formula. The results in a European sample of children are comparable to the US data.

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The Broselow tape was designed to estimate body weight and drug dosage, as well as endotracheal tube size, of emergency paediatric patients on the basis of body length. The tape is recommended by the Advanced Trauma Life Support<sup>®1</sup> and the Pediatric Advanced Life Support<sup>2</sup> courses which have grown in popularity all over Europe in recent years. Validation of the Broselow tape was done for weight<sup>3</sup> and for endotracheal tube size selection<sup>4,5</sup> in children from the United States. The aim of this study was to assess the accuracy of the Broselow tape in European children.

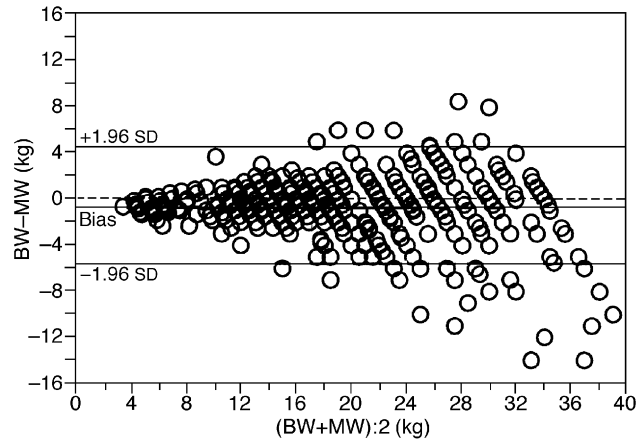
## Methods and results

All 904 paediatric anaesthetic charts at the Triemli City Hospital from 1999 were reviewed and the following information was recorded: age (yr), gender (m/f), ASA classification, body length (cm), body weight (kg) and the size (internal diameter [ID] in cm) of the uncuffed tracheal tube size used. On admission to the paediatric ward, body weight and body length were measured to the nearest 0.1 kg and 0.1 cm, respectively. Charts from 222 children (24.6%) who had a body length exceeding the range of the Broselow tape (up to 154 cm) and 97 charts (10.7%) in which data were estimated or incomplete were excluded from statistical analysis. The remaining 585 charts of 330 male (56.4%) and 255 female children (43.6%) were used for statistical analysis by Statview 5.01<sup>®</sup> software (SAS Institute Inc., Cary, USA). A *P* value <0.05 was considered statistically significant. All statistical analyses were performed separately for children weighing ≤20 kg and those weighing >20 kg. Children were either ASA I or II. They ranged in age from 6 months to 11 yr 10 months. Forty-eight per cent of the children were aged between 2 and 6 yr; 13% were younger than 2 yr. Body weight ranged from 3.5 kg to 39.3 kg; 45% of the children weighed between 10 and 20 kg.

### Length-based weight determination

The body weight was estimated using the Broselow tape (Broselow weight) on the basis of the body length measured before surgery, and was compared with the measured body weight. Using a Bland–Altman plot (Fig. 1) to determine the mean bias and the limits of agreement.<sup>6,7</sup> There was a statistically significant mean bias of –0.52 kg (*P*<0.0001) and the limits of agreement were –5.8 kg and 4.8 kg (Fig. 1). The mean bias for children ≤20 kg was –0.05 kg (limits of agreement: –3.0/2.9 kg) and for children >20 kg was –1.05 kg (limits of agreement: –8.0/5.9 kg).

The Broselow weight was found to be within a 10% error for 65%, and a 15% error for 83% of the children. The 10% error for children ≤20 kg was 66% and for children >20 kg was 65%. Differences between these groups were pronounced above the 15% error range (≤20 kg: 14%; >20 kg: 19%). There was a good correlation between Broselow



**Fig 1** Bland–Altman analysis for body weight determined by the Broselow tape. BW, Broselow weight in kg (weight determined by the Broselow tape); MW, measured body weight in kg. Mean bias was –0.52 kg (95% confidence intervals [CI]: –0.7/–0.3 kg; lower and upper limits of agreement were –5.8 kg (CI: –6.2/–5.4 kg) and 2.6 kg (CI: 4.5/5.2 kg), respectively).

weight and measured weight ( $r^2=0.88$ ), with no significant differences between female and male children (*P*=0.28; Student's *t* test). For children ≤20 kg,  $r^2$  was 0.9 and for children >20 kg,  $r^2$  was 0.58.

### Length-based tracheal tube size selection

The tracheal tube size selection using the Broselow tape was the same as the size used in 55% of cases, and underestimated the used size in 39% of cases. Results of the two different weight groups were comparable (matching ≤20 kg: 57%; >20 kg: 53%). Tracheal tube size selection using the age-based standard formula ( $[\text{age in years}+16]4^{-1}$ ) matched the used size in 41% of cases, and overestimated it in 57% of cases. There was a significant difference in tracheal tube size selection between the Broselow tape method and the age-based formula (*P*<0.001,  $\chi^2$ -test).

## Comment

The Broselow tape provided accurate estimation of the body weight based on measured body length. The tape slightly underestimated the body weight of the whole study population. In smaller children with a body weight ≤20 kg, the underestimation was negligible. Underestimation of body weight was pronounced in children with a body weight >20 kg.

The tracheal tube size selection by the Broselow tape met clinical needs better than estimation using a standard age-based formula. Correct match was more frequent using the tape than the formula. Moreover, the observed underestimation by the tape may be less relevant clinically in terms of airway injury than the frequent overestimation that occurs when using the standard age-based formula.

The results of the current study performed in a European paediatric population are comparable to the published data in US paediatric populations for body weight estimation<sup>3</sup> and tracheal tube size selection.<sup>4</sup> However, tracheal tube size selection using the Broselow tape was not superior to the age-based formula used in one US study.<sup>5</sup>

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