

The PAWPER Tape: A More Accurate Form of Tape-Based Weight Estimation

Mike Wells

Tape-based weight estimation in paediatric emergency care has been used for some time. The Broselow tape has been used for this purpose, however there are concerns about its accuracy amongst different paediatric populations. The PAWPER tape uses a different approach for weight estimation and has been shown to be more accurate in estimating the weights of a cohort of South African children.

The PAWPER (Paediatric Advanced Weight Prediction in the Emergency Room) tape is a low-cost single-use tape that is used to provide an estimation of a child's weight for the purposes of drug dose calculation during emergency medical care. Ideally a measured weight should be used for this purpose, but this is not practical in the pre-hospital environment nor when emergency medical management such as cardiopulmonary resuscitation, airway management or spinal immobilisation is required. The PAWPER tape was designed and developed in South Africa.

Why not just use the Broselow tape?

The Broselow tape is an excellent device to aid in paediatric emergency care, but has a number of important shortcomings:

- It is expensive at a cost of about R400 per tape.
- It has been shown to be worryingly inaccurate in a large variety of different populations of children across the world.
- It contains a limited amount of information on drug doses of important medications, but not enough information to qualify as a complete resuscitation aid.

Why was the PAWPER tape developed?

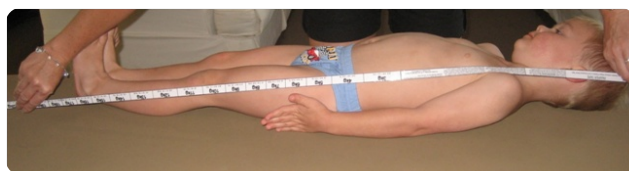
The PAWPER tape was developed to counter some of the failings of the Broselow tape:

- It was planned to be cheap and disposable (about R5 per tape with no commercial incentive to make a profit from the device).
- It was designed to be more accurate than the Broselow tape because of a unique system of weight estimation.
- It is the first component of a two-part complete resuscitation aid (the second part of which is the Emergency Drug Dosing in Children book). Since it is difficult to fit all the necessary information on a tape we decided to split the device into a dedicated disposable weight-estimation device and a comprehensive drug-dosing book.

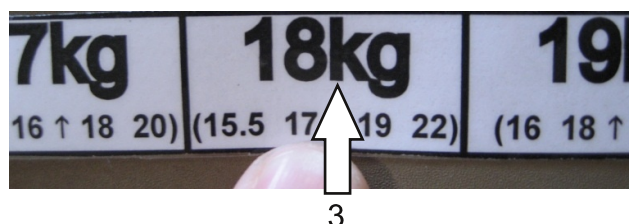
How does the PAWPER tape work?

There are several steps to weight-estimation using the PAWPER tape. The first step is a standard tape-based weight estimation. The tape is used to measure the child's vertex-to-heel length and the weight read off from the segment where the heel crosses the tape. The divisions are at different lengths to those of the Broselow tape since they were derived using different statistical premises. This estimated weight may be used without proceeding further, although the next steps significantly increase the accuracy of the weight estimation.

Step 1: Position the child supine on the bed or trolley. Use the PAWPER tape to measure from the child's head at the vertex (the most superior part of the head) to their heel (with the ankle flexed at 90°), starting from the end that reads "MEASURE FROM THIS LINE". Read off the primary weight estimation at the point at which the tape crosses the heel.



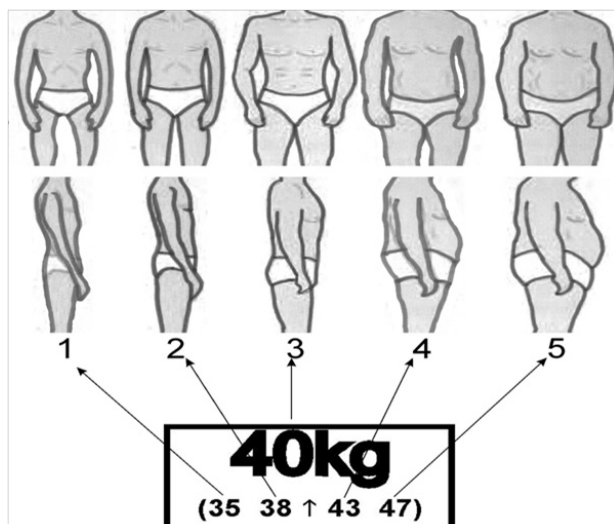
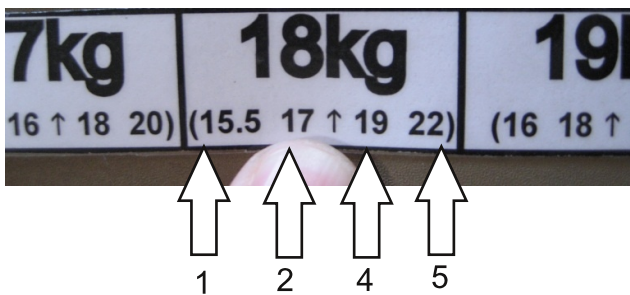
Step 2: This primary weight estimation at the point which represents the child's head-to-heel length is equivalent to the weight predicted by a system such as the Broselow tape and may be used for drug dose calculations.



Step 3: If, however, you think that the child is heavier or lighter than average for their length, the weight estimate may be adjusted by the use of a habitus score (HS). Assign the child a score from one to five based on the size of their frame and their degree of adiposity:

- 1 – Very thin, somewhat wasted, or tiny frame (XS).
- 2 – Thin, petite, slim, or small frame (S).
- 3 – Average body fat and frame size (M).
- 4 – Heavy, chubby, overweight, or large frame (L).
- 5 – Fat, significantly overweight, obese (XL).

The numbers in brackets on the PAWPER tape (as shown below) correspond to the secondary weight estimations for each habitus score at that length, and represent approximations of the 5th, 25th, 75th and 95th centiles of the World Health Organisation weight-for-length charts. For example, at an indicated length of 18kg a child who is slightly underweight or “petite” would have a primary weight estimation of 18kg, but since she would receive a habitus score of two, her secondary weight estimation would be 17kg.



The weight can be estimated with a much higher degree of accuracy by using the modified secondary weight estimation in children with a higher or lower than average weight-for-length. A child with a habitus score of three (average) has an unchanged weight estimation (use the big number). Since not all children of the same length will have the same weight (some are thin, some are average and some are fat) we felt it was important to devise a way to improve the accuracy of weight-

estimation for children with differing weight-for-length. The HS is a score from 1 to 5 which is assigned to the child based on visual inspection by the tape-user. There are no objective criteria for this assessment (which would make the process much more cumbersome albeit possibly more accurate) but simply a gestalt impression of body size and composition.

How accurate is the PAWPER tape?

In a study on 453 children attending the Emergency Department at a private hospital in Johannesburg, the PAWPER tape functioned extremely well and significantly outperformed the Broselow tape. The Broselow estimated weight to within 10% of measured weight in 63.6% of children and the PAWPER tape in 89.2% of children. The PAWPER tape performed equally well in underweight and overweight children and equally well in children across the weight spectrum of the tape (three to 40kg) with about 90% of children receiving a weight estimation within 10% of their actual weight. The Broselow tape, on the other hand, was even less accurate in children who were overweight (28.2% within 10% of actual weight) and in children at the upper end of the weight spectrum (58.5% within 10% of actual weight). In this study more than half the children received a modified weight-estimation because they had an above- or below-average weight-for-length. In only 0.25% of the study sample did the use of the HS to modify the weight-estimation result in a worse estimation.

Figure 1 shows the percentage of patients falling within each error-category for the Broselow tape (white bars) and the PAWPER tape (black bars). The negative percentages reflect an underestimation of weight and the positive percentages an overestimation.

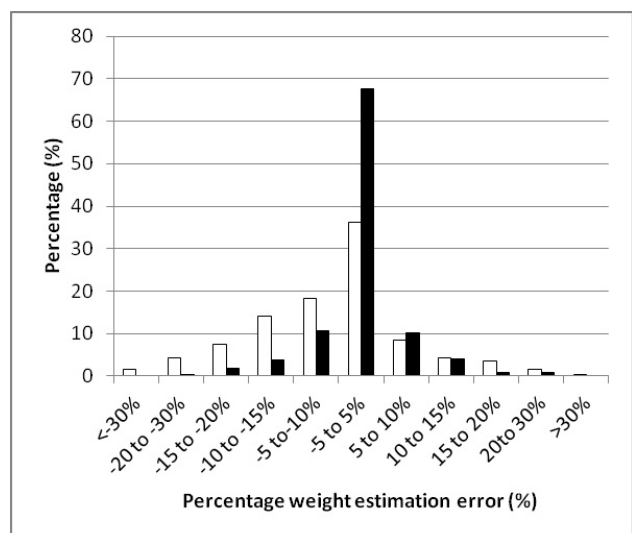


Figure 1

The accuracy of the PAWPER tape has proved to be better than any other published data on weight estimation systems up until now (although it still needs to be tested in a range of populations and study conditions).

What about other methods of weight estimation?

There are a number of other methods of weight estimation, including guesses by healthcare providers or caregivers, age-based formulas and other more unconventional techniques (such as foot length).

- “Guesstimates” by healthcare providers have been shown to be very inaccurate and should not be used to determine drug doses.
- “Guesstimates” by parents, when based upon a recent measured weight, may be much more reliable and may be accurate enough for resuscitation drug dose calculation if no better method of weight estimation is available.
- Age-based formulas, of which there are more than 10 different variations, are universally dreadfully inaccurate and should not be used, nor taught in advanced life support courses.
- Most unconventional techniques proposed to date are not accurate enough or practical to use in an emergency.

In the absence of an accurately measured body weight, tape-based methods should be used to estimate weight. That does mean that healthcare providers must be equipped with appropriate tapes whenever they might need them.

What else is there about weight estimation that is important?

When we get right down to it, we still know very little about pharmacokinetics in children. There is also very little data on how to determine drug doses in children who are underweight or overweight (i.e. the use of total body weight, ideal body weight or adjusted body weight) and an equal scarcity of information on how to adjust doses for children who are critically ill or injured. So, for now, the best evidence suggests that tape-based total body weight estimation systems should be used until further evidence emerges.

Conclusion

The PAWPER is a cheap and accurate weight-estimation system that is available in South Africa. Any healthcare provider that may encounter emergencies involving children should have one close-to-hand at all times.

Mike Wells is a consultant and lecturer in the Division of Emergency Medicine, University of the Witwatersrand and Netcare Union Hospital Emergency Department.

PAWPER tapes can be ordered from Dr Lara Goldstein (drg666@gmail.com).