UCDAVIS

The Department of Emergency Medicine (EM) at the University of California Davis, Health is conducting a faculty search for EM physicians in either a clinician/educator or clinician/researcher track. Candidates must be residency trained in EM (or Pediatric EM training) with board certification/eligibility and be qualified for licensure in California. At least one year of post-residency clinical experience and/or fellowship training is preferred. Candidates are expected to enter at the Assistant/Associate level, commensurate with experience and credentials. EM faculty members at UC Davis who have preference for night shifts work fewer clinical shifts each month.

The University of California, Davis, Medical Center, one of the nation's "Top 50 Hospitals," is a 613 bed academic medical center with approximately 80,000 emergency department visits annually, including approximately 20,000 pediatric visits. The emergency services pavilion opened in 2010 and is state-of-the-art. Our program provides comprehensive emergency services to a large local urban and referral population as a level 1 trauma and burn center, paramedic base station and training center. The department also serves as the primary teaching site for a fully accredited EM residency program and nine different EM fellowship programs. Our residency training program began more than twenty years ago and currently has 54 residents. The Department has a separate area for the care of children and is one of the leading centers in the Pediatric Emergency Care Applied Research Network (PECARN).

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Interested candidates should submit a letter outlining interests and experience, and curriculum vitae to: recruit.ucdavis.edu/apply/JPF02202

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Failed Validation of the Argall Weight Formula for Estimating Children's Weight in an Australian Emergency Department

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Abstract

Background: An estimate of a child's weight is required for critical interventions, particularly pharmacotherapy. Weight measurement is not always practical, so weight estimation methods are used. Recently, a new weight estimation formula was suggested. The Argall formula estimates weight in kilograms as follows: (age in years + 2) × 3.

Objectives: To validate the Argall weight formula.

Methods: This was a prospective, observational, cohort study conducted in the pediatric emergency department (ED) of Sunshine Hospital. Children aged up to 11 years who presented to the ED during August 18, 2005, to February 25, 2006, were included. Actual weight, height, age, and ethnicity were obtained. Data were analyzed by descriptive statistics (proportion, mean, median, and SD). Agreement between estimated weight using the Argall formula and measured weight is reported by using mean bias, SD, and root mean square error (RMSE) analysis.

Results: Four hundred ten cases were included, 46% were female, and the median age was 4 years. The Argall formula had a mean bias of –1.66 kg and RMSE of 5.65. Only 37% of Argall estimates were within 10% of the child's actual weight. The formula performed less well in children weighing more than 35 kg but performed better in Asian children than white children.

Conclusions: The Argall weight estimation formula has poor accuracy for weight estimation in Australian children, in particular those weighing more than 35 kg.

ACADEMIC EMERGENCY MEDICINE 2007; 14:486–488 © 2007 by the Society for Academic Emergency Medicine

Keywords: weight, pediatric, Argall formula

It is often necessary to know a child's weight in the emergency department (ED) for assessment of clinical status and to enable accurate drug calculation. Most drugs, including resuscitation drugs, opiates, intravenous fluids, and sedatives, are administered according to weight (milligrams per kilogram). Overestimation can lead to drug overdosing, and underestimation may lead to subtherapeutic drug administration. Weight is also used to determine the proper setting for DC cardioversion for pediatric resuscitation.

Measuring a child's weight on a set of calibrated scales is the criterion standard but may not always be possible. In an emergency situation, such as cardiopulmonary resuscitation, it may not be practical to weigh a child, and parents or guardians may not know a child's actual weight.

Several methods have been devised that aim to accurately estimate a child's weight. They include the Advanced Pediatric Life Support (APLS) formula[1] and the Broselow tape technique.[2] These methods have been shown to be inaccurate in several recent studies.[3–6]

Recently, a new weight estimation technique, the Argall formula, has been developed in the United Kingdom. It uses a child's age to determine weight, and it is calculated as weight (kilograms) = (age in years + 2) × 3.[7] It has been reported that this formula is more accurate than the Broselow tape for estimating weight.[7] To date, this formula has not been validated, either in the study population in which it was developed, or externally. The

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Received August 3, 2006; revision received December 1, 2006; accepted December 5, 2006.

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ISSN 1069-6563
PII ISSN 1069-6563583

doi: 10.1197/j.aem.2006.12.009

aim of this study was to externally validate the Argall weight estimation formula.

METHODS

Study Design

This was a prospective, observational external validation study. Melbourne Health Research Directorate waived the requirement for formal ethics approval because the study was considered a quality assurance, clinical audit, or clinical best-practice development activity. Consent was not required for study participation.

Study Setting and Population

This study included a convenience sample of pediatric patients who presented to Sunshine Hospital ED between August 18, 2005, and February 25, 2006. Sunshine Hospital is a metropolitan community teaching hospital with a mixed adult and pediatric ED that treats 23,000 children annually. We collected data on medically stable children, aged between 1 and 11 years, with a wide variety of clinical conditions. Children were excluded if their condition was such that urgent care or resuscitation was required.

Patients were recruited across shifts and days, with the vast majority being collected on day and evening shifts by the principal investigator (KN), supplemented with some data collected by nurses. All investigators were trained in use of the measuring devices, and they were not blinded to the study hypothesis.

Study Protocol

Data collected included demographic data, date of presentation, child's height (in centimeters), child's weight (to the nearest kilogram), and ethnicity. All children were weighed on a single set of digital standing scales (Seca, Hamburg, Germany) or on a chair-like scale (Healthometer; Jarden Corp., Rye, NY), without shoes and heavy layers of clothing. Scales were calibrated by the biomedical department before the commencement of the study, on a monthly basis after study commencement, and at study conclusion. For uncooperative children, weights were obtained indirectly: the parent's weight was subtracted from the combined parent and child weight to determine the child's weight. This has been shown to be accurate in a previous study.[8] Height (without shoes) was measured with a stadiometer. Children who could not stand and were less than 1 m tall were measured in the supine position with a Seca 207 infant measurement rod.

The primary outcome was the agreement between weights that were estimated by the Argall weight estimation formula and the measured weight.

Data Analysis

Data were analyzed by using Stata (release 8.2; Stata Corporation, College Station, TX) and Analyse-It for Microsoft Excel (Analyse-It, Leeds, UK; http://www.analyse-it.com) data analysis programs. We report descriptive statistics (numbers, mean, SD, range, proportions) for age, gender, ethnicity, height, body mass index (BMI), and weight. Agreement between the Argall formula and measured weight was assessed by calculation of mean bias, SD, and root mean standard error (RMSE). RMSE combines an assessment of both bias and spread of data. We also report the proportion of cases that were accurate in weight estimation to within 10% of measured weight, by age and weight groups. A subgroup analysis was conducted to assess the formula's performance in the two predominant ethnic groups (Asian and white).

RESULTS

Four hundred ten children were enrolled into the study. The mean and median ages of the sample were 4.5 and 4 years, respectively (range, 1–10 yr; SD ± 2.8). There were more boys (54%), and the majority of children were white (75%). The mean BMI of the sample was 17 kg/m^2 (SD ± 2.7) and ranged from 12 to 35 kg/m^2. The mean measured weight was 21 kg (SD ± 10.2), ranging from 7.5 to 71 kg.

Comparison of the weight estimated by the Argall formula with measured weight showed an average difference of –1.66 kg (95% CI = –2.2 to –1.1 kg), and RMSE was 5.65 (Figure 1). The 95% limits of agreement were –12.3 kg to +8.9 kg, indicating poor agreement. The formula underestimates weight in heavier children, particularly those weighing more than 35 kg.

Overall, only 37% of Argall estimates were within 10% of the child's actual weight. For children weighing less than 10 kg, the Argall estimates were within 10% of actual weights in 85% of cases. Fewer than 50% of estimates were within 10% of actual weight for children weighing more than 10 kg.

When children were separated into age groups, fewer than 50% of Argall weight estimates were within 10% of actual weight in all groups, with the exception of the group of children 4 years of age, which achieved 64% agreement within 10% actual weight.

Asian children were lighter in our study compared with white children (mean weight: 19 kg vs. 17 kg), but because Asian children were shorter (mean height: 111 m vs. 107 m), BMI was similar (17 vs. 17). The Argall formula performed better in Asian children (mean bias, –0.86 kg; RMSE, 4.66) than in white children (mean bias, –1.66 kg; RMSE, 5.71).

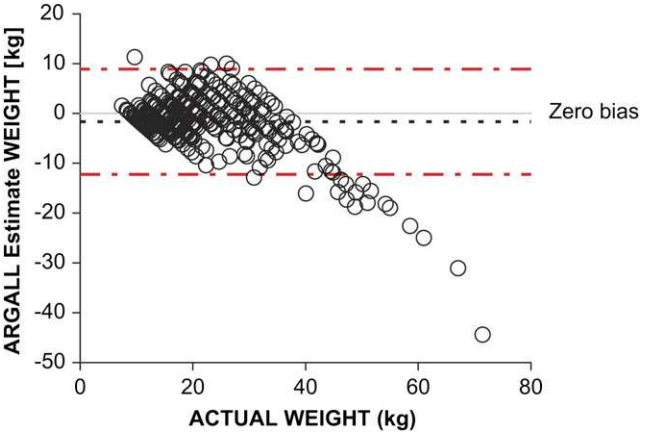

Figure 1. Plot of the difference between Argall estimate and actual weight. (Color version of this figure available online at www.aemj.org.)

DISCUSSION

Several methods have been developed for estimating children's weight, the most recent of which is the Argall formula.[7] We found the Argall formula to have poor accuracy, particularly in children weighing more than 35 kg, with wide 95% limits of agreement.

To our knowledge, this is the first study reporting an external validation of the Argall formula. We closely followed the derivation study's design so as to collect data that were as comparable as possible. Unfortunately, we showed less accuracy for the Argall weight formula than did the derivation study. The formula, when applied to our sample, underestimated weight, with a mean bias of –1.66 kg, compared with a mean bias of −0.52 kg in the derivation study.[7] RMSE was not reported for the derivation study. Our findings suggest that the spread of error in weight estimate is unacceptable (RMSE, 5.65; 95% limits of agreement, –12.3 kg to +8.9 kg). Only 37% of Argall estimates were within 10% of the child's actual weight in this study. The reasons for the differences in findings are unclear. Possible explanations include differences in the sample in terms of age, weight, ethnicity, and BMI spread. Our finding that the formula performed better in Asian children probably reflects that they usually are of smaller body habitus.

Comparison of the Argall formula with other weight estimation techniques and formulae, such as the Broselow tape[2] or APLS formula,[1] would be useful future research.

LIMITATIONS

This study has some limitations that must be considered when interpreting the results. This was a convenience sample and excluded seriously ill children, and therefore it may have been biased. The sample is derived from a single, multiethnic Australian study site and may not be generalizable to other settings. Most data were collected when the principal researcher was available to do so. This limited participant numbers and thus potentially introduced bias. More representative sampling may have been achieved with a larger sample size or a multicenter design. The Polynesian and African patient ethnicity groups were too small to allow for comparative analysis. It therefore would be inaccurate to claim that study findings truly reflect the ethnic diversity of the study population.

CONCLUSIONS

The Argall weight estimation formula has poor accuracy for weight estimation in children seeking care in a single Australian ED, in particular for those weighing more than 35 kg.

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