

# Can Undergraduate Paramedic and Nursing Students Accurately Estimate Patient Age and Weight?

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#### Abbreviations:

BCP = Bachelor of Clinical Practice  
BEH = Bachelor of Emergency Health  
BN = Bachelor of Nursing

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#### Abstract

**Introduction:** Accurate estimation of a patient's age and weight are skills expected of all healthcare clinicians, including paramedics and nurses. It is necessary because patients may be unable to communicate such information due to unconsciousness or an altered state of conscious. Age and weight estimation influence calculation for medication dosages, defibrillation, equipment sizing, and other invasive procedures such as intubation. The objective of this study was to identify whether undergraduate paramedic and nursing students were able to accurately estimate a patient's age and weight based on digital patient photos.

**Methods:** A prospective, observational study involving undergraduate paramedic and nursing students from two Australian universities was used to estimate the age and weight of seven patients (adult and pediatric). Each patient image appeared in a PowerPoint™ presentation for 15 seconds, followed by a short pause, with the next patient image commencing automatically.

**Results:** The findings demonstrated variable accuracy in age and weight estimation of the patients. Age estimations of pediatric patients were more accurate than estimations for adult patients. The majority of patient weights were under-estimated, with university undergraduate students in one university displaying similar estimations to the other university counterparts.

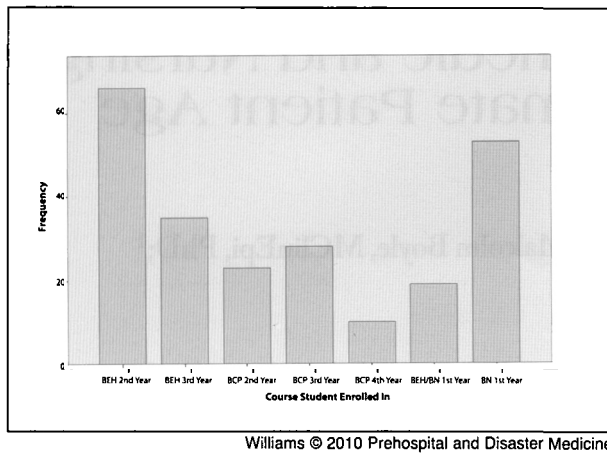
**Conclusions:** Results from this study identified variations in students' ability to accurately estimate a patient's age and weight. This study shows that consideration should be given to age and weight estimation education, which could be incorporated into undergraduate healthcare curriculum.

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#### Introduction

Accurate estimation of a patient's age and weight are skills expected of all emergency healthcare providers, including paramedics and nurses. It is a difficult and necessary skill often complicated by the inability of patients to communicate such information due to unconsciousness or an altered conscious state. Furthermore, historical information from relatives, caregivers, or bystanders may be inaccurate. Therefore, visual estimation by paramedics and other healthcare providers may be required.<sup>1-3</sup> More specifically, weight estimation often is necessary, as it is impractical to weigh a patient who may be disabled, in severe pain, receiving active resuscitation, or non-weight bearing due to trauma/injury.<sup>2</sup>

Accurate age estimation is important in patient safety standards, particularly in the pediatric and elderly population given their body mass and physiological differences.<sup>4,5</sup> In a prehospital setting, advanced age may require alternative triage considerations, especially for trauma patients. Smaller drug dosages also may be required. Age-based estimations of a child's weight are crucial for the paramedic if a parent or guardian is unavailable to provide the actual weight. Similarly, accurate estimation of weight is important in pediatric and adult patients. Weight estimation influences calculations for medication dosages, defib-



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**Figure 1**—Frequency distribution of courses are enrolled at Monash University and Charles Sturt University

rillation, equipment sizing, and other invasive procedures such as endotracheal intubation. Accurate estimation of weight by the healthcare provider is especially important when administering medication.<sup>1–6</sup> As Anglemeyer *et al* explained, over-estimation of weight and a particular drug dosage may result in potentially life-threatening side effects, while under-estimation may lead to a lack of therapeutic effect or toxic doses of the medication. However, it still is unclear what threshold of over- or under-estimation of weight is dangerous to a patient when administering drugs.<sup>7</sup>

In a search of the Medline, CINAHL, and EMBASE electronic databases, no prehospital studies were identified on the ability of paramedics to accurately estimate a patient's age. Two age estimation studies comparing manipulated, unfamiliar faces to the original un-manipulated images were conducted. Participants demonstrated accurate age estimation abilities when assessing the un-manipulated images.<sup>8,9</sup> Subsequently, one study compared age estimation by human participants to various automatic age estimation systems and found that overall, humans were inaccurate by 3.6 years.<sup>10</sup>

Using the same medical databases, a total of seven prehospital weight estimation studies, both adult and pediatric were located.<sup>2,7,11–15</sup> All of these papers studied qualified and experienced paramedic personnel, which is not the intention of this study. There are limited studies investigating weight estimations.<sup>1,3–6,16–19</sup> In those that have, the most accurate group for estimating weights in both adult and pediatrics have been the patients or caregivers themselves.<sup>1–3,12,18,19</sup>

In Australia, the paramedic discipline is an emerging healthcare field still developing its body of local knowledge and autonomous practice. This study provides the discipline with data that can be used in research-led teaching approaches that may inform undergraduate paramedic curricula. The two universities included in this study offer well-respected, pre-employment (pre-registration) degree programs offering single paramedic degrees and dual paramedic/nursing degrees. Both universities follow national competencies and curriculum standards that are offered over the same time periods.

The objective of this study was to identify whether undergraduate paramedic and nursing students from two

Australian universities were able to accurately estimate a patient's age and weight using digital patient photo images.

## Methods

### Design

This was a prospective, observational study.

### Participants

The study consisted of 234 students from two universities. Of this group, 173 (74%) students were enrolled full time at Monash University in Victoria, Australia, in the Bachelor of Emergency Health (BEH), Bachelor of Nursing (BN), or the double degree Bachelor of Emergency Health/Nursing (BEH/BN). A total of 61 (26%) students were enrolled full time at Charles Sturt University in either the Bachelor of Clinical Practice (BCP) degree or the Bachelor of Nursing/Bachelor of Clinical Practice dual degree. Inclusion criteria were being enrolled in the BEH, BN, BEH/BN, BCP, or BN/BCP and consenting to participate in the study. There were no exclusion criteria. Participation in this study was voluntary. This study was approved by the ethics committees of both universities.

### Materials

A Microsoft PowerPoint™ [Microsoft, Inc., Redmond, WA] presentation was used to show students seven patients of varying age and weight. The PowerPoint™ presentation was used so that the students, who were located in separate states, could view the same "patients". Real "patients" were not used due to the different locations of the universities and the use of minors, which has additional ethical implications. The total of seven patients of varying ages and weights was deemed sufficient to determine the student's ability to estimate age and weight. Patients were selected on a random, *ad hoc* basis that provided a varied range of gender and age. Students were shown a frontal and lateral view of the patient in a standing position. Common objects were used in the images to ensure standard depth perception. Data collection forms were supplied to record student estimations.

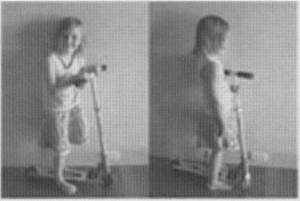
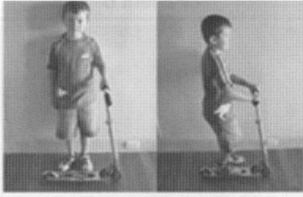


### Procedure

Students were shown the presentation in the classroom and asked to record their estimations for age and weight of each patient on their forms. Each patient appeared in the presentation for 15 seconds, then the next slide automatically appeared. This approach was used to allow students an opportunity for initial estimations of both age and weight. Fifteen seconds was considered to be an adequate time to achieve these impressions.

Data were processed using SPSS [Statistical Package for the Social Sciences Version 15.0, SPSS Inc., Chicago, IL]. Descriptive statistics were used to describe the mean and median estimations, and *t*-tests used to compare student estimations between universities. All confidence intervals (CI) were 95%.



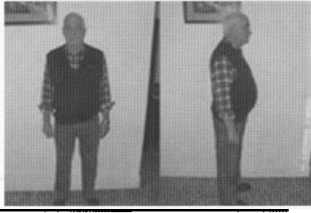
## Results

There were 234 students involved in the study; 72.6% were female and 27.4% were male, with 49% of students ( $n = 115$ ) were between 20 and 24 years of age. Students (43.2%) pri-

Patient 1	
	
<b>Actual Weight:</b> 18 kg <b>Mean:</b> 22.87 kg <b>CI:</b> 22.0 to 23.73 kg <b>Median:</b> 20 kg <b>Range:</b> 8 to 48 kg <b>% correct</b> 10.3	<b>Actual Age:</b> 4 years <b>Mean:</b> 5.29 years <b>CI:</b> 5.12 years to 5.49 years <b>Median:</b> 5 years <b>Range:</b> 3 years to 10 years <b>% correct:</b> 25.2
Patient 2	
	
<b>Actual Weight:</b> 28 kg <b>Mean:</b> 24.76 kg <b>CI:</b> 23.83 to 25.70 kg <b>Median:</b> 24 kg <b>Range:</b> 10 to 50 kg <b>% correct</b> 3.8	<b>Actual Age:</b> 6 years <b>Mean:</b> 5.64 years <b>CI:</b> 5.44 years to 5.83 years <b>Median:</b> 5 years <b>Range:</b> 2 years to 12 years <b>% correct:</b> 27.4
Patient 3	
	
<b>Actual Weight:</b> 58 kg <b>Mean:</b> 56.03 kg <b>CI:</b> 55.02 to 57.04 kg <b>Median:</b> 55 kg <b>Range:</b> 39 to 82 kg <b>% correct</b> 3.0	<b>Actual Age:</b> 83 years <b>Mean:</b> 75.56 years <b>CI:</b> 74.79 years to 76.33 years <b>Median:</b> 75 years <b>Range:</b> 55 years to 89 years <b>% correct:</b> 0.4
Patient 4	
	
<b>Actual Weight:</b> 105 kg <b>Mean:</b> 89.91 kg <b>CI:</b> 86.99 to 89.46 kg <b>Median:</b> 90 kg <b>Range:</b> 50 to 150 kg <b>% correct</b> 1.7	<b>Actual Age:</b> 44 years <b>Mean:</b> 39.21 years <b>CI:</b> 38.63 years to 39.79 years <b>Median:</b> 39 years <b>Range:</b> 29 years to 53 years <b>% correct:</b> 1.3

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Table 1—Actual age and weight for each patient is listed below with mean, median, and range. (continued on page 174)

Patient 5	
	
<b>Actual Weight:</b> 55 kg <b>Mean:</b> 59.77 kg <b>CI:</b> 58.82 to 60.72 kg <b>Median:</b> 60 kg <b>Range:</b> 43 to 110 kg <b>% correct:</b> 14.5	<b>Actual Age:</b> 60 years <b>Mean:</b> 49.44 years <b>CI:</b> 48.67 years to 50.22 years <b>Median:</b> 50 years <b>Range:</b> 34 years to 63 years <b>% correct:</b> 5.6
Patient 6	
	
<b>Actual Weight:</b> 85 kg <b>Mean:</b> 82.54 kg <b>CI:</b> 81.45 to 83.63 kg <b>Median:</b> 82 kg <b>Range:</b> 55 to 110 kg <b>% correct:</b> 14.1	<b>Actual Age:</b> 66 years <b>Mean:</b> 67.65 years <b>CI:</b> 66.58 years to 68.72 years <b>Median:</b> 68 years <b>Range:</b> 7 years to 95 years <b>% correct:</b> 0
Patient 7	
	
<b>Actual Weight:</b> 92 kg <b>Mean:</b> 80.20 kg <b>CI:</b> 79.05 to 81.35 kg <b>Median:</b> 80 kg <b>Range:</b> 30 to 120 kg <b>% correct:</b> 0	<b>Actual Age:</b> 28 years <b>Mean:</b> 34.96 years <b>CI:</b> 34.32 years to 35.60 years <b>Median:</b> 35 years <b>Range:</b> 25 years to 55 years <b>% correct:</b> 3.8

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Table 1—(continued from page 173) Actual age and weight for each patient is listed below with mean, median, and range.

marily were enrolled in year two and three of BEH, while 26.1% of students were enrolled in years 2, 3, and 4 of BCP. The remaining 30.7% of students were enrolled in the BEH/BN and BN degrees (Figure 1).

There was variable accuracy in age estimation of the seven patients, (Table 1). The closest age estimation occurred in Patient 2 with the most inaccurate age estimation occurring in Patient 5. No student correctly estimated the ages of Patient 3 or Patient 6. However, 27.4% and

25.2% of the students, respectively were able to accurately estimate the ages of Patient 2 and Patient 1.

The results also demonstrated variability in weight estimation of the seven patients. Weight was under-estimated by most students in five of the seven patients. The closest estimation occurred with Patient 6, where 14.1% of students correctly estimated the patient's weight. The most inaccurate estimation was in Patient 4, where 1.7% of students correctly estimated the patient's weight. No student

Patient	Percentage Estimates within actual weight		
	5%	10%	20%
1	10.3	14.1	48.7
2	6.4	20.1	42.7
3	26.9	47.4	82.5
4	10.7	22.2	63.1
5	19.2	73.0	85.5
6	25.6	66.2	95.7
7	15.0	33.8	84.2
Mean	16.3	39.5	73.2

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**Table 2**—Percentage of student's estimates that were within 5%, 10%, and 20% of the seven patient's actual weight

correctly estimated the weight of Patient 7. Overall, 16.3% of estimations by students were within 5% of actual patient weight, 39.5% of estimations within 10% of the actual weight, and 73.2% of estimations were within 20% of the patients actual weight. (Table 2).

For five of the seven patients, Charles Sturt University students were not significantly different in weight estimates compared to their Monash University counterparts. The two universities significantly differed in weight estimation for the pediatric patients (Table 3). Monash University students were more accurate at estimating Patient 1 than Charles Sturt University students (mean = 18.84 vs. mean = 24.29,  $p < 0.001$ ); conversely, Monash University students were more accurate at estimating Patient 2 than Charles Sturt University Students (mean = 26.50, vs. mean = 19.85,  $p < 0.001$ , Table 3)

### Discussion

This study has demonstrated that undergraduate paramedic and nursing students find estimating a patient's age and weight using digital photo images difficult in a controlled non-clinical setting. Other studies have used simulated patients and qualified personnel. Therefore, caution is required when generalizing these results.

This study does not support the findings by Lanitis *et al*, who demonstrated humans were able to reliably estimate the age of face images.<sup>11</sup> The current study demonstrated that age estimations were more accurate for pediatric patients than for adults. These findings may be the result of students using the pediatric age-weight calculations that are taught in their undergraduate studies to assist with their estimations. The pediatric weight estimation formula,  $2 \times (\text{age} + 4)$ , commonly is used in paramedic clinical practice throughout Australia and in the Advanced Pediatric Life Support course.<sup>20</sup> The use of this formula has been questioned by some<sup>21,22</sup> as not reflecting the change in international obesity levels. The use of Broselow Tape for pediatric weight and drug calculations is not used commonly in

Patient	Mean Difference	Significance
1	5.453	$p = 0.000$
2	6.645	$p = 0.000$
3	-0.758	$p = 0.519$
4	0.732	$p = 0.634$
5	0.220	$p = 0.841$
6	-1.267	$p = 0.316$
7	0.737	$p = 0.581$

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**Table 3**—Mean difference in weight estimation (kg) between Monash University students and Charles Sturt University students

Australia by on-road paramedic practice or taught in undergraduate paramedic education, although its clinical use is worthy of future considerations and examination.

The use of the Broselow Tape has been investigated in a previous out-of-hospital prospective study,<sup>6</sup> where the authors found that qualified paramedic personnel (mean experience of six years) were accurate (95%) in the four pediatric weight estimations (4.5 kg–17.3 kg) using the Broselow Tape. Of note, despite the high levels of accuracy achieved by using the Tape, the paramedics still felt uncomfortable estimating pediatric weights, thus emphasizing that future qualitative research should be performed to assess the reasons for these feelings and perceptions. In a similar prospective study,<sup>15</sup> investigators found paramedics to be reasonably accurate with pediatric weight when using the Broselow Tape (80% of the time), however, their corresponding medication doses were slightly above 50% (56%), highlighting the potential issues surrounding length-based resuscitation tapes.

Previous studies<sup>2,8,11,12,14,15,19</sup> assessed the ability of paramedics to estimate both adult and pediatric weights. All studies demonstrated that paramedics are moderately accurate at estimating body weight. Anglemyer *et al* found that visual estimation of body weight correlated well with actual weights ( $r = 0.79$ ).<sup>8</sup> Similarly, Martin *et al* found paramedic's estimation of body weight in cardiac arrest patients correlated well with actual weights ( $r = 0.93$ ).<sup>14</sup> Anglemyer *et al* found paramedic weight estimations were within 5% of the patient's actual weight 21.5% of the time.<sup>8</sup> Martin *et al* postulated that paramedic weight estimations were within 10% of actual weight 74% of the time, and within 20% of actual weight 93% of the time.<sup>14</sup> These results are similar to a prospective study in which paramedic staff were 94% accurate (within 20% of actual weight).<sup>12</sup> The results are difficult to generalize, as previous paramedic studies have not included undergraduate paramedic students, but have used experienced paramedics in their sample.

Undergraduate paramedic and nursing students appear inaccurate in estimating a patient's age and weight, especially for adult patients. Other studies using physicians, anesthetists, and nursing and paramedic personnel also have had similar results.<sup>1-6,12,17</sup> These inaccuracies have been shown to increase when patient weights are at either end of the weight spectrum.<sup>1,7</sup> Therefore, it may be useful to incorporate age and weight estimation training principles into the undergraduate health curriculum.

Frequent estimations alone do not appear to increase consistency and accuracy of weight estimation in pediatric patients, nor does being a parent<sup>11</sup> or levels of experience or qualifications.<sup>1,7,11</sup> No study has demonstrated if this is isolated to pediatric patients. Alternatively, training with feedback appears to improve age estimation ability, especially for patients in the older age group.<sup>23</sup> No studies state whether training inclusive of feedback also would improve weight estimation ability. Similarly, there have been no published paramedic-specific weight estimation papers that have compared estimations between paramedics and patients. Given the evidence of patient accuracy at self-estimations, it would be of interest to examine this relationship closer within the prehospital environment. In addition, further investigation into the application of an age and weight estimation training program should be considered for undergraduate health degrees such as paramedics and nursing.

Paramedics have been shown to over-estimate patient weights more often than they under-estimate them.<sup>14</sup> An estimation study of supine patients in ambulances demonstrated that there was an association between the number of years of experience as a paramedic and the accuracy of weight estimation.<sup>13</sup> However, the level of training was not shown to influence the accuracy of weight estimation by paramedics.<sup>11,13</sup>

Previous nursing studies have shown varied accuracy of weight estimation. Menon and Kelly demonstrated that nurses were more accurate than physicians at patient weight estimation.<sup>18</sup> Nurses were within 10% accuracy of actual weight 78% of the time, 4% greater accuracy than para-

medics discussed above.<sup>14,18</sup> Assessment of emergency department staff showed they were within 10% of actual weight on 63% of estimates.<sup>24</sup> A study of intensive care unit staff demonstrated there was a trend for staff to over-estimate low-body weight patients, yet under-estimate high-body weight patients.<sup>25</sup>

This study may be limited by several factors. First, students involved in the estimations were of varying levels of experience and year of university study. Second, the estimations were made using PowerPoint™ presentation slides rather than assessing the patients in person. The PowerPoint™ presentation was used due to ethical implications and the fact that the students were in two different locations, thereby making it difficult to use real people. These estimations also were made in a non-clinical setting. Therefore, this method may not be as reliable as realistic, stressful clinical situations. Students were limited by a 15-second timeframe in which to estimate each patient's age and weight, which may have been insufficient.

### Conclusions

This study identified a variation in paramedic and nursing students from two Australian universities, and their ability to accurately estimate a patient's age and weight. This study has shown that consideration should be given to age and weight estimation education, which subsequently could be incorporated into undergraduate healthcare curriculum. Students demonstrated variable accuracy in age estimation, with age estimations of pediatric patients more accurate than estimations of adult patients. Additionally, weight estimation results demonstrated inaccuracy and a tendency for underestimation, with Monash University students being no different in age or weight estimation ability than their Charles Sturt University counterparts.

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### References

- Corbo J, Corbo J, Canter M, Grinberg D, Bijur P: Who should be estimating a patient's weight in the emergency department? *Acad Emerg Med* 2005;12(3):262-266.
- Hall WL 2nd, Larkin GL, Trujillo MJ, et al: Errors in weight estimation in the emergency department: Comparing performance by providers and patients. *J Emerg Med* 2004;27(3):219-224.
- Sanchez LD, Imperato J, Delapena JE, et al: Accuracy of weight estimation by ED personnel. *Am J Emerg Med* 2005;23(7):915-916.
- Coe TR, Halkes M, Houghton K, Jefferson D: The accuracy of visual estimation of weight and height in pre-operative supine patients. *Anaesthesia* 1999;54(6):582-598.
- Uesugi T, Okada N, Sakai K, et al: Accuracy of visual estimation of body height and weight in supine paediatric patients. *Paediatr Anaesth* 2002;12(6):489-494.
- Greene S, Dargan P, Shin GY, Jones AI: Doctors and nurses estimation of the weight of patients: A preventable source of systematic error. *J Toxicol Clin Toxicol* 2004;42(5):611-615.
- Anglemyer BL, Hernandez C, Brice JH, Zou B: The accuracy of visual estimation of body weight in the ED. *Am J Emerg Med* 2004;22(7):526-529.
- Burt DM, Perrett DI: Perception of age in adult Caucasian male faces: Computer graphic manipulation of shape and colour information. *Proc Biol Sci* 1995;259(1355):137-143.
- George PA, Hole GJ: The role of spatial and surface cues in the age-processing of unfamiliar faces. *Visual Cognition* 2000;7(4):485-509.
- Vilke G, Marino A, Fisher R, Chan T: Estimation of pediatric patient weight by EMT-PS. The *Journal of Emergency Medicine* 2001;21(2):125-128. Available at [http://www.jem-journal.com/article/S0736-4679\(01\)00354-7/abstract](http://www.jem-journal.com/article/S0736-4679(01)00354-7/abstract). Accessed 19 March 2010.
- Lanitis A, Draganova C, Christodoulou C: Comparing different classifiers for automatic age estimation. *IEEE transactions on systems, man, and cybernetics. Part B, Cybernetics: A publication of the IEEE Systems, Man, and Cybernetics Society* 2004;34(1):621-628.
- Axelband J, Malka A, Jacoby J, Reed J: Can emergency personnel accurately estimate adult patient weights? (Abstract). *Ann Emerg Med* 2004;44(4):S81.
- Lieb N, Gluckman WA: Accuracy of adult patient weight estimation by EMS providers. *Prehosp Emerg Care* 2004;8(1):96-97.
- Martin DR, Soria DM, Brown CG, et al: Agreement between paramedic-estimated weights and subsequent hospital measurements in adults with out-of-hospital cardiac arrest. *Prehosp Disaster Med* 1994;9(1):54-57.
- Moore BR, Hankins DG, Shimmin S: Use of the length-based resuscitation tape for estimating pediatric weight in the pre-hospital setting (abstract). *Prehosp Emerg Care* 2004;8(1):87.
- Bloomfield R, Steel E, MacLennan G, Noble DW: Accuracy of weight and height estimation in an intensive care unit: Implications for clinical practice and research. [see comment]. *Crit Care Med* 2006;34(8):2153-2157.
- Determann RM, Wolthuis EK, Spronk PE, et al: Reliability of height and weight estimates in patients acutely admitted to intensive care units. *Crit Care Nurs* 2007;27(5):48-56.

18. Menon S, Kelly AM: How accurate is weight estimation in the emergency department? *Emerg Med Australasia* 2005;17(2):113–116.
19. Zikos V, Patel A, Rzechula K, McQuillen K: The accuracy of pediatric weight in the emergency department: Do caregiver weight estimates measure up? (abstract). *Ann Emerg Med* 2007;50(3):S123–S124.
20. Advanced Life Support Group: *Advanced Pediatric Life Support*. 3rd ed. London: BMJ Publishing Group, 2003.
21. Luscombe M: Kids aren't like what they used to be: A study of paediatric patient's weights and their relationship to current weight estimation formulae. *British Journal of Anaesthesia* 2005;95(4):578.
22. Tinning K, Acworth JP: Make your best guess: An updated method for paediatric weight estimation in emergencies. *Emerg Med Australasia* 2007;19(6):528–534.
23. Sorqvist P, Eriksson M: Effects of training on age estimation. *Applied Cognitive Psychology* 2007;21(1):131–135.
24. Kahn CA, Oman JA, Rudkin SE, et al: Can ED staff accurately estimate the weight of adult patients? *Am J Emerg Med* 2007;25(3):307–312.
25. Bloomfield R, Steel E, MacLennan G, Noble DW: Accuracy of weight and height estimation in an intensive care unit: Implications for clinical practice and research. *Crit Care Med* 2006;34(8):2153–2157.