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Emergency Medicine Australasia (2005) **17**, –

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ORIGINAL RESEARCH

How accurate is weight estimation in the emergency department?

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Abstract

Objective: To determine the accuracy of medical staff, nursing staff and patients for estimating weight in an ED population.

Methods: This is a prospective, observational study. Medical staff, nursing staff and patients were asked to estimate patient weight that was then measured. The main outcome was average per cent error in weight estimation for each group.

Results: Average per cent error in estimates was 3.9% for patients (95% CI 3.6–4.1%), 7.7% (95% CI 7.2–8.2%) for nurses and 11% (95% CI 10.2–11.7%) for physicians. Ninety-one per cent of patients (95% CI 90–93%), 78% of nurses (95% CI 75–80%) and 59% of physicians (95% CI 56–63%) made weight estimates accurate to within 10% of actual weight.

Conclusion: Patients are generally accurate in estimating their true weight and health care workers showed only moderate accuracy. Where possible, drug dose calculations should be based on measured weight and if this is not possible, patient estimate of weight should be sought. Health care worker estimation should be used only when this is not possible.

Key words: *drug dosage*, *weight*.

Introduction

2 Accurate patient weight is an important because a number of drugs administered in the ED are administered based on weight, including thrombolytic agents, low molecular weight heparin, phenytoin and amiodarone. Incorrect dosing of these drugs could lead to adverse effects including toxicity and lack of therapeutic effect.

Ideally, patients could be weighed, however, for a significant proportion of ED patients, this is not always practical. These include those who are critically ill, have altered mental state, are disabled or are non-weight bearing because of injury. For this population, it is common for weight to be estimated by treating nursing and medical staff and drug doses calculated accordingly. The safety of this practice is open to question. Previous studies in both adults and children suggest that weight estimations by treating staff are inaccurate.[1,2] These have, however, involved fairly small samples (100 and 117 patients, respectively). The objective of the study was to determine the accuracy of medical staff, nursing staff and patients at estimating patient weight in the ED population in a large sample of patients.

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Methods

The study was a prospective, observational study of a convenience sample of patients presenting to the ED of Western Hospital, a 300-bed community teaching hospital with an annual ED census of 32 000, the vast majority of whom are adults. The population served by this ED is culturally and ethnically diverse with 20 major language groups. Data were collected in the months of February to May 2004 and entered directly onto specifically designed data collection forms. It included age, gender, nursing, medical and patient estimates of weight and actual weight (measured in kilograms to the nearest kilogram). Staff were asked to record their estimates before weighing the patient and not to reveal them to each other or the patient. Weight was measured using two standing scales that were regularly checked for accuracy.

All patients able to have their weight measured by a standing scale were eligible for entry into the study. Ethics approval was waived as no specific identifying information was collected from patients and the estimation and measurement of weight could be considered part of the normal examination.

The main outcome was average per cent error in weight estimation (calculated as the absolute difference between estimated and actual weight divided by actual weight) for each of the nursing, physician and patient groups. Secondary analyses included per cent accuracy to within 5 kg and 10 kg of actual weight by group.

Data were analysed using descriptive statistics, multivariate analysis and modified Bland–Altman analysis plotting and comparing actual weight to the absolute difference between actual and estimated weight for each group. Significance was set at $P < 0.05$.

Results

A total of 1137 patients were studied. This represents 11% of patient attendances during the study period. The median age was 45 years (range 1–96 years) and only 16 patients were children aged less than 16 years. Fifty-eight per cent of the sample were men. There were 1028 patient estimations, 1135 nurse estimations and 775 physician estimations. The weights ranged from 9 to 231 kg with a median of 74 kg (interquartile range 24 kg).

Average per cent error in estimates was 3.9% for patients (95% CI 3.6–4.1%), with 91% (95% CI 90–93%) of patients accurate to within 10% of actual weight and 74% (95% CI 71–76%) to within 5% actual weight. For nurses, the average per cent error in estimates was 7.7% (95% CI 7.2–8.2%), with 78% (95% CI 75–80%) accurate to within 10% actual weight and 44% (95% CI 41–47%) to within 5% of actual weight. Physicians performed less well with average per cent error in estimates of 11% (95% CI 10.2–11.7%). They were accurate to within 10% actual weight in 59% (95% CI 56–63%) of cases and to within 5% in 33% of cases (95% CI 30–36%). The distribution of per cent error in estimation compared with actual weight for each group is shown in Figure 1. In all groups, overestimation of weight was more common than underestimation.

Modified Bland–Altman plots, plotting absolute difference between true and estimated weight versus true weight are shown in Figures 2–4. The 95% limits of agreement for patients in estimation of their weight were −8 to +10 kg, for nurses was −12 to +20 kg and for doctors was −44.5 to +55 kg.

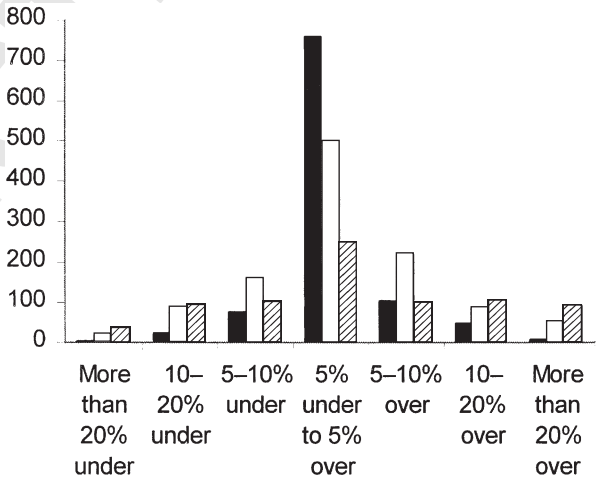

Figure 1. Per cent error in weight estimation compared with actual weight for each group. ■, Patient estimate; □, nursing estimate; ▨, physician estimate.

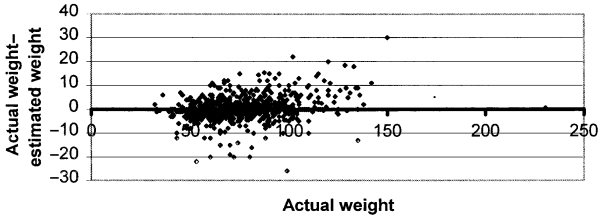

Figure 2. Modified bias plot of absolute difference between actual weight and weight estimated by patient versus actual weight.

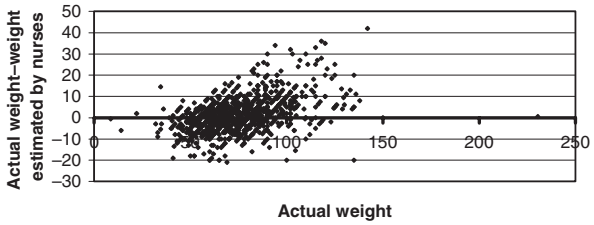

Figure 3. Modified Bland–Altman plot of actual weight versus the absolute difference between actual weight and weight estimated by nurses.

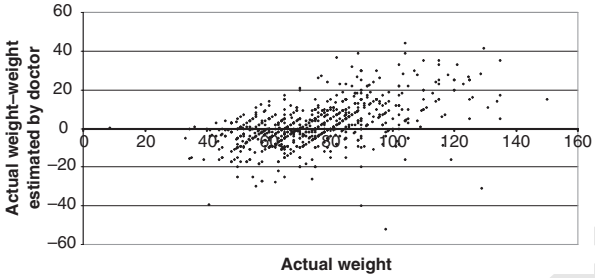

Figure 4. Modified Bland–Altman plot of actual weight versus the absolute difference between actual weight and weight estimated by doctor.

Multivariate analysis exploring the relationship between per cent error in weight estimate and the variables (patient age, patient gender and actual weight), found that for patients, nurses and physicians, per cent variance from actual weight increased with actual weight ($P < 0.001$).

Discussion

Our results confirm that patients are generally accurate in estimating their true weight and that health care workers have only moderate accuracy. The large sample size and ethnic diversity of this sample taken together with previously published data[1–3] suggest the errors in weight estimation by health care workers are common.

These findings were similar to those reported by Fernandes[2] *et al.* who found that nurses and physicians were accurate in weight estimates to within 10% of actual weight only 66% of the time. In contrast, 97% of patients were accurate in estimating to within 10% of their actual weight. Similarly, Harris *et al.*[1] in a study comparing weight estimates by parents, nurses and doctors with actual weights in 100 children, found that the range of estimates was broad in each group (parents +292% to –41%, nurses +30% to –36% and physicians +43% to –56%). They reported that 29% of physicians' estimates, 40% of nurses' estimates and 16% of parents' estimates differed from the actual weight by more than 15%. A similar study[3] comparing weight estimates by paramedics and actual weights for 133 patients who had suffered a cardiac arrest, found that paramedic estimates of weight were within 10% of the measured weights in 74% of the patients, and within 20% of measured weights in 93% of the patients.

Recently Sanchez *et al.*[4] reported the results of a study comparing the accuracy of weight estimations in the ED for 255 patients in the USA. They reported the mean percentage error was 2.8% for patients, while it was 11% for nursing staff and 11.5% for medical staff. Similar inaccuracy of medical and nursing staff has been reported in the anaesthetic and ICU settings.[5,6]

Taken together, the weight of evidence suggests that health care worker accuracy in weight estimates is only moderate. When weight cannot be measured, an estimate by the patient should be sought with health care worker estimation used only when this is not available.

The findings that physicians perform worse than nurses in estimating weights is interesting. This study was not designed to identify reasons for this, however, one potential explanation might be that nurses assist patients to remove clothing for examination and have an opportunity to examine patients undressed.

The clinical implications of error in weight estimation are considerable. In particular, they relate to the safety and efficacy of drugs administered. An example of this is the thrombolytic tenectplase. The TIMI 10B and ASSENT-1 studies[7,8] have shown that weight-optimized drug dosing improved the efficacy and safety of this drug. It has also been shown that patients with lower body weights may have a higher likelihood to develop bleeding complications.

In this study we measured actual weight while most weight-based drug dosages are traditionally based on ideal body weight. The evidence base for this practice is unclear. A recent review found that total body weight tends to be a better predictor of drug volume of distribution.[8] This is of particular importance to drugs that have a high lipophilicity. Lean body weight was a more accurate predictor of the clearance of a drug. This is particularly of concern in chronic drug administration and it was recommended that chronic dosing of drugs

be based on lean body weight.[8] The optimum dosing regime, especially for loading doses, in EDs remains unclear.

If it is accepted that 'ideal' body weight is the preferred basis for drug dosing, it may be possible to calculate this from body parameters including height and frame size.[9] Unfortunately, patients who are unable to be weighed for clinical reasons are also likely unable to stand for an accurate height estimation. Also the tables upon which these are based are derived from the US population so generalizability to the ethnic mix of the Australian population can be challenged.

This study has some limitations that should be considered when interpreting the results. This was a convenience sample of patients and was reliant on staff enrolling patients. We are unable to say what proportion of eligible patients were enrolled but believe that the large sample size minimizes any bias this might have introduced. We asked staff to record their estimates before weighing patients, but this instruction may not always have been followed. If that were the case, the average per cent error of health care worker estimates reported here would likely be an underestimation. No attempt was made to investigate if per cent error varied by ethnicity.

Conclusion

Patients are generally accurate in estimating their true weight and health care workers have only moderate accuracy. Where possible, drug dose calculations should be based on measured weight and if this is not possible, patient estimate of weight should be sought. Health care worker estimation should be used only when this is not possible.

Acknowledgements

The authors would like to thank the staff of the ED of Western Hospital for their participation in this project and Ms Debra Kerr and Professor Stephen Farish for assistance with data analysis and constructive comments on the manuscript.

Author contribution

Drs Menon and Kelly designed the study. Dr Menon organized data collection and data entry. Dr Kelly analysed the data. Drs Menon and Kelly interpreted the results. Dr Menon wrote the draft manuscript that was modified with input from Dr Kelly.

Competing interests

None declared.

Accepted 9 November 2004

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