Estimation of body surface area: nomogram vs mathematical equations

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Introduction

Body surface area (BSA) has been used in clinical practice to determine dosage of medication and in standardisation of biological parameters such as creatinine clearance, cardiac out put etc. BSA is estimated from measured height and weight, either with a nomogram or using a mathematical equation. There are many mathematical equations in the published literature but many are complex and may not be practical for use in busy wards or clinics [1]. The equation described by Mosteller is the simplest, and could estimate BSA using a non-scientific calculator [2]. The Boyd-West nomogram is a simple technique to estimate BSA, but has led to more estimation errors than the Mosteller equation [3]. Many would prefer to use a simple mathematical equation over a nomogram if the results produced by latter are accurate [4]. This study was designed to compare the accuracy of the Boyd-West nomogram and Mosteller equation in the estimation of BSA when used by medical officers (MO).

Methods

Medical officers of the Lady Ridgeway Hospital who volunteered participated in this study. The investigators administered a single data set, collected during a previous community study, to the volunteers (MO). Twenty pairs of height and weight measurements were given to each MO. The MO estimated the BSA first with the nomogram, and after one week using the Mosteller equation. Two authors (VPW and GS) independently estimated the BSA using both methods and mutually agreed on the final BSA. The BSA estimated by each MO was cross validated against the BSA estimated by the authors for each of the two methods. Pearson product moment correlation was used to assess the association between BSA estimated by each MO and investigator. Bias was calculated by subtracting the BSA assessed by the investigators from the value obtained by the MO. Data were analysed using the NCSS 2000 (Hintze JL, Kayswille, Utah, USA) statistical computer package.

Results

Sixty six medical officers belonging to five different categories were recruited. There were 25 intern house officers (HO), 7 senior house officers (SHO), 24 third year trainee paediatric registrars, 8 paediatric senior registrars (SR) and two consultant paediatricians. Due to the small numbers, data of the two paediatricians were not included in the analysis.

Table 1 shows the Pearson product moment correlation between BSA assessed by investigator and medical officers of each category for both methods. All showed statistically significant associations, but the correlation when using the nomogram was weaker than when using the Mosteller equation. Table 2 shows the bias in the assessment of BSA by each medical officer category, for the two methods. Bias was highest when using the nomogram and the mean bias ranged from 0.093 m^2 to 0.245 m^2. When assessment was done by the Mosteller equation, and the mean bias was relatively lower and ranged from 0.0014 m^2 to 0.0108 m^2. When using both methods the highest bias was seen when SHOs made the assessment. There were few common errors: plotting the child's weight in kilograms on the scale labeled "weight in pounds" and reading errors of the decimal points.

Discussion

Calculation of BSA is frequently used in day to day clinical practice. Accurate assessment is important as BSA is mostly used for prescribing medication. The Boyd-West nomogram has been used widely and has become accepted as almost the gold standard. However, there are studies which show that several mathematical equations give equally consistent results. Of these equations, the Mosteller is the easiest to use and gives reliable estimates of BSA [Wickramasinghe *et al* unpublished data].

This study showed a high degree of error when using the nomogram to estimate BSA. The medical officers were all familiar with the nomogram, and although they may have checked values more carefully in an actual clinical setting, the errors made show the potential weakness of the nomogram. The degree of error when using the Mosteller equation was relatively low. Most of the assessments using both methods were under-estimations, and this could result in under dosing of medication with poor treatment outcomes.

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Table 1. **Association between BSA assessed by each medical officer and the criterion method for each technique**

		Nomogram	*Mosteller*
	N	*r (p value)*	*r (p value)*
SR	8	0.691 (<0.01)	0.999 (<0.01)
Registrar	24	0.783 (<0.01)	0.999 (<0.01)
SHO	7	0.642 (<0.01)	0.995 (<0.01)
HO	25	0.724 (<0.01)	0.998 (<0.01)

Table 2. **Mean bias and standard error for the assessment of BSA using the two methods by each medical officer category**

		Nomogram		*Mosteller*	
	N	*Mean bias ± SD*	*SE*	*Mean bias ± SD*	*SE*
SR	8	-0.155±0.25	0.0197	-0.001 ±0.005	0.0004
Registrar	24	-0.093 ±0.21	0.0098	-0.001 ±0.005	0.0003
SHO	7	-0.245 ±0.27	0.0229	-0.011 ±0.026	0.0022
HO	25	-0.171 ±0.34	0.0105	-0.004 ±0.015	0.0006

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