Section: Paediatrics

Original Research Article

A STUDY ON ESTIMATION OF WEIGHT USING MUAC AND LENGTH IN CHILDREN 6 MONTHS TO 6 YEARS

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Abstract

Background: The mid arm circumference is already being used as a screening tool to determine nutritional assessment, especially for monitoring of improvement among malnourished children. Because of its correlation to weight, a study has been done among children, made use of the mid upper arm circumference and generated a formula that can be used to estimate the weight. Weight=(MAC-10) × 3 in kg. In our present study the actual weight of children aged 6 months to 6 years old is compared to the estimated weight using mid upper arm circumference and length using Broselow tape and to analyse their significance. **Materials and Methods:** The patient's actual weight was observed by trained person (intern) in SVMCH & RC who were not be aware of this study. Weighing machine was used for children >2 years of age and infant weighing machine was used for <2 years. The patients was weighed wearing light clothing and no foot wear. Results rounded off to nearest 0.2 kg. Mid arm circumference measured using a standard measuring tape, with the child's left arm relaxed in a 90 degree angle, the midpoint between the acromion and olecranon marked, and the tape wrapped around the arm, making sure that the tape lies flat against the skin. Results rounded off to the nearest 0.1 cm. Length of the baby measured using Borselow tape. **Result:** From our analysis, the prediction accuracy of the Broselow tape and MUAC in estimating weight of children was significant in any of the groups ($p<0.0005$). In this study population, Broselow tape and MUAC perform well in estimating weight. **Conclusion:** Broselow tape performed well in our study population. The implication of this study is that Broselow tape and MUAC are relatively accurate. Additional research is needed to establish a pharmacokinetic "target weight" which should be used for drug dose calculation, and therefore weight estimation strategies.

INTRODUCTION

There is a need to have simple length-based estimation method. One of the most widely used method would be the Broselow -Luten color coded tape designed to estimate the body weight, drug doses and endotracheal tube sizes based on body length among children aged 6 months to 6 years old. This method was discussed in the AHAP Advanced Life Support courses. Recent studies show that it may underestimate weight among obese children, children of different race and ethnicity.[1-6] Because of these limitations, a better way to estimate weight has been put forth. Alternate method proposed is by making use of the midarm circumference (MAC). The mid arm circumference is already being used as a screening tool to determine nutritional assessment, especially for monitoring of improvement among malnourished children. Because of its correlation to weight, a study has been done among children, made use of the mid upper arm circumference and generated a formula that can be used to estimate the weight. Weight=(MAC-10) × 3 in kg.[7-10]

In our present study the actual weight of children aged 6 months to 6 years old is compared to the estimated weight using mid upper arm circumference and length using Broselow tape and to analyse their significance.

Aim

To compare the actual weight of children aged 6 months to 6 years old to the estimated weight using mid upper arm circumference and child's length using Broselow tape.

MATERIALS AND METHODS

This comparative study included 468 patients of children aged 6 months to 6 years in the Department

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of paediatrics for one year. This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Children aged 6 months to 6 years old seen at Pediatrics Outpatient Department who gave their informed consent was included in the study.

Exclusion Criteria

1. Date of birth is not known
2. With apparent upper limb deformities.
3. Children >2 years old who cannot stand upright

Methods: All subjects who met the inclusion criteria will take part in the study. Patient information sheet which includes basic information such as patient's name, age and gender will be answered by the relative or primary caregiver. The patient's actual weight was observed by trained person (intern) in SVMCH & RC who were not be aware of this study. Weighing machine was used for children >2 years of age and infant weighing machine was used for <2 years. The patients was weighed wearing light clothing and no foot wear. Results rounded off to nearest 0.2 kg. Mid arm circumference measured using a standard measuring tape, with the child's left arm relaxed in a 90 degree angle, the midpoint between the acromion and olecranon marked, and the tape wrapped around the arm, making sure that the tape lies flat against the skin. Results rounded off to the nearest 0.1 cm. Length of the baby measured using Borselow tape.

Statistical analysis: The collected data were analysed with IBM.SPSS statistics software 23.0 Version.To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To assess the relationship between the variables Pearson's Correlation was used and to repreent the degree of relationship between the method the Scatter plot was used and the Bland Altman plot was used to assess the agreement between the methods of predict the weights in the above statistical tools the probability value .05 is considered as significant level.

RESULTS

During the study period, 468 children were included in our study. 88 children were grouped under 10kg, 351 children were included in 10 – 20kg group, 29 children in more than 20kg group. Majority of them were females (65%, n=304). The below [Table 1] illustrates the gender distribution of the sample.

Table 1

		Frequency	Percent
	Female	164	35.0
	Male	304	65.0
	Total	468	100.0

The correlation between actual weight and tape weight was excellent, with the r2 values for the Broselow tape being 0.937 and with the r2 values for the MUAC being 0.876. Correlation using Broselow tape is better compared to correlation using MUAC. Correlation was generally best in lesser weight groups ie., infants and younger children when compared with older children

The analysis shows the performance of Broselow tape in estimating weight of the children, in which only 41.3% of children have predicted weight within 10% of actual weight. 96.6% cases are within 25% of actual weight. The performance of MUAC in estimating weight of the children, in which only 32.9% of children have predicted weight within 10% of actual weight. 67.9% cases are within 25% of actual weight.From our analysis, the prediction accuracy of the Broselow tape and MUAC in estimating weight of children was significant in any of the groups ($p<0.0005$). In this study population, Broselow tape and MUAC perform well in estimating weight.

The study enrolled 304 (65%) male children and 164 (35%) female children. The overall mean ± standard deviation for age was 3.06 ± 1.67 years (median age 3.0 years). The mean ± standard deviation for measured weight as 13.47 ± 4.32kg (median 13.0kg). The mean ± standard deviation for Broselow tape weight was 13.88 ± 4.36kg. The mean ± standard deviation for MUAC weight was 15.26 ± 6.52kg Demographic characteristics are summarised in [Table 2].

Table 2: Statistics

	Age	Actual Weight	Estimated Weight Using MUAC	Error MAUC	Weight Using TAPE	Error TAPE
Mean	3.06	13.47	15.26	11.42	13.88	4.14
Median	3.00	13.00	13.50	12.50	13.00	0.00
Std. Deviation	1.67	4.32	6.52	24.01	4.36	11.97
Minimum	.50	4.5	4.5	-50.00	6.0	-33.33
Maximum	6.00	28.0	34.5	80.00	28.0	60.00

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DISCUSSION

Safety of patients and reducing the medical errors, both are contemporary issues in emergency settings. In our settings, we have found that ED has been the most error prone place with drug dosage error as the principal cause in paediatric age group. In an emergency resuscitation, management of critically ill children requires accurate weight to determine drug doses. Hence we need a reliable method of estimating weight in that particular emergent setting. The end point in estimation of weight, should be more than just the weight itself, which means during management of sick children, the resuscitation team must concentrate on medical management of patient and should not get distracted by other issues such as determination of drug doses and equipment sizes which can be made easy by incorporating evidence based resuscitation aids such as looking them on a chart or computer that does not require active or non-automatic thinking or memory.[11,12]

In view of this simple reason, a complete system is ideal for use during the paediatric resuscitation so that one or more devices can be used automatically to predict weight, to guide on equipment size selection and to provide drug dosaging, dilution and delivery information. Other issues that are important in the selection or development of a resuscitation aid include cost, availability, ease of use, disposability and transportability. There are two components in a resuscitation aid. First one being the weight estimation system, which are best embodied in a length-based tape system and MUAC. The second component is to provide essential information to the resuscitation team on drug doses and equipment sizes which should not be trusted to memory. It may come from a tape or a chart or a booklet that should be specifically designed to provide relevant information to the entire team and not just the doctor, to minimise the possibility of errors during a time of high cognitive load and emotional stress.[13]

Currently Broselow tape is used during resuscitation aid. Previous studies have used target estimation error of within 10% as acceptable for drug dose calculation and this error percentage has been followed by most in weight estimation studies. Few studies have been done using a weight-estimation error of within 20% as acceptable. Our study also have used 10% error as acceptable for drug dose calculation. The reason why an error percentage of 10% has been allowed was, other latent, unavoidable and undetectable errors may occur. It is outrageous to expect weight estimation to be more precise than the drug dose error that is already possible because of drug concentration variability. Errors related to the rounding-off of body weight also contributes to a remarkable degree of variability that cannot be easily determined.[14]

In our study the performance of Broselow tape in estimating weight of the children, only 41.3% of children have predicted weight within 10% of actual weight. 96.6% cases are within 25% of actual weight. The performance of MUAC in estimating weight of the children, only 32.9% of children have predicted weight within 10% of actual weight. 67.9% cases are within 25% of actual weight. From our analysis, the prediction accuracy of the Broselow tape and MUAC in estimating weight of children was significant in any of the groups ($p<0.0005$).[15]

In a study by Saily Britnell et al, they have found that Broselow tape included 73.4% of children within 10% of a child's measured weight. In a study by Michael David John Wells et al, the percentage of children within 10% of measured weight was around 64%.

The mean percentage error (MPE) for broselow tape, showed an overestimation of 4.14%,and the precision for MPE, reflected by Standard deviation was 11.97. The mean percentage error (MPE) for predicted weight using MUAC, showed an overestimation of 11.42%, and the precision for MPE, reflected by Standard deviation was 24.01.

The overall bias, as demonstrated by Bland-Altman methodology was an underestimation of mean weight 1.8 kg for the weight measurement using MUAC. Precision of our study with 95% confidence limits of the Bland-Altman methodology was -8.5kg to 5kg. Similarly for Breslow tape, the underestimation of mean weight 0.4 kg . Precision of our study with 95% confidence limits of the Bland-Altman methodology was -3.4kg to 2.6kg.

The coefficient correlation of the agreement between measured weight and weight predicted by Broselow tape for entire study population and for each groups are comparable with other studies. Our study had a correlation coefficient of 0.937 using Breslow tape and of 0.876 using MUAC. The study by Michael David John Wells et al had a correlation coefficient of 0.946 and in the study by Farhad Asskaryar et al the correlation coefficient was found to be 0.954 for boys and 0.9 for girls.

Correlation was generally best in lesser weight groups ie., infants and younger children when compared with older children.

CONCLUSION

The correlation with actual weight was better overall and in each weight category. Both measures of the tape bias (Mean Percentage Error and Bland-Altman analysis) were significantly higher in the study population. The measure of tape precision (SD of Mean Percentage Error) was significant in this study population. Broselow tape predicted weight within 10% of actual weight only in 41.3% of the entire study population and MUAC predicted weight within 10% of actual weight only in 32.9% of the entire study population.Broselow tape often underestimates weight in our study population. Statistical analysis shows that the tape has underestimated weight by 0.4 kg and MUAC has underestimated weight by 1.8kg.The Mean percentage error for tape was 4.14%,

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which is high and SD of MPE was 11.97. Mean percentage error for MUAC was 11.42%, which is high and SD of MPE was 24.01 .Broselow tape performed well in our study population. The implication of this study is that Broselow tape and MUAC are relatively accurate Additional research is needed to establish a pharmacokinetic "target weight" which should be used for drug dose calculation, and therefore weight estimation strategies.

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