

FOOT TAPE MEASURE FOR IDENTIFICATION OF LOW BIRTH WEIGHT NEWBORNS

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ABSTRACT

The majority of births in rural India take place at home, Logistic constraints make early and reliable identification of low birth weight babies difficult. Using neonatal foot length as a proxy measure for birth weight, we devised a tri colored foot tape intended for use at home by the neonatal caretaker or birth attendant. The tape was field tested in a rural community in the Pune district. Results showed a sensitivity of 68.2% and a predictive value of 45.5% for identifying low birth weight. For very low birth weights (<1500 g) the sensitivity was 100%, specificity 95.2% and the positive predictive value 60%. Interobserver reliability comparing a trained medical social worker and the household member was high (κ score of 0.82). If implemented on a larger scale this simple, low cost technology has the potential to significantly enhance the yield of identification of low birth weight babies born at home.

Key words: Foot length, Low birth weight.

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Early identification of low birth weight babies is difficult in most communities as the majority of births are conducted by untrained attendants at home. The non-availability of weighing scales makes it difficult to record the weight even if a health worker does reach the household within the first 24 hours. Various anthropometric-measurements have been identified as proxy measures for birth weight during the first week of life(1-8). Though easier to obtain than birth weight, they still require a health worker to visit the household within the first week. Identification of low birth weight babies delivered at home can be enhanced only if the tool used for detection is simple enough to be used by the mother. Using foot length as the proxy measure, we designed a tri-colored foot tape to detect low birth weight. This study was undertaken to test the sensitivity and specificity of the tape to detect low birth weight and also to test the observer variability between a trained social worker and an illiterate neonatal caretaker in the use of this tape.

Material and Methods

Based on the analysis of data of 1922 newborns from the community based WHO study, on low birth weight and infant morbidity and mortality, undertaken by K.E.M. Hospital Research Center, Pune (unpublished observations—Final report submitted in 1990 to WHO, SEARO), it was decided to take birth weights of 1500 g and 2500 g as the cut off points for high risk, as the neonatal and infant mortality risks changed significantly at these birth weights (Table I).

Foot lengths of 6.35 and 7.63 cm were identified from regression analysis as the cut-off points corresponding to a birth weight of 1500 and 2500 g respectively. Using these cut off points, a 10 cm long

TABLE I—Neonatal and Infant Mortality Risks in Relation to Birth Weight

Birth weight (g)	Neonatal mortality risk (95% CI)*	Infant mortality risk (95% CI)
<1500	56.21 (26.9, 117.2)	20.72 (13.0, 32.9)
1500-1750	18.52 (7.2, 47.7)	6.45 (3.0, 13.8)
1750-2000	9.07 (2.9, 28.7)	4.73 (2.1, 10.9)
2000-2250	4.13 (1.7, 10.3)	2.16 (1.15, 4.1)
2250-2500	2.02 (0.74, 5.5)	2.0 (1.1, 3.6)
2500-2750	1.00	1.00
2750-3000	0.25 (0.03, 2.0)	0.53 (0.22, 1.3)
3000-3250	0.52 (0.11, 2.4)	0.36 (0.12, 1.02)
>3250	0	0

*CI = Confidence intervals

paper tape divided into three color zones, was designed. Each color zone, in addition to indicating the birth weight also suggests the course of action to be taken should the weight of the child fall in that particular zone. Thus the red zone (0-6.3 cm) advises immediate referral to the hospital, while the yellow zone (>6.3-7.5 cm) suggests domiciliary management under supervision of a health worker. The green zone (>7.5 cm) is an indication for continuing with routine neonatal care. Each tape was pasted on to a used X-ray film (of which supplies were readily available) to give it rigidity without sacrificing flexibility.

This study was conducted in a population of 100,000 spread over 45 villages in a

rural area of Pune district, from January to April 1991. All live births identified in the study area during this period and weighed within 24 hours of birth, were included in this study. Birth weight was measured to the nearest 50 g using a Salter type of spring balance. Live births who could not be weighed within 24 hours were excluded. Live births beyond 7 days of age at the time of identification were also excluded from the study since foot length taken beyond the first week of life may not be a valid proxy for birth weight. A total of 89 newborns were thus enrolled in the study.

Two observations of foot tape measurements were recorded for each neonate, one made by a social worker trained in the

correct use of the foot tape, and the other by the neonatal caretaker/mother. All observations were made within the first seven days from birth. Foot length was measured by placing the tape obliquely along the sole of the right foot from the tip of the heel to the tip of the great or second toe (whichever was the longer length) ensuring that the toes were fully extended (*Fig.*). The use of the foot tape was explained to the mother by the social worker but both observations were made independently and the latter if present when the mother used the foot tape, remained a passive observer and did not offer any suggestions of point out faults in the technique. The results obtained by the social worker and by the mother independently, were recorded. The social worker and the neonatal caretaker were blinded with respect to the relation between the color zones on the foot tape and the birth weight categories.

Sensitivity, specificity and predictive value of the foot tape were calculated. The

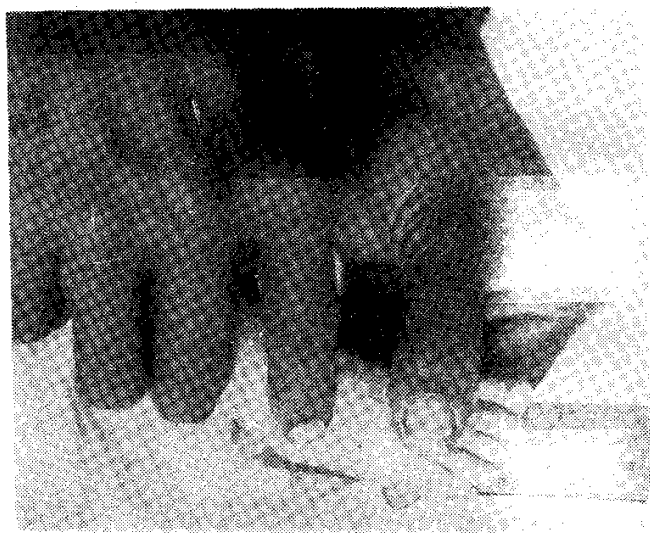


Fig. The foot tape being used to determine the birth weight status of a newborn.

degree of inter observer agreement was quantified using the κ score which is a measure of the degree of agreement over and above that expected by chance alone(9). The direction of disagreement between the two observers was determined using matched odds ratios. The ratio is a measure of the two types of discordances that can occur when pairs of observations are expressed in a 2×2 contingency table(9-11). The intra class correlation coefficient(ICC) was also computed since this is a better approximation of the κ score when dealing with observations that involve ordered categories with two or more observers(10,11).

Results

A total of 178 observations were made on 89 newborns. A total of 37.1% were low birth weight (1500-2500 g) and 6.74% were very low birth weight (<1500 g). The sensitivity, specificity and positive predictive value of the tape stratified by birth weight category are presented in *Table II*. The positive predictive value (74.6%) was the maximum for predicting a normal weight newborn. The sensitivity and specificity of the tape was highest when the birth weight was <1500 g. The tape had a relatively lower specificity and positive predictive value for neonates between normal and low birth weight (1500-2500 g).

Table III presents the inter-observer agreement between the social worker and the neonatal caretaker. The unstratified analysis shows an excellent agreement (κ score = 0.82) between the neonatal caretaker (mother) and the social worker. The crude and stratified matched odds ratio was >1 in all categories indicating that compared to the social worker, the neonatal caretaker tends more often, to correctly identify the birth weight status. However,

TABLE II—Sensitivity, Specificity and Predictive Value of Foot Tape Stratified by Birth Weight

Parameter	BW <1500 (g)	BW 1500-2500 (g)	BW >2500 (g)
Sensitivity	100	68.2	44.0
Specificity	95.2	51.8	80.8
Positive predictive value	60.0	45.5	74.6

TABLE III—Inter-Observer Comparison of Foot Tape Measurements

Birth weight (g)	No. of pairs	Discordance (Pairs)	κ score	Matched OR**	p value for OR
<1500	6	0	—	—	—
1500-2500	33	5	0.66	4	>0.05
>2500	50	3	0.88	2	>0.05
Total	89	8	0.82	3	>0.05

**OR = Odds ratio

the p value of the Chi square test of significance for the matched odds ratio was >0.05, i.e., discordance between observer are equally likely to occur in both directions. The value of the intra class correlation coefficient(10,11) calculated from the analysis of variance for the same population of 89 newborns examined by different observers, is 0.896, suggesting that the inter observer concordance in the use of the foot tape was excellent.

Discussion

Though other studies have used chest, thigh or midarm circumference as the proxy measure, we preferred foot length. Foot length bears a good correlation with birth weight (unpublished observations—WHO Study on Low Birth Weight and Infant Morbidity and Mortality, 1990, K.E.M. Hospital Research Center, Pune) and foot length as taken from the footprint has been used as a predictor of birth weight and ges-

tational age, with good results(7). Also, it would be simpler to use and less prone to measurement error than midarm or thigh circumference. This was an important consideration since the technique is to be used by the untrained, often illiterate mother. The tapes used by us were made using colored paper and X-ray film, essentially because these materials were readily available at no cost. But low cost alternatives like plastic can also be used if the tape is to be produced in large numbers. The study demonstrated that the foot tape was an efficient screening tool in identifying low birth weight. The high false positive rate leads to over identification of low birth weight but this is acceptable as the anticipated benefits to those correctly identified as low birth weight far outweigh the costs of treating a normal weight baby as high risk. The reliability of this instrument is also high as seen from the concordance of results when used by the trained social

worker or by the neonatal caretaker/mother (*Table III*).

Given the logistic constraints of care during delivery, and the imperative need to identify low birth weight newborns, there is a felt need for low cost, easy to use, appropriate technology interventions. The foot tape is a simple technique that can be used even by an illiterate neonatal caretaker at home. Further management is advised on the tape itself, thus a referral decision can be taken by the user herself. These low cost disposable foot tapes may be given to the pregnant woman at her first contact with the Primary Health Care system after appropriate training in its use which can be reinforced at subsequent contacts.

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