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SPECIAL ARTICLE

Clinical assessment of gestational age in the newborn infant

A scoring system for gestational age, based on 10 neurologic and 11 "external" criteria, has been applied to 167 newborn infants. The "external" score gave a better correlation with gestation than did the neurologic score, but the combined total score was better than either alone. The correlation coefficient for the total score against gestation was 0.93. The error of prediction of a single score was 1.02 weeks and of the average of two independent assessments was 0.7 weeks. The method gives consistent results within the first 5 days and is equally reliable in the first 24 hours of life. This scoring system is more objective and reproducible than trying to guess gestational age on the presence or absence of individual signs.

Lilly M. S. Dubowitz, M.B., B.S., D.C.H.,* Victor Dubowitz, B.Sc., M.D.,
Ph.D., M.R.C.P., D.C.H.,** and Cissie Goldberg, B.A.

SHEFFIELD, ENGLAND

IN RECENT years there has been increasing interest in the assessment of gestational age in the newborn infant and in differentiating the short-gestation from the

small-for-date infant. A number of clinical parameters have been used. These have fallen into two broad groups—a series of neurologic signs, dependent mainly on postures and primitive reflexes, and a series of superficial or external characteristics.

THE NEUROLOGIC ASSESSMENT

The original impetus for the neurologic assessment came from the classical work of the French school under André Thomas and subsequently Madame Saint-Anne Dargassies.¹ Various criteria, based mainly on tone and primitive reflexes, were assessed and a

From the Departments of Child Health and Sociology, University of Sheffield.

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***Address: Dr. V. Dubowitz, Department of Child Health, University of Sheffield, Sheffield 10, England.*

gestational age was established at which each particular clinical sign appeared. Koenigsberger² and Amiel-Tison³ have recently reviewed the criteria used.

Robinson⁴ selected 20 criteria from the Prechtl⁵ schema for detection of neurologic abnormality in the newborn infant and applied these to the assessment of infants of varying gestational age. He concluded that the 5 most useful tests of gestational age were the pupillary reflex, which is consistently absent under 29 weeks and present after 31 weeks, the glabellar tap, which is absent before 32 weeks and present after 34 weeks, the neck-righting reflex, which appears between 34 and 37 weeks, the response of the neck flexors to traction on the hands, which is positive after 33 weeks, and the head turning to light, which appears between 32 and 36 weeks.

EXTERNAL CHARACTERISTICS

Farr and associates⁶ reviewed a number of external characteristics which might be

useful in the assessment of gestational age and developed a system of scoring each criterion. Farr and associates⁷ subsequently analyzed the value of 11 of these criteria in the assessment of gestational age. In a series of 272 infants, they obtained a correlation coefficient between score and gestation of 0.75 for boys and 0.77 for girls and found that the best regression formula for the prediction of gestational age was $1.1201T - 0.0170T^2$ with 95 per cent confidence limits of ± 2.4 weeks. The characteristics they measured were skin texture, skin color, skin opacity, edema, lanugo, ear form, ear firmness, genitals, breast size, nipple formation, and plantar skin creases.

MATERIAL AND METHODS

Pilot study. We initially did a pilot study of all the neurologic criteria, as defined by Koenigsberger,² Amiel-Tison,³ and Robinson,⁴ in a series of 133 infants. We found that there was a wide overlap of gestational age at which an individual neurologic sign

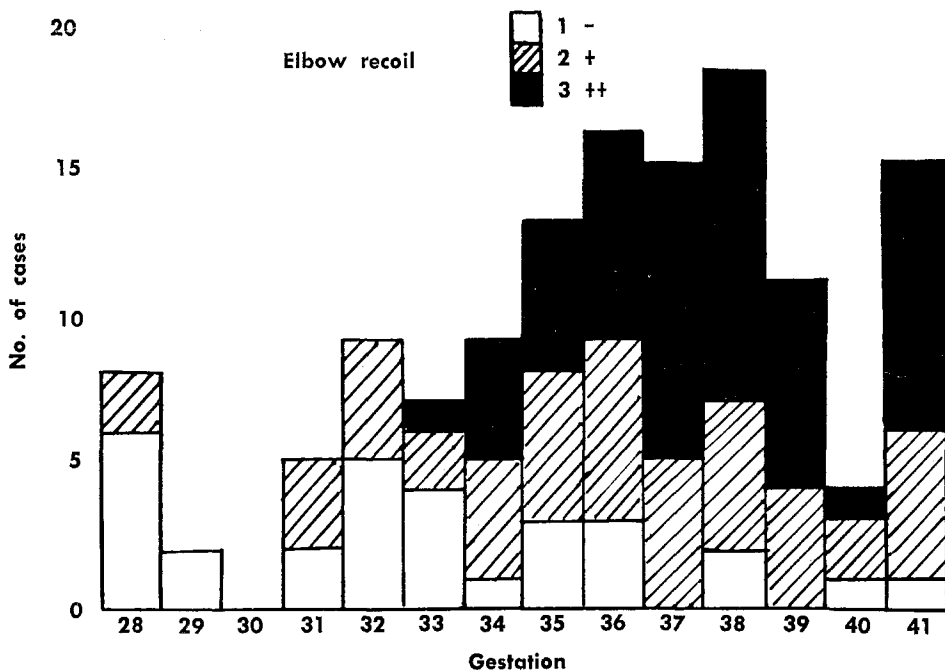


Fig. 1. Histogram showing wide range of gestational age at which a particular neurologic criterion (elbow recoil) may be fully or partially developed.

might be present or absent and that it was very difficult to predict gestation objectively on the basis of individual criteria (Fig. 1). Moreover, some signs were difficult to elicit. These included the pupillary reflex, for which it was often difficult to get the eyes adequately open and to see the pupil against the dark iris. The neck-righting reflex was also difficult to elicit and was frequently absent, even in full-term infants. The glabellar tap was consistently present in all the infants over 30 weeks' gestation and thus of little value within the range covering the majority of infants for assessment.

Selection of criteria. A series of neurologic criteria were selected on the basis of being easily definable and reproducible by different observers and least influenced by the "state" of the baby or the presence of neurologic abnormality (Table I). Because of the difficulty of trying to give an estimate of gestational age based on the presence or absence of a particular neurologic sign, as done by previous authors, we decided instead to score each neurologic sign along the lines used by Farr and associates⁶ for external characteristics (Table II).

Scoring system. In each instance, 0 was the lowest score and compatible with the posture or state of the reflex in the immature infant. We did not selectively load any particular sign but divided each into the number of grades that could be readily defined (Figs. 2 to 6). In parallel with this

series of selected neurologic criteria, we also used the criteria for external characteristics as defined by Farr and associates⁶; the same scores were used with the exception that we divided nipple formation into 4 instead of 3 grades (Table III). If the score differed on the two sides, the mean was taken.

Case material. Newborn infants on the obstetric landings and in the Special Care Unit and Premature Nursery of the Jessop Hospital for Women were studied. The infants were unselected. The only ones excluded were those too ill to be examined or those with an absent Moro response.

All of the assessments in this report were made by one observer (L. M. S. D.). At the time of the examination, the expected date of delivery was not known to the observer. After the assessment, the mother was personally interviewed in every instance, and details were obtained of the last menstrual period. We included for subsequent analysis all infants of mothers who were certain of the date of their last menstrual period, had a regular 28 day (± 2 days) cycle, and had no bleeding subsequent to the last menstrual period. We excluded all cases in which the mother had been on oral contraceptives during the 12 months prior to conception. We did not exclude cases in which the uterine size was considered during pregnancy to be incompatible with the duration, as Farr and associates⁷ had, as

Table I. Neurologic criteria

Criterion	Score
Posture	0 - 4
Square window	0 - 4
Dorsiflexion of Foot	0 - 4
Arm recoil	0 - 2
Leg recoil	0 - 2
Popliteal angle	0 - 5
Heel to ear	0 - 4
Scarf sign	0 - 3
Head lag	0 - 3
Ventral suspension	0 - 4
Total	0 - 35

Table II. External criteria

Criterion	Score
Edema	0 - 2
Skin texture	0 - 4
Skin color	0 - 3
Skin opacity	0 - 4
Lanugo	0 - 4
Plantar creases	0 - 4
Nipple formation	0 - 3
Breast size	0 - 3
Ear form	0 - 3
Ear firmness	0 - 3
Genitals	0 - 2
Total	0 - 35






































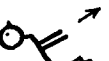







NEUROLOGICAL SIGN	SCORE					
	0	1	2	3	4	5
POSTURE						
SQUARE WINDOW	 90°	 60°	 45°	 30°	 0°	
ANKLE DORSIFLEXION	 90°	 75°	 45°	 20°	 0°	
ARM RECOIL	 180°	 90-180°	 <90°			
LEG RECOIL	 180°	 90-180°	 <90°			
POPLITEAL ANGLE	 180	 160°	 130°	 110°	 90°	 <90°
HEEL TO EAR						
SCARF SIGN						
HEAD LAG						
VENTRAL SUSPENSION						

Fig. 2. Scoring system for neurologic criteria. For legend see opposite page.

SOME NOTES ON TECHNIQUES OF ASSESSMENT OF NEUROLOGIC CRITERIA

POSTURE: Observed with infant quiet and in supine position. Score 0: Arms and legs extended; 1: beginning of flexion of hips and knees, arms extended; 2: stronger flexion of legs, arms extended; 3: arms slightly flexed, legs flexed and abducted; 4: full flexion of arms and legs.

SQUARE WINDOW: The hand is flexed on the forearm between the thumb and index finger of the examiner (Fig. 3). Enough pressure is applied to get as full a flexion as possible, and the angle between the hypothenar eminence and the ventral aspect of the forearm is measured and graded according to diagram. (Care is taken not to rotate the infant's wrist while doing this maneuver.)

ANKLE DORSIFLEXION: The foot is dorsiflexed onto the anterior aspect of the leg, with the examiner's thumb on the sole of the foot and other fingers behind the leg (Fig. 4). Enough pressure is applied to get as full flexion as possible, and the angle between the dorsum of the foot and the anterior aspect of the leg is measured.

ARM RECOIL: With the infant in the supine position the forearms are first flexed for 5 seconds, then fully extended by pulling on the hands, and then released. The sign is fully positive if the arms return briskly to full flexion (Score 2). If the arms return to incomplete flexion or the response is sluggish it is graded as Score 1. If they remain extended or are only followed by random movements the score is 0.

LEG RECOIL: With the infant supine, the hips and knees are fully flexed for 5 seconds, then extended by traction on the feet, and released. A maximal response is one of full flexion of the hips and knees (Score 2). A partial flexion scores 1, and minimal or no movement scores 0.

POPLITEAL ANGLE: With the infant supine and his pelvis flat on the examining couch, the thigh is held in the knee-chest position by the examiner's left index finger and thumb supporting the knee. The leg is then extended by gentle pressure from the examiner's right index finger behind the ankle and the popliteal angle is measured (Fig. 5).

HEEL TO EAR MANEUVER: With the baby supine, draw the baby's foot as near to the head as it will go without forcing it. Observe the distance between the foot and the head as well as the degree of extension at the knee. Grade according to diagram. Note that the knee is left free and may draw down alongside the abdomen (Fig. 6).

SCARF SIGN: With the baby supine, take the infant's hand and try to put it around the neck and as far posteriorly as possible around the opposite shoulder. Assist this maneuver by lifting the elbow across the body. See how far the elbow will go across and grade according to illustrations. Score 0: Elbow reaches opposite axillary line; 1: Elbow between midline and opposite axillary line; 2: Elbow reaches midline; 3: Elbow will not reach midline.

HEAD LAG: With the baby lying supine, grasp the hands (or the arms if a very small infant) and pull him slowly towards the sitting position. Observe the position of the head in relation to the trunk and grade accordingly. In a small infant the head may initially be supported by one hand. Score 0: Complete lag; 1: Partial head control; 2: Able to maintain head in line with body; 3: Brings head anterior to body.

VENTRAL SUSPENSION: The infant is suspended in the prone position, with examiner's hand under the infant's chest (one hand in a small infant, two in a large infant). Observe the degree of extension of the back and the amount of flexion of the arms and legs. Also note the relation of the head to the trunk. Grade according to diagrams.

If score differs on the two sides, take the mean.

we considered it would eliminate some of the small-for-date infants, who form an integral part of the study.

All assessments were made within 5 days of delivery; in a large proportion the first assessment was made within 24 hours. In many infants multiple assessments were made. The series comprises 167 infants.

RESULTS

Fig. 7 shows the distribution of total score against gestation in the 167 infants. Only



Fig. 3. Technique for square window.

the first assessment in each infant was included in this analysis. The correlation coefficient of the total score against gestation was 0.93.

The regression formula for the total score (x) against gestation (y) is:

$$y = 0.2642x + 24.595.$$

The best regression line for the data is a linear one (Fig. 8). The error of prediction of a single score based on this data is 1.02 weeks and the 95 per cent confidence limits ± 2 weeks. If two independent assessments are done on the same infant, the error of prediction of the average of the 2 readings is 0.7 weeks and the 95 per cent confidence limits 1.4 weeks.

The correlation coefficient of the external characteristics against gestation was 0.91 and of the neurologic criteria 0.89. The corresponding 95 per cent confidence limits on the single scoring by the superficial characteristics were 2.4 weeks and of the neurologic criteria 2.6 weeks.

An analysis of multiple assessments done in 70 of these infants showed that the score was not influenced by the state of the baby and that it was as reliable during the first 24 hours as during the subsequent 4 days.

After completion of the survey, the scores obtained independently by 3 pediatricians

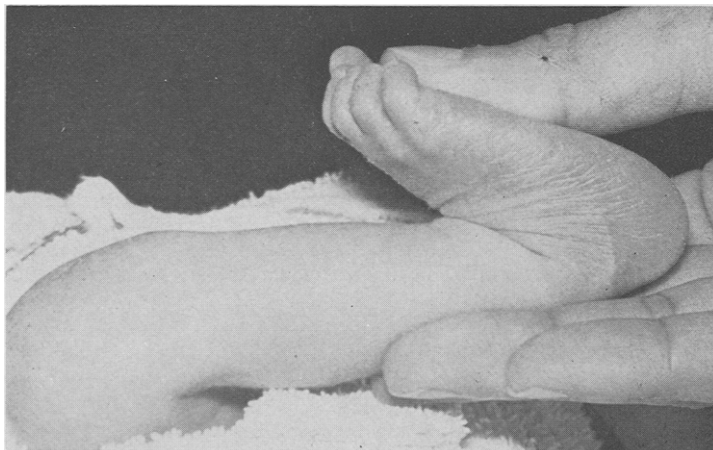


Fig. 4. Technique for dorsiflexion of foot.

Table III. Scoring system for external criteria

External sign	Score*				
	0	1	2	3	4
Edema	Obvious edema of hands and feet; pitting over tibia	No obvious edema of hands and feet; pitting over tibia	No edema		
Skin texture	Very thin, gelatinous	Thin and smooth	Smooth; medium thickness. Rash or superficial peeling	Slight thickening. Superficial cracking and peeling especially of hands and feet	Thick and parchment-like; superficial or deep cracking
Skin color	Dark red	Uniformly pink	Pale pink; variable over body	Pale; only pink over ears, lips, palms, or soles	
Skin opacity (trunk)	Numerous veins and venules clearly seen, especially over abdomen	Veins and tributaries seen	A few large vessels clearly seen over abdomen	A few large vessels seen indistinctly over abdomen	No blood vessels seen
Lanugo (over back)	No lanugo	Abundant; long and thick over whole back	Hair thinning especially over lower back	Small amount of lanugo and bald areas	At least 1/2 of back devoid of lanugo
Plantar creases	No skin creases	Faint red marks over anterior half of sole	Definite red marks over > anterior 1/2; indentations over < anterior 1/8	Indentations over > anterior 1/8	Definite deep indentations over > anterior 1/8
Nipple formation	Nipple barely visible; no areola	Nipple well defined; areola smooth and flat, diameter < 0.75 cm.	Areola stippled, edge not raised, diameter < 0.75 cm.	Areola stippled, edge raised, diameter > 0.75 cm.	
Breast size	No breast tissue palpable	Breast tissue on one or both sides, < 0.5 cm. diameter.	Breast tissue both sides; one or both 0.5 - 1.0 cm.	Breast tissue both sides; one or both > 1 cm.	
Ear form	Pinna flat and shapeless, little or no incurving of edge	Incurving of part of edge of pinna	Partial incurving whole of upper pinna	Well-defined incurving whole of upper pinna	
Ear firmness	Pinna soft, easily folded, no recoil	Pinna soft, easily folded, slow recoil	Cartilage to edge of pinna, but soft in places, ready recoil	Pinna firm, cartilage to edge; instant recoil	
Genitals Male	Neither testis in scrotum	At least one testis high in scrotum	At least one testis right down		
Female (with hips 1/2 abducted)	Labia majora widely separated, labia minora protruding	Labia majora almost cover labia minora	Labia majora completely cover labia minora		

Adapted from Farr and associates, *Develop. Med. Child Neurol.* 8:507, 1966.

*If score differs on two sides, take the mean.

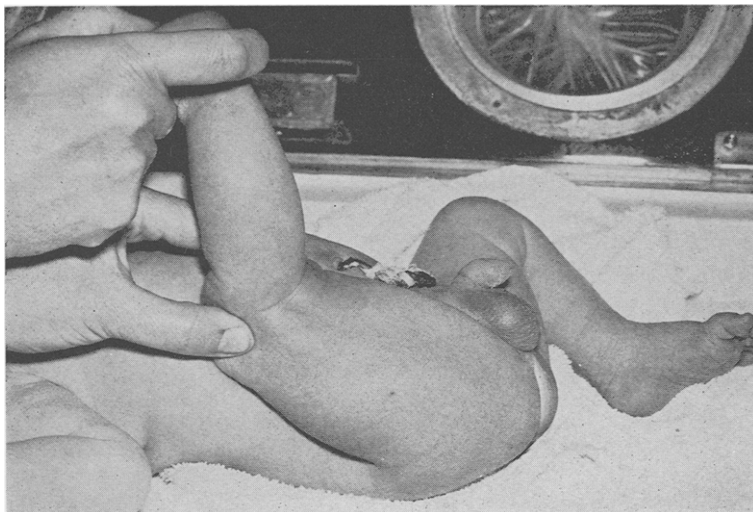


Fig. 5. Technique for popliteal angle.

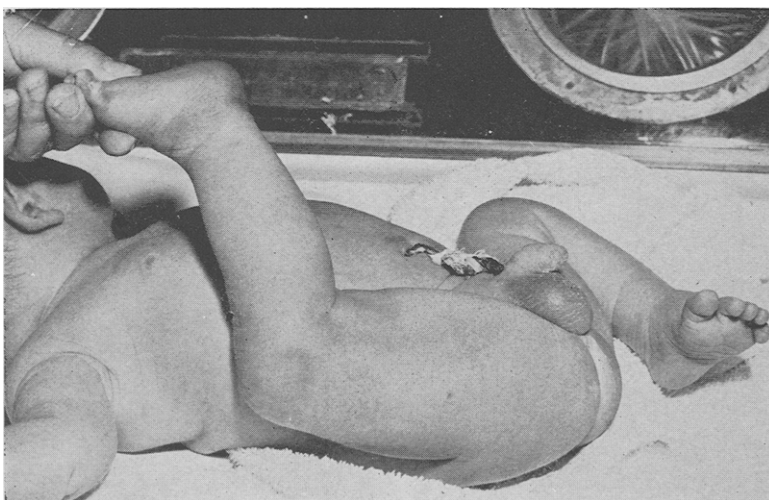


Fig. 6. Technique for heel to ear maneuver.

(A, B, and C) were compared with those obtained by L. M. S. D. in the same infants. The 3 series comprised 9, 10, and 130 infants, respectively; in each case the pediatrician practiced the scoring system on a number of infants before doing the comparative study. The Student's *t* test of the difference in scores between those of L. M. S. D. and each of the observers showed no significance.

The scores obtained by 3 nurses (D, E, and F) were then compared with those obtained by L. M. S. D. on the same infants. The 3 series comprised 11, 7, and 11 infants, respectively. None of the nurses had any previous experience at all with the method. The Student's *t* test showed no significant difference in scores between observers D and F and L. M. S. D. but did show a difference with observer E, who con-

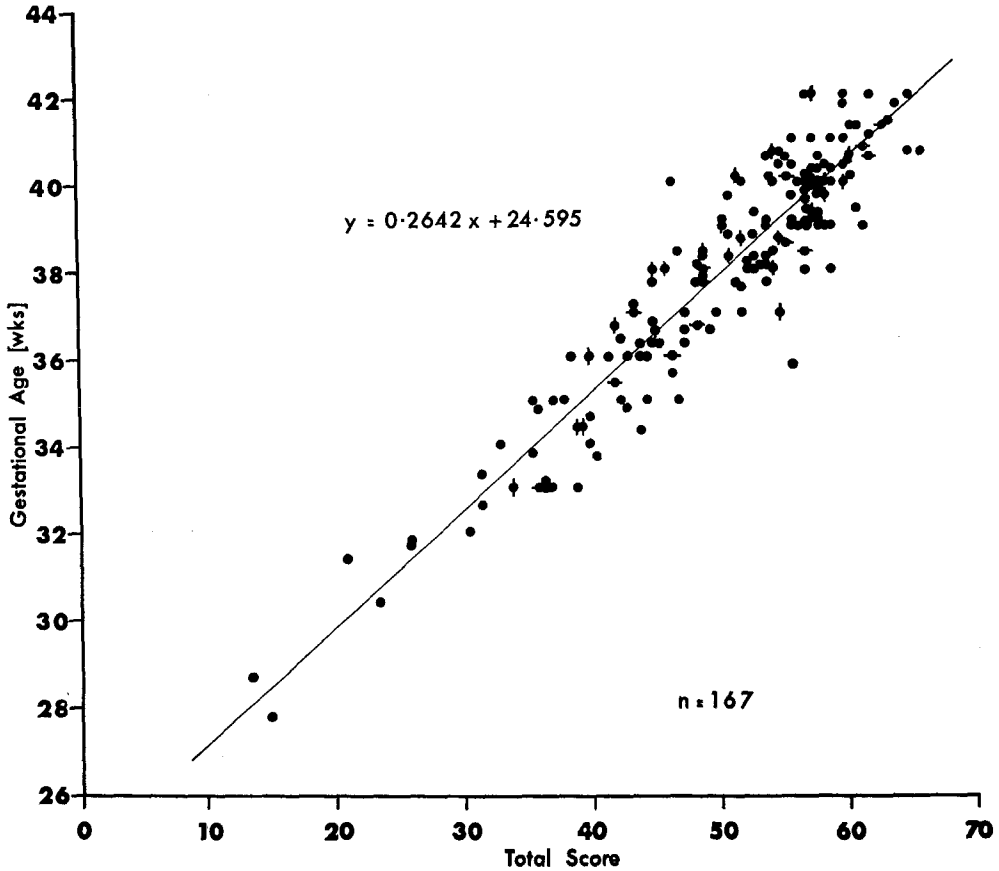


Fig. 7. Distribution of total score against gestational age in 167 infants. The best regression line is a straight line. Filled circle with vertical line through it = small-for-date infants with weight under the tenth percentile for gestational age (No. = 23); filled circle with horizontal line through it = large-for-date infants, with weight above the ninetieth percentile for gestational age (No. = 14); filled circle = appropriate weight for dates with weight between the tenth and ninetieth percentile (No. = 130).

sistently scored 5 points higher for each infant than did L. M. S. D.

DISCUSSION

The scoring system we have used has proved to be a reliable technique for assessment of gestational age in the newborn infant. The criteria used are easily defined and the scoring system can be readily learned by doctors and nurses. With a little practice, the whole procedure can be completed in about 10 minutes.

The system as a whole is much more objective and reliable than the method of trying to base gestation on the pres-

ence or absence of individual criteria.

Analysis of our data has shown that the external characteristics scored collectively give a better index than the neurologic criteria. However, the total score, using both groups of parameters, gives a better result than either alone.

The greater accuracy using the total score (with 95 per cent confidence limits of 2.0 weeks) compared with the superficial criteria (95 per cent confidence limits 2.4 weeks) is of the same order as that attained by Farr and associates⁷ when comparing their superficial criteria (95 per cent confidence limits 2.4 weeks) with prediction of

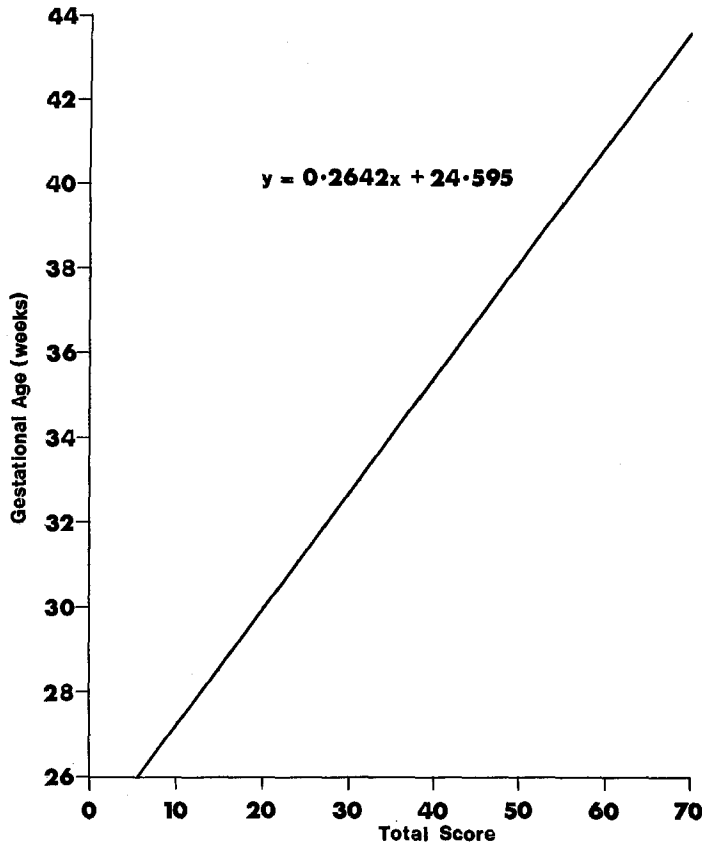


Fig. 8. Graph for reading gestational age from total score.

gestation by birth weight (95 per cent confidence limits 3.0 weeks).

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