Asphyxia Neonatorum — Assessment of the Infant at Birth

C. D. MOLTENO, A. F. MALAN, H. DE V. HEESE

SUMMARY

Asphyxia neonatorum is defined as failure of a newborn infant to establish sustained respiration after its complete delivery. In 206 asphyxiated infants reviewed, details of the Apgar scores, time to sustained respiration and resuscitation required, were documented. The value of each of these observations, as well as that of the heart rate and acid-base status after birth, is assessed. From the findings definite recommendations for the routine assessment of the infant at birth are made.

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The term asphyxia is derived from the Greek word meaning 'pulseless' (*a* = negative + *sphyxis* = pulse). Since the presence of a heartbeat is often the only sign of life in a depressed infant at birth, the literal application of the term is not appropriate. Physiologically, the condition of hypoxia associated with hypercapnia is implied. As a working definition of asphyxia neonatorum, failure of a newborn infant to establish sustained respiration after its complete delivery is recommended, because it may be applied in the delivery room.

An accurate clinical assessment is fundamental to the efficient management of the asphyxiated infant. Not only is it important in resuscitation, but careful factual documentation of conditions at birth is essential in the future developmental assessment of the child. To be practical, the methods used must not be beyond the scope of routine practice. The purpose of this article is to discuss these methods, and to make recommendations regarding their use.

PATIENTS AND METHODS

All deliveries from 1 April 1971 to 31 March 1972 in the Groote Schuur Maternity Hospital were included in a prospective study. A carefully recorded Apgar score[1] at 1 and 5 minutes; the time to sustained respiration (TSR), and details of the resuscitation carried out, were documented on each infant. The TSR was taken as the time in minutes between delivery and when the infant begins to maintain reasonably regular and adequate ventilatory activity without recurrent stimulation.[2] Asphyxia neonatorum was diagnosed if the Apgar score at 1 minute was 0 - 3, or if assisted respiration was needed in the first 10 minutes of life. Each asphyxiated infant was examined neurologically by the methods prescribed by Prechtl and Beintema.[3] Intact neonatal survival was considered when an infant survived the neonatal period without evidence of gross neurological abnormality.

In selected patients continuous heart rate tracings were obtained with a cardiotachograph, commencing within 30 seconds of birth. One hour after delivery, all babies had blood taken for acid-base measurements by heel stab after warming, precautions being taken to ensure the correct collection of samples,[4] and to prevent crying before and during the procedure. Further samples were taken at intervals during the first 24 hours. In all cases acid-base values were determined by the Astrup method.[5]

Statistical methods employed in the study were the comparison of sample means by the unpaired *t*-test, and the chi-square test.

RESULTS

During the period of study 206 (6,6%) of the total live births (3 167) suffered from asphyxia neonatorum, as judged by the criteria mentioned above. The distribution of 1- and 5-minute Apgar scores is given in Figs 1 and 2. The 13 infants with a 1-minute score of greater than 3 were included because they required positive pressure ventilation in the first 10 minutes of life. Exactly half of the asphyxiated infants had a score of 1 - 6 by 5 minutes. From Fig. 3 it can be seen that approximately a third of the infants established sustained respiration by 5 minutes, and two-thirds by 10 minutes. Thirteen infants took longer than 20 minutes to start breathing spontaneously. There is a significant correlation between intact neonatal survival as defined above, and TSR, and a very strong correlation between intact neonatal survival and the 5-minute Apgar score (Tables I and II).

During resuscitation, those infants who did not start breathing after clearing of the airway and application of peripheral stimulation, were intubated and given positive pressure ventilation. This form of treatment was necessary in 140 of the 206 asphyxiated infants, including all 10 who were neurologically abnormal, and 20 of the 27 who died in the neonatal period.

Fig. 4 compares the means of the heart rates of asphyxiated infants in minutes after the establishment of sustained respiration with those of infants who breathed immediately after birth. The asphyxiated group had significantly lower heart rates at 1, 2 and 3 minutes, but not at 4 minutes after the commencement of sustained respiration. In addition, the heart rate at 1 minute after birth, prior to respi-

Department of Paediatrics and Child Health, University of Cape Town
C. D. MOLTENO, F.C.P. (S.A.) M.MED. (PAED.), D.C.H.
A. F. MALAN, M.MED. (PAED.), M.D., DIP.MID.C.O.G.
H. DE V. HEESE, B.SC., M.D., F.R.C.P., D.C.H.

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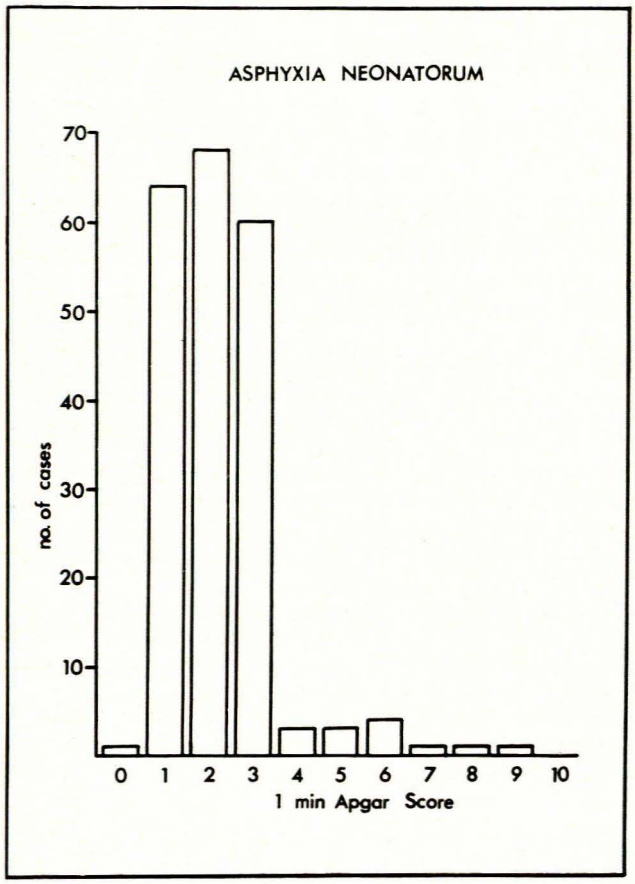

Fig. 1. Apgar score at 1 minute.

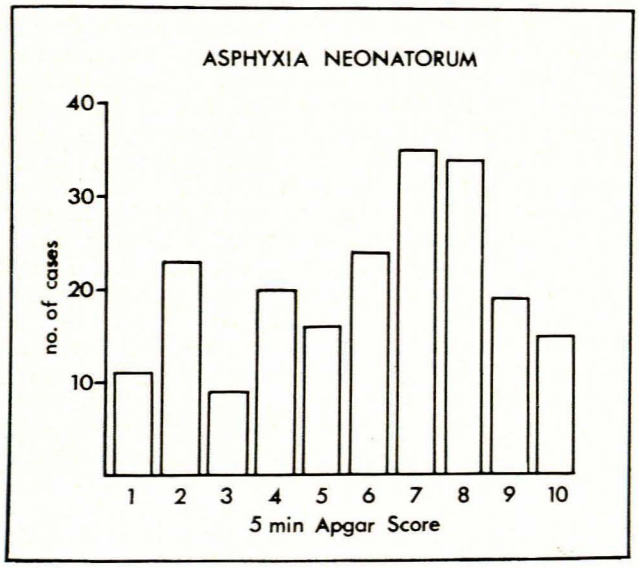

Fig. 2. Apgar score at 5 minutes.

ration, did not differ from that in an infant who has breathed, and then becomes apnoeic. It would appear, therefore, that in apnoeic infants the heart rate falls to approximately 60 beats/minute. With the onset of respiration it then rapidly rises to a level of over 100 beats/minute. Thereafter, over a period of roughly 4 minutes, it approximates with that of an infant vigorous at birth.

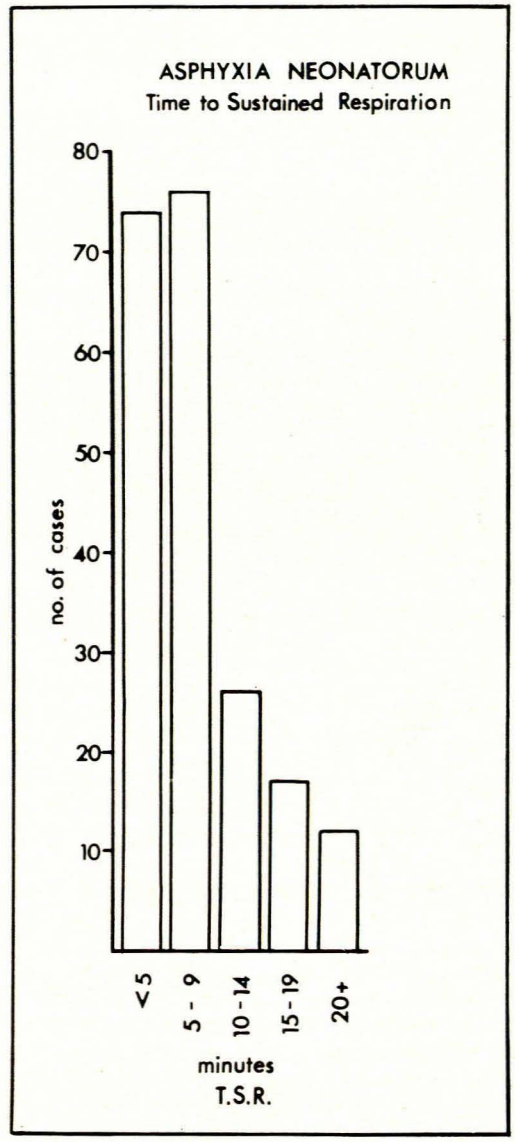

Fig. 3. Time to sustained respiration.

TABLE I. INTACT SURVIVAL AND TIME TO SUSTAINED RESPIRATION

	Time to sustained respiration (min)			
	<5	5 - 9	10 - 14	15+
Intact survival	67	69	18	15
Neonatal deaths + CNS abnormality ...	7	7	8	15

$\chi^2 = 9{,}31$; $P < 0{,}05$.

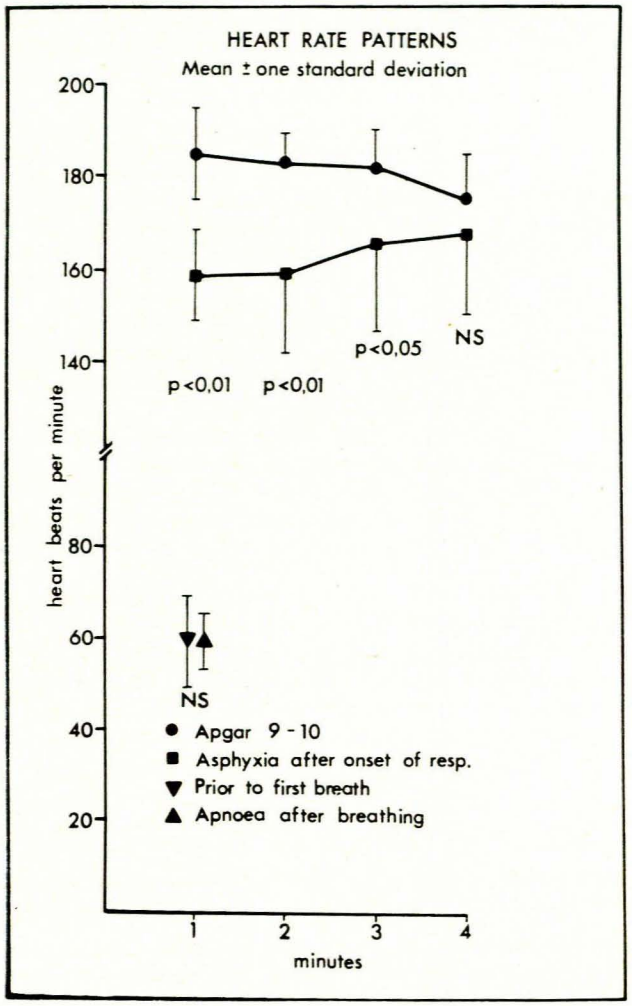

Fig. 4. Heart rate patterns.

TABLE II. INTACT SURVIVAL AND 5-MINUTE APGAR SCORE

	5-minute Apgar score		
	0 - 3	4 - 6	7 - 10
Intact survival	**24**	**49**	**96**
Neonatal deaths + CNS abnormality	**19**	**11**	**7**

$\chi^2 = 31{,}37$; $P < 0{,}01$.

Figs 5 and 6 demonstrate that changes in acid-base status persist for at least an hour after birth. The most marked differences between asphyxiated and normal infants can be seen in the vaginal delivery base excess readings. It can be assumed that in those infants with an Apgar score of 0 - 3 at 1 minute after Caesarean section, some of the depression could be attributed to the effect of the anaesthetic.

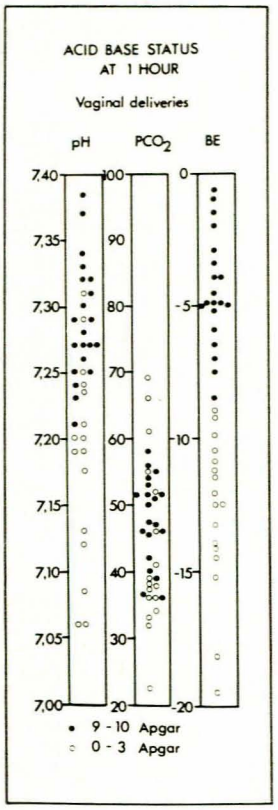

Fig. 5. Acid-base status at 1 hour — vaginal deliveries.

DISCUSSION

The Apgar scoring system, based on the recording of five objective signs pertaining to the condition of the infant at birth, is widely used. Despite limitations[6] and a number of criticisms,[7] the score remains useful because of its simplicity.[8] The 1-minute score is of value in assessing the need for treatment, whereas at 5 minutes it is strongly associated with infant mortality and morbidity.[9] The present study demonstrates that the 5-minute score also strongly correlates with intact neonatal survival. The recording of separate figures for the different systems yields more information than giving the total score only.[10]

The establishment of sustained respiration is the most important achievement required of the fetus in its adaptation to extra-uterine life, and all efforts at resuscitation are aimed either directly or indirectly at this aspect. Although the Apgar score deals with respiration, since it is done at set times, it fails to record this information. The TSR has been shown in this study to correlate with intact neonatal survival.

Studies on the pathophysiology of asphyxia in experimental animals have revealed a standard sequence of events.[11] Following the onset of asphyxia, an exaggerated respiratory activity gives way to primary apnoea. This is succeeded by gasping, and then secondary apnoea after the last gasp. During primary apnoea, pain, cold and

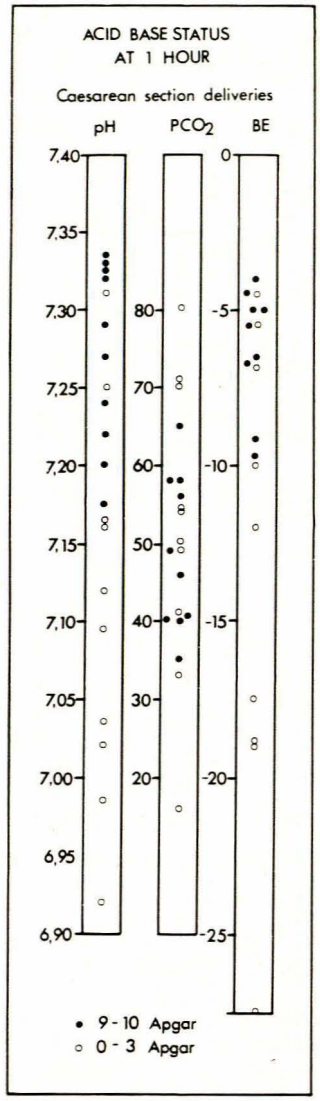

Fig. 6. Acid-base status at 1 hour — Caesarean section.

analeptic drugs can stimulate gasping, whereas in secondary apnoea, only intermittent positive pressure ventilation, and intravenous correction of the acidosis, can do this. Asphyxia of the fetal monkey beyond the last gasp leads to permanent symmetrical and bilateral damage in the brain stem nuclei.[12] It is therefore important to record which methods were required during resuscitation. In addition, the Apgar score and TSR may be influenced by the timing of these. In this study 20 of the 27 neonatal deaths, and all of those found to be neurologically abnormal required endotracheal intubation and positive pressure ventilation.

It has long been known that the duration and severity of asphyxia are reflected in acid-base changes.[13] Hypoxia gives rise to an accumulation of lactic acid, which results in a metabolic acidosis.[14] Intra-uterine hypoxia is accompanied by an increasing difference between maternal and fetal pH, and negative base excess.[15] The changes are also reflected in maternal arterial and umbilical vein samples at birth.[16] Measuring these parameters, however, is not possible as a routine, since only a small percentage of newborn infants suffer from asphyxia neonatorum. From this study, it is evident that changes in acid-base status persist for at least an hour after birth, and that the most marked differences between asphyxiated and normal infants can be seen in the base excess readings. It can be concluded that a negative base excess reading during the first hour gives an indication of the amount of hypoxia suffered by the infant during the whole birth process.

The importance of the heart rate in the newborn has been stressed in the literature.[17] The results of this study show that in an apnoeic infant the heart rate rapidly falls to a level of approximately 60 beats/minute. To judge from animal experiments, the rate would presumably remain at this level, unless resuscitation took place, until cardiac glycogen reserves became exhausted.[18] With oxygenation of the myocardium, the heart rate rises rapidly to a level of over 100 beats/minute. Thereafter, over a period of a few minutes, it rises further to reach normal levels. The heart rate is, therefore, of importance, but recording a figure at a particular stage fails to add to information gained from the Apgar score itself. Continual assessment of the heart beat does, however, give a valuable guide to the success of the resuscitative measures applied.

CONCLUSIONS

In addition to the usual recording of the Apgar score at 1 and 5 minutes and the resuscitation carried out, it is recommended that the time to sustained respiration and base excess reading on arterialised capillary blood at approximately half an hour after birth, be recorded on every asphyxiated infant. The heart rate, although valuable during resuscitation, does not add significantly to the information recorded in the Apgar score.

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