

Intensive Care in Labour

SIMULTANEOUS FETAL HEART MONITORING AND FETAL SCALP SAMPLING IN 83 PATIENTS

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SUMMARY

The purpose of this study was to investigate correlation between continuous beat-to-beat fetal heart monitoring and fetal scalp blood pH values in labour. The results showed that readings of pH 7,250 or greater were more reliable than those of pH 7,200 or less. Secondly, of 26 cases showing clinical fetal distress which were monitored, only 10 required Caesarean section and therefore 16 Caesarean sections were avoided. Other studies reflecting pH values in fetal and maternal blood are also mentioned.

The conclusions reached are that this type of intensive care is useful in unexpected cases of fetal distress in labour, but that where there is good clinical evidence of placental insufficiency, elective Caesarean section is often the method of choice for delivery.

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Techniques for close observation of the fetus during labour have been used for about 15 years, since the work of Caldeyro-Barcia *et al.*¹ and Hon² on fetal heart rate monitoring, and since the studies by Saling³ on fetal blood gas analyses. James *et al.*⁴ showed that of all the blood gas level estimations, the pH of the fetal blood was the most reliable indicator of the fetal state. This account describes continuous fetal heart monitoring used simultaneously with fetal scalp capillary blood pH measurement.

Reference to the literature reveals contradictory impressions and statements. For instance, it is claimed that an accurate clinical estimation of the fetal heart rate is not possible;² this has been challenged.⁵ Quilligan and Katigbak⁶ and Hobel⁷ have claimed that fetal tachycardia is not associated with a serious fetal acidemia; but Coltart *et al.*,⁸ Huntingford and Pendleton⁹ and Beard *et al.*¹⁰ have all shown that it is frequently associated with serious acidemia, and Mendez-Bauer *et al.*¹¹ even suggest that it is usually of more significance than a bradycardia. A bradycardia late in labour does not necessarily indicate much lowering in pH¹² and yet earlier in labour it can be a sign of serious fetal hypoxia.¹³ It has been suggested that fetal heart rate changes occur earlier than fetal blood pH changes as a sign of hypoxia.¹⁴

The results of investigating the effect of maternal acidosis on the fetus are also at variance. Blechner *et al.*¹⁵ did

not find that maternal acidosis caused a fall in fetal pH, while Bowes *et al.*¹⁶ found that in a high percentage of patients it did.

The degree of benefit conferred by the use of these specialised methods of monitoring in labour is in dispute. In one unit fetal scalp blood pH measurements have lowered the perinatal mortality by more than three-fold;¹⁷ in another unit it is estimated that it might have saved only two babies in a year.¹⁸

Objects of Study

The objects of the study were to investigate the following: (a) the correlation between fetal heart rate monitor patterns and fetal state as measured clinically at birth; (b) the correlation between fetal scalp blood pH values and fetal state as measured clinically at birth; and (c) the correlation between fetal heart rate monitor patterns and fetal scalp blood pH values taken simultaneously.

In addition, some other observations were made with the material available. These were: (a) to measure the maternal blood pH and the fetal blood pH simultaneously; and (b) to compare the fetal scalp capillary blood pH taken just before birth with umbilical arterial and venous blood pH at birth.

The effect of such intensive care on the stillbirth rate, perinatal mortality rate, perinatal morbidity rate and Caesarean section rate was also investigated.

PATIENTS AND METHODS

Eighty-three patients were monitored during labour. Seven of these patients were normal and were done initially to gain experience and to establish a normality baseline. Of the remaining 76 patients, 50 were elective and were chosen because in each case some jeopardy to the placenta was suspected, and 26 were emergency cases monitored because clinical signs of fetal distress appeared. Table I shows the indications in detail and the mode of delivery.

The fetal heart rate monitor used was the Hewlett-Packard 8020A; the fetal scalp electrode used was the insulated Michel clip type. Fetal scalp capillary blood was obtained by a technique similar to previously well-described methods.^{19,20}

Monitoring was begun either at the time of surgical induction or when fetal distress occurred. First a drop of blood was obtained from the fetal scalp and then the clip of the electrode was placed so that it closed the

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TABLE I. INDICATIONS FOR MONITORING AND MODE OF DELIVERY*

RESULTS

	Normal delivery	Ventouse	Forceps	Caesarean section	Total
Emergency cases					
Fetal distress in normal patients	4	1	2	4	11
Fetal distress assoc. with pre-eclamptic toxæmia	2	1	1	2	6
Fetal distress assoc. with postmaturity	0	1	2	3	6
Fetal distress assoc. with pre-eclamptic toxæmia and postmaturity	1	1	0	1	3
Total	7	4	5	10	26
Elective cases					
Pre-eclampsia	14	2	1	5	22
Postmaturity	7	0	2	1	10
Pre-eclampsia and postmaturity	1	0	0	0	1
Pre-eclampsia and IUGR†	1	0	0	1	2
IUGR, no obvious cause	2	0	0	0	2
Diabetes and prediabetes	5	0	0	1	6
Antepartum haemorrhage	1	0	0	1	2
Antepartum haemorrhage and postmaturity	1	0	0	0	1
Prolonged rupture of membranes	2	1	0	0	3
Poor obstetric history	1	0	0	0	1
Total	35	3	3	9	50
Normal labour	6	1	0	0	7
Totals	48	8	8	19	83

* Note that of 26 patients showing clinical fetal distress (the emergency group), intensive care allowed a vaginal delivery in 10 of them, thus avoiding unnecessary Caesarean sections.

† Intra-uterine growth retardation.

wound made by the lancet. The presence of the scalp electrode did not interfere with subsequent amnioscopy if a second or a third fetal scalp blood sample was required. It was frequently found that during descent of the head in labour the electrode had been carried sufficiently to one side to leave a clear field of view of the scalp.

Fifty-one patients had both fetal heart rate monitoring (FHR) and fetal scalp blood pH estimations (FSB pH) performed simultaneously. In 48 of these patients the fetal scalp electrode was used; in the remaining 3 the abdominal transducer was used. Thirty patients had only FHR monitoring performed, and the remaining 3 had FSB pH estimations only.

There were no maternal deaths, stillbirths or neonatal deaths in the series and the fetal morbidity rate was 15%.

Of the 26 emergency cases showing clinical fetal distress, only 10 (36%) were delivered by Caesarean section. These figures are similar to those of Coltart *et al.*⁸ and Philpott.²¹

In the 50 elective cases, 9 Caesarean sections were performed. However, 4 of these were performed for indications other than placental inadequacy (e.g. cephalopelvic disproportion, failed trial of labour). In only 5 cases (10%) in this group, therefore, was the monitoring decisive in indicating that urgent delivery was required.

Table II shows the average Apgar rates in each group of patients.

TABLE II. AVERAGE APGAR RATES

	Mode of delivery				Total
	NVD	Vent.	For- ceps	CS	
Emergency cases	7	8	9	6	26
Elective cases	8	10	5	6	50
Normal cases	10	10	—	—	7

Fetal Heart Rate Monitor Patterns Compared with Subsequent Health of Babies at Birth

Babies born with low Apgar scores were found with late deceleration patterns. The important feature was that with the passage of time they became persistent and more marked. A 'steppe-like' pattern was seen in one patient with a low Apgar. In healthy babies, on the other hand, a great variety of FHR patterns was seen. In these patients there was a tendency for the patterns to change, modify or disappear with the passage of time. Deceleration with uterine contractions alone is common and compatible with fetal health, provided recovery to basal rate occurs within half a minute.

Although many of these patterns are described as abnormal and as representing early hypoxia, in practice some latitude can be exercised in interpretation and management. Provided that the patterns do not change to the types showing late deceleration and slow recovery, and that the FSB pH in particular, remains above 7.250, labour can be allowed to continue.

Fetal Scalp Blood pH Values Compared with Subsequent Health of Babies at Birth

Fifty-two patients had FSB pH estimations performed during labour, at the time of surgical induction. Nineteen of these patients had a subsequent estimation done later in labour and one patient had it done three times. Fig. 1 shows the results.

In the patients with babies of an Apgar score of 6 and less, the spread of FSB pH results is wide. Out of 12 readings, 5 were above 7.250, but this is not surprising since

Correlation Between Fetal Heart Rate Patterns and Fetal Scalp Blood pH Values

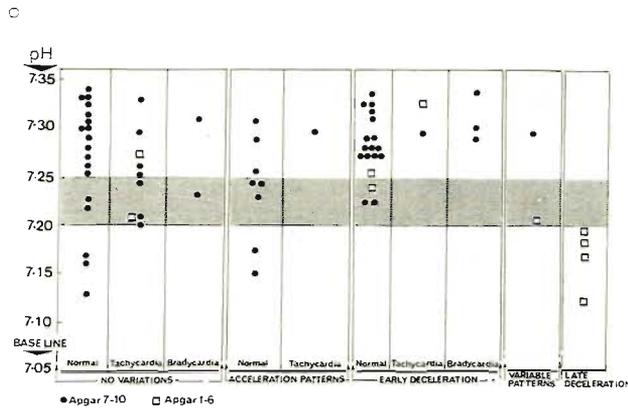


Fig. 2. The only patients in whom there is a consistently low Apgar score and low fetal scalp blood pH value are those showing the late deceleration pattern.

TABLE III. FETAL AND MATERNAL pH DIFFERENCES*

	Fetal pH	Maternal pH	Difference: maternal pH — fetal pH
Apgar 1 - 6 (6 cases, 8 readings)			
Least difference	7,330	7,400	0,070
Greatest difference	7,180	7,430	0,250
Average	7,206	7,368	0,162
Apgar 7 - 10 (21 cases, 29 readings)			
Least difference	7,298	7,330	0,032
Greatest difference	7,180	7,524	0,344
Average	7,242	7,395	0,153

* This table demonstrates that the maternal venous blood pH does not influence that of the fetus.

Fetal Scalp Blood pH and Maternal Blood pH Measured Simultaneously

In 37 patients, the maternal blood pH was measured simultaneously with the FSB pH, and the difference, maternal pH minus FSB pH, calculated. This was done because it is thought that factors affecting the pH of maternal blood can influence FSB pH and need to be taken into account. For instance, starvation would cause maternal acidemia. The results varied widely, and are shown in Table III. It was concluded, therefore, that though there might be theoretical objections, in practice it was not necessary to take into account the maternal blood pH when trying to assess the presence of fetal hypoxia. This agrees with the conclusions of Blechner *et al.*¹⁵ but is contrary to the findings of Bowes *et al.*¹⁶

Comparison of pH Values of Blood from Fetal Scalp, Umbilical Artery and Umbilical Vein at the Time of Birth

In 11 patients the pH of fetal scalp blood taken just before birth was measured, and compared with the pH of blood from a section of umbilical cord taken a minute or two later at birth, and clamped and cut before the baby breathed. The results are shown in Table IV.

The pH of the fetal scalp capillary blood should lie somewhere between the value found for that of the umbilical artery and vein. The findings in this series do not bear this out. In 5 patients the FSB pH was lower than both the umbilical arterial and venous blood pH. In 1 patient it was higher than both. Even in those patients in whom the pH of the scalp blood lay between the other

TABLE IV. COMPARISON OF FETAL SCALP, UMBILICAL, ARTERIAL AND VENOUS BLOOD pH

	Series No.	Apgar score	Umbilical artery	Fetal scalp	Umbilical vein	FHR pattern
Low Apgar	33	1	7,135	7,180	7,230	Severely abnormal
	26	10	7,290	7,077	7,300	Variable accelerations
	28	10	7,343	7,180	7,365	No tracing
	29	9	7,120	7,030	7,170	High baseline
	30	10	7,210	7,160	7,330	Normal
High Apgar	31	10	7,096	7,225	7,257	Early decelerations
	32	10	7,219	7,225	7,220	Normal
	35	10	7,177	7,269	7,272	Normal
	37	10	7,246	7,310	7,413	Normal
	50	8	7,215	7,280	7,290	Early decelerations
	57	10	7,300	7,280	7,350	Early marked decelerations
	Average	10	7,222	7,204	7,297	

* This table shows that measurement of fetal scalp blood pH in the second stage of labour is inaccurate and of no practical value.

two, the value was, in 3 cases, much closer to the value of the venous oxygenated blood than to that of the arterial blood, the latter of which probably presents a more accurate picture of the state of the fetus. In only 2 patients did the FSB pH lie between the other two.

The high incidence of low scalp pH readings found in the second stage of labour is probably due to local ischaemia caused by caput succedaneum or temporary cessation of circulation during a contraction.

These errors might also occur in the first stage of labour, which would account for some of the low FSB pH values encountered in association with normal FHR patterns and healthy babies. There is no place for FSB pH measurement in the second stage of labour, as the decision on the method of delivery must be a clinical one.

Effect on the Stillbirth and Perinatal Mortality Rates

A retrospective study of the paediatric and obstetric reports of stillbirths in the previous 6 months in the unit revealed that 4 stillbirths might have been avoided had fetal monitoring been applied in these cases. The total number of stillbirths was 123 cases out of a total of 3 401 deliveries (Table V). Of these, 83 were premature deliveries. Therefore, in a year, the stillbirth rate might have been cut by 8 cases out of 123, or 6.4%. This is a disappointingly low figure. Whether the neonatal mortality would be lowered is conjectural and difficult to evaluate. It is possible that minor degrees of cerebral damage might be avoided but to what extent is also largely guesswork.

TAELE V. NEONATAL MOREIDITY AND MORTALITY FIGURES COMPARED WITH TOTAL FIGURES (GROOTE SCHUUR HOSPITAL, 1971)

	Total deliveries	Stillbirths	Neonatal deaths (over 28 wks)	Total neonatal morbidity
Total No. of deliveries	3 401	123 (3,6%)	39	613 (18%)
Series cases	83	0	0	13 (15,6%)

Effect on Perinatal Morbidity Rates

The neonatal morbidity rate was 13 out of 83 cases, of which 10 were in the elective group and 3 in the emergency group. They are detailed in Table V.

Of the 13 babies, 1 developed sepsis as a result of the techniques involved and 1 cerebral damage due to an error of judgement. In the remaining 11 cases, a direct causal connection with the techniques involved is possible but doubtful. It must be remembered that these patients were a high-risk group and that the morbidity rate depends greatly on paediatric care as well as obstetric management.

Effect on the Caesarean Section Rate

This was significant. In 16 patients (see Table I) a Caesarean section was avoided which would otherwise have

been performed on clinical grounds for fetal distress. Of these patients, 9 were under 25 years and 7 of these were primiparas with adequate pelvis. This represents a saving of about 30 Caesarean sections a year, half of them on young primiparas.

DISCUSSION

This type of care in labour requires a separate room in the labour ward, designed and kept for this specific purpose. A patient being monitored needs the full attention of one member of the staff. These techniques can be performed by a specially trained midwife. In fact, it is an advantage that the person who decides that intensive care is necessary should not be the person who performs it.²¹

It was found that FHR patterns showing late decelerations and slow recovery were associated with low Apgar babies and fetal hypoxia, and were an indication for delivery. This has been shown many times before. All other FHR patterns could await a confirmatory fetal scalp pH measurement before action was taken. Meanwhile, simple steps could be taken, such as turning the patient on her side and giving oxygen. Sometimes all that was necessary was to decrease the frequency of uterine contractions by slowing the rate of the oxytocin infusion.

In this series a low pH of less than 7.250 was frequently found with healthy babies and was not, therefore, a reliable indication of fetal hypoxia. This may have been due to caput succedaneum, temporary ischaemia due to uterine contraction: errors in technique or in the Astrup machine. Whatever the cause, it was a frequent finding. In contrast, a high pH of more than 7.250 was rarely associated with a hypoxic fetus, and was nearly always a reliable sign of fetal well-being. Therefore, in practice, each chosen patient was placed on a continuous fetal heart monitor and an initial FSB pH estimation was done. If changes occurred in the pattern, a FSB pH estimation was repeated. If the pH was more than 7.250 this confirmed that the fetus was healthy. If the pH was less than 7.250 it was interpreted with more caution and more reliance was placed on the appearance of the FHR tracing, which was usually the deciding factor in policy. In this we differed from Beard *et al.*¹³ who used the pH as the final arbiter in all cases. The two parameters taken in conjunction are a greater aid to clinical judgement than either one alone.

FHR monitoring has other advantages. It facilitates the task of 'specialling' the case for the midwife; it makes judging and controlling of timing of uterine contractions more accurate and it leaves a permanent graphic record of labour.

There are some disadvantages. Multiplicity of wires and plastic tubing — one to the uterine receptor on the abdomen, and one to the fetal scalp — can interfere with the patient's freedom. The use of apparatus without wires, which is being developed,²² would be an advantage. Often an intravenous infusion set is present as well. The electric leads may be a hazard to the staff if the wall plugs are not conveniently situated. The abdominal transducer is not comfortable and few patients can tolerate it for more than 2 hours. They naturally wish to change position, and when lying on their sides the quality of recording falls.

Patients are made apprehensive by the array of machinery and the isolation. This apprehension frequently causes a fetal tachycardia which takes 20 minutes or so to settle down. The fetus is also endangered. Septicaemia has been known to occur in association with the scalp electrode.²³ It would seem wise, therefore, to regard a history of ruptured membranes for more than 24 hours, or the presence of infection or vaginal discharge, as contra-indications to these procedures.

Obliquity of the uterus, obesity, and the occipito-posterior position all make it harder to apply the abdominal transducer properly, and in order to obtain fetal scalp blood samples and apply the scalp electrode, a favourable soft cervix, slightly dilated (1-2 cm) is required. With a closed cervix, a high head, and an occipito-posterior position in an obese woman it is almost impossible to obtain a fetal heart recording. Lastly, the equipment is costly.

This series of patients was collected in a rather random fashion, patients being selected on purely clinical grounds when it was thought that placental insufficiency might be present, or that the fetus was at greater risk than normal. These indications are vague. It would be better to definitely establish the existence of placental insufficiency clinically during the antenatal period, and to detect and confirm intra-uterine growth retardation with the aid of investigations such as ultrasound, hormone assays and stress tests.²⁴ Once patients are positively confirmed as having placental insufficiency, a decision on the mode of delivery has to be made. There seems to be little point in subjecting a patient with marginal placental function to the risk of labour unless there is a desire to avoid Caesarean section, for example in a young primigravida with a good pelvis. This is especially so if the cervix is unfavourable and the head is high. In addition, there is a small, though not negligible, risk to the fetus and possibly to the mother, and this risk must be weighed against the advantages. There is no point in saving one or two babies out of a hundred with this elaborate technique, if an equal number are going to be lost through sepsis. Therefore, in the majority of such patients there is a good case for making elective Caesarean section the treatment of

choice. If in doubt, the effect of uterine contractions on the fetal heart can be observed by running an oxytocin infusion for a short while.²⁵ In an obese patient with a closed cervix, and where the abdominal fetal heart pick-up is poor, the Pinard stethoscope serves very adequately; with practice and care, type 2 late deceleration patterns can be recognised by ear.

The value of this type of care in healthy patients who develop unexpected fetal distress is more certain; 9 Caesarean sections in young primiparas were avoided in this series.

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