cord was located by performing a series of longitudinal scans, and the above-mentioned procedure was performed. A 5-MHz probe, attached to a Doppler velocity flowmeter (Model 806 C; Parks Electronics), was placed to one side of the pulsed-echo probe, and the continuous beam of ultrasound was directed in the same plane as the pulsed beam, with an angle of approximately 30° between it and the umbilical vessel. The Doppler probe, which was hand-held, required slight angular manipulation to obtain optimum Doppler-shift signals, which were monitored through headphones. The position of the probe was held, and the signals recorded on a tape recorder. The recorded signals were then processed through an audiofrequency analyser (Kay Sonagraph 6061) to produce a display (sonagram) of red-cell velocity in real time. The density of the signal in the sonagram is proportional to the number of red cells travelling at a particular velocity at a particular time.

The angle of the Doppler probe is held at approximately 30 to the vessels, and positioning is made possible by using the B-scan to place the pulsed-echo probe at right angles to the vessels. This serves as a guide to position the Doppler probe. Experience in collecting Doppler signals also helps in obtaining the optimum angle of the probe to the vessel.[6] The audiofrequency analyser displays the signals in terms of frequency against time, and there is a linear relation between frequency and velocity at these levels.[7] These signals are records of blood velocity, however, and do not represent volume flow.

Results

Twenty patients, whose pregnancies ranged from 12 to 40 weeks' gestational age, were referred for ultrasonic examination either to confirm gestational age or to locate the placenta before amniocentesis. Using the method described above Doppler signals were obtained from the umbilical cord in each patient examined. By small movements of the direction of the ultrasound beam venous and arterial signals could be detected. These were sometimes mixed, but could be separated by careful changes of the beam direction. The position of the umbilical cord in a 12-week-old fetus as detected by the echoscan is shown in fig 1. Sonagrams of venous and arterial blood-velocity signals from the cord are shown in fig 2. The sonagram is composed of the spectrum of red-cell velocities passing through the ultrasound beam. An example of artery (a), vein (b), and artery and vein mixed (c) is shown. There is a clear difference in the shape of the two signals, which can also be discerned while listening to the signals. Re-examination of the patient three or four times at intervals during the same session gave reproducible signals, of which the illustrations are representative examples.

Discussion

This technique is safe and non-invasive, and allows fetal umbilical blood-flow patterns to be observed from as early as 12 weeks' gestation. It required no elaborate preparation, and was thus suitable for use as an outpatient procedure. The technique is basically simple and easy to learn, and can be used throughout pregnancy. The shape of the blood-velocity waveform will change with conditions affecting the efficiency of blood supply,[6] and the method should be useful in assessing such conditions as pre-eclampsia and intrauterine growth retardation.

References

1 Comline, R S, and Silver, M, *British Medical Bulletin*, 1975, **31**, 25.
2 Clavero, J A, *et al*, *American Journal of Obstetrics and Gynecology*, 1973, **116**, 340.
3 McCallum, W D, *American Journal of Obstetrics and Gynecology*, 1977, **127**, 491.
4 Campbell, S, and Wilkin, D, *British Journal of Obstetrics and Gynaecology*, 1975, **82**, 689.
5 FitzGerald, D E, Gosling, R G, and Woodcock, J P, *Lancet*, 1971, **1**, 66.
6 FitzGerald, D E, and Carr, J, *American Journal of Roentgenology*, 1977, **128**, 385.
7 Woodcock, J P, *Theory and Practice of Blood Flow Measurement*, ch 5. London, Butterworths, 1975.

(*Accepted 27 September 1977*)

Active management of labour: care of the fetus

KIERAN O'DRISCOLL, MALACHI COUGHLAN, VINCENT FENTON, MAIRE SKELLY

British Medical Journal, 1977, **2**, 1451-1453

Summary

A prospective study of 1000 consecutive primigravidae was conducted to assess the relevance of the colour of the liquor to the welfare of the child. The results showed that clear liquor early in labour virtually ensures the birth of a healthy infant, provided the duration of labour is limited and delivery is effected without trauma; and, conversely, that meconium—or no liquor—marks the fetus who may suffer death or brain damage during normal labour. Special techniques were reserved for the second group of cases.

University College Dublin, Department of Obstetrics and Gynaecology, National Maternity Hospital, Dublin 2, Eire
KIERAN O'DRISCOLL, MD, FRCOG, clinical professor
MALACHI COUGHLAN, MRCOG, FRCSED, assistant master
VINCENT FENTON, MRCOG, FRCSED, assistant master
MAIRE SKELLY, MAO, MRCOG, registrar

Introduction

A policy of active management of labour was adopted in this hospital 10 years ago with the aim of reducing maternal stress by restricting the duration of exposure.[1] This policy has been successful to the extent that delivery is usually completed within 12 hours. Several additional benefits have accrued to mothers: these include a personal nurse for every patient, reduced demand for analgesia, a low rate of operative intervention, and elimination of trauma.[2] Initially we feared that the use of oxytocin to ensure effective uterine action might prove detrimental to infants, but this has not been the case. We report on the method of supervision of the fetus, based on colour of liquor, which has evolved in this hospital during the past decade. Good results can be achieved in a busy delivery unit when special techniques are used selectively.

Patients and methods

A prospective study of 1000 consecutive primigravidae was conducted between 1 June and 12 October 1976. Management of labour was directed to ensure delivery within 12 hours. The fetus was supervised by simple auscultation when clear liquor was shown early in labour. Special techniques were reserved for cases in which meconium

was present, or when no liquor was released at artificial rupture of membranes, and for cases in which labour was prolonged. The procedure was to take a fetal blood sample and to attach a fetal heart monitor at the same time.

A specimen of liquor was retained for inspection in every case in which the presence of meconium was suspected. The incidence of meconium, or no liquor, was 10%. Each specimen was classified as grade I, II, or III, according to the concentration of meconium and the volume of liquor. No action was taken in grade I, special techniques were used in grade II, and caesarean section was performed in grade III unless delivery was imminent. The special techniques were used in 56 cases. The pH was less than 7·25 in two cases. Fetal blood-sampling was not repeated in any case.

Results

Labour was induced on 87 occasions. The total number of caesarean sections performed was 38—20 before, and 18 during labour. Caesarean section was performed for fetal distress on four occasions only, and meconium was the indication in each case; acidosis was confirmed in two cases, and was not tested in the other two because thick meconium was released early in labour. There were 204 forceps deliveries. Neither Kielland's forceps nor the ventouse were used. Epidural anaesthesia was given on 61 occasions. Labour was prolonged in 13 cases.

No death occurred during labour. There were 16 perinatal deaths. Necropsy was performed in each instance. The deaths were classified as: congenital malformation (6); late fetal death (5); abruptio placentae (3); premature birth (1); and aspiration of meconium (1). The malformations were: anencephaly (4); hydrocephaly (1); and diaphragmatic hernia (1). The late fetal deaths resulted in macerated infants. The fetus was dead at admission in all three cases of abruptio placentae. The premature infant died from hyaline membrane disease at 29 weeks' gestation.

Every infant was examined for evidence of cerebral dysfunction. A positive diagnosis was made on two occasions. The liquor was clear in the first case, but the infant suffered from intoxication with diazepam administered for eclampsia; the serum concentration reached 21·56 mmol/l (6·15 mg/ml). Complete recovery followed exchange transfusion, and the child was normal at three months. The mother of the second infant was admitted with fever and purulent liquor 12 days after spontaneous rupture of the membranes. The infection was treated with antibiotics and the infant was born six hours later. The child was normal at three months. One death may have been related to hypoxia during labour. This patient was admitted at 41 weeks, and the membranes ruptured after one hour. The liquor contained meconium, but the special techniques were not used because the meconium was classified as Grade I. A normal infant weighing 2920 g was born five hours later. Apgar score was nine at five minutes; respiratory distress developed after three hours; *x*-ray picture showed diffuse opacities in both lungs; and the infant died at 21 hours. Necropsy showed aspiration of meconium. No case of cerebral dysfunction was related to hypoxia or trauma during labour.

Discussion

The records of this hospital for the past 10 years show that fetal deaths in labour fall into two main groups—those which occur early because placental function is impaired, and those which occur late because labour is prolonged. Prolonged labour often ends in difficult forceps delivery. A similar pattern is seen in cerebral dysfunction. The exceptions are accidents of labour, mainly prolapse of the cord. Pearson[3] noted the same division in cases of fetal distress in which delivery was by caesarean section. Control of the duration of labour is therefore important for the child's welfare. When the duration of labour is limited and trauma avoided, care of the fetus is reduced to a simple problem: how to identify those who may not tolerate the stress of normal labour because placental function is already impaired.

The practice of looking to the mother for evidence that her child is vulnerable, which forms the basis of conventional assessment of high-risk groups, has been abandoned in this hospital because most fetal deaths during labour occur in normal mothers. Edington, Sibanda, and Beard[4] concluded that a fetal heart monitor is necessary to identify a vulnerable fetus, because they too found it impossible to base predictions of fetal welfare on maternal indications. Our experience suggests that this may not be a valid conclusion, because obstetricians have concentrated not only on the wrong patient, the mother instead of the child, but on the wrong evidence also, the fetal heart instead of meconium. Meconium has been an almost constant feature of cases in which the fetus died during labour or suffered cerebral dysfunction after birth in this hospital. Ten years ago, when active management of labour was introduced, infusion of oxytocin to accelerate slow progress was prohibited until the membranes were ruptured and clear liquor demonstrated.[1] Matthews and Martin[5] also attach great importance to early detection of meconium: they reported 12 cases in which fetal death occurred during labour without a specific cause; meconium was present on each occasion, and in 10 cases no abnormality was suspected until the membranes ruptured. They concluded that all of these deaths were avoidable.

The significance of meconium during labour is often misinterpreted. An important observation in the present series is that meconium did not appear in any case after clear liquor had been demonstrated. Thus the appearance of meconium always coincided with rupture of the membranes, at whatever stage of labour this occurred. We conclude that meconium is not a product of labour but of pregnancy, a sign of impaired placental function which exposes the fetus to the risk of hypoxia during labour. Care of the fetus in labour therefore requires that the membranes be ruptured after a firm diagnosis of labour is made; this again emphasises the importance of the initial diagnosis of labour.[1] One of the difficulties in any study of labour is to achieve a uniform standard of diagnosis from nurses and doctors, who frequently change, even for the same patient. We adopted the procedure of retaining a specimen of liquor in a test tube for general inspection during labour and for subsequent discussion. We found a considerable subjective element in diagnosis that makes it impossible to state precisely the number of cases of meconium. This raises doubts about the accuracy of some reports on the subject. The simple test-tube procedure, however, has proved most instructive, and has now been incorporated into the routine practice of the hospital.

A fetal blood sample was examined in 56 cases; because clear liquor was not demonstrated early in labour in 52, and because labour was prolonged in four cases. Acidosis was found in two cases, and both were delivered by caesarean section. Slow progress was corrected after acidosis had been excluded in the remaining cases, and fetal blood sampling was not repeated because subsequent labour was short. One possible interpretation of the contribution of fetal blood sampling to the welfare of 1000 infants is that it saved two lives; but a more likely interpretation is that it reduced the number of caesarean sections for fetal distress to a total of four cases only, and was therefore of greater benefit to mothers. A low incidence of caesarean section is a feature of the present series.

A fetal heart monitor was used in 54 cases, in all of which acidosis had been excluded, and each resulted in normal delivery of a healthy infant. Fetal heart monitoring did not alter the management of any case. There have been claims in recent years that a fetal heart monitor is necessary for the proper care of every fetus during labour,[1 6] and cost-benefit analyses have purported to show that it is cheaper to provide a fetal heart monitor than it is to support a handicapped child.[7] Steer[8] reported that one commercial firm alone sold 800 fetal heart monitors during 1976, at a cost of £2 million, and commented that the fetal heart monitor has ceased to be a research instrument and has entered the realm of big business. Our experience suggests that the introduction of fetal heart monitors into routine clinical practice may have been premature, and that they should be confined to research purposes until a cheap, reliable, and non-invasive technique is developed.

Two unusual features of the present series are a low rate of induction and a low incidence of fetal distress. As induction of labour extends the period of stress to which a fetus is exposed,

the effect is at odds with the basic purpose of active management of labour.[9] This suggests that observers who report a much higher incidence of fetal distress are recording evidence of distress caused by induction.

The current tendency to discount clinical methods of supervision of the fetus during labour is not well founded, partly because the importance of meconium is not always appreciated, and partly because insufficient attention is paid to the management of labour. In this series of 1000 primigravidae the concept of high risk was transferred from mother to child, where it belongs. Clear liquor gave reliable evidence that the fetus would survive normal labour and not suffer brain damage; meconium, or no liquor, distinguished the fetus who was vulnerable because placental function was already impaired. A single fetal blood sample was enough to identify infants affected by hypoxia, but fetal heart monitoring contributed nothing to the management of these cases. We conclude that obstetricians engaged in clinical practice can provide an excellent service for the fetus by ascertaining the colour of the liquor early in labour, by restricting the duration of exposure to stress, and by avoiding difficult forceps delivery. Special techniques may be restricted to a few cases. We confined the study to primigravidae because the problems of labour and delivery are concentrated in this group. The inclusion of multigravidae in studies of labour dilutes results. During the study 1911 multigravidae were delivered in this hospital; there was one death during labour, in a breech presentation, and one case of cerebral dysfunction, in a second twin.

We thank Dr Declan Meagher, Master of the National Maternity Hospital, for his advice; Dr Niall O'Brien for assessing the newborn infants; Dr Francis Geoghegan for performing the postmortem examinations; and the sisters in the delivery unit for their unfailing co-operation.

References

1 O'Driscoll, K, Jackson, R J A, and Gallagher, J T, *British Medical Journal*, 1969, **2**, 477.
2 O'Driscoll, K, Stronge, J M, and Minogue, M, *British Medical Journal*, 1973, **3**, 135.
3 Pearson, J F, *Proceedings of the Third Study Group of the Royal College of Obstetricians and Gynaecologists*, 1975, 199.
4 Edington, P T, Sibanda, J, and Beard, R W, *British Medical Journal*, 1975, **3**, 341.
5 Matthews, C D, and Martin, M R, *American Journal of Obstetrics and Gynecology*, 1974, **120**, 808.
6 Hon, E H, and Petrie, R H, *Clinical Obstetrics and Gynecology*, 1975, **18**, 1.
7 Quilligan, E J, and Paul, R H, *Obstetrics and Gynecology*, 1975, **45**, 96.
8 Steer, P J, *British Journal of Hospital Medicine*, 1977, **17**, 219.
9 O'Driscoll, K, Carroll, C J, and Coughlan, M, *British Medical Journal*, 1975, **4**, 727.

(*Accepted 27 September 1977*)

CONDENSED REPORTS

Haemoperfusion with R-004 Amberlite resin for treating acute poisoning

J A P TRAFFORD, R H JONES, R EVANS, P SHARP, P SHARPSTONE, J COOK

British Medical Journal, 1977, **2**, 1453-1456

Summary

Eleven patients who had taken overdoses of barbiturates, glutethimide, tricyclic antidepressants, and chloroquine were treated by resin haemoperfusion using an R-004 haemoperfusion cartridge containing XAD-4 resin. All but one patient showed rapid clinical recovery and the drugs were cleared rapidly from the plasma. There were few complications.

Resin haemoperfusion is more effective than dialysis and other perfusion methods, especially in poisoning with tricyclic antidepressants. Although haemoperfusion is expensive, it greatly reduces the length of the patient's stay in an intensive care unit and hence is cost-effective.

Renal Unit, Royal Sussex County Hospital, Brighton BN2 5BE
J A P TRAFFORD, FRCP, director
R H JONES, MRCP, medical registrar
R EVANS, SRN, sister-in-charge, renal unit
P SHARPSTONE, FRCP, consultant physician

Department of Biochemistry, Royal Sussex County Hospital, Brighton BN2 5BE
P SHARP, BSC, biochemist
J COOK, PHD, principal biochemist

Introduction

Self-poisoning is a common cause of admission to hospital, and, although most patients recover with only minimal care, some need full ward care and a few need expensive intensive care.

The overall mortality from self-poisoning is 0·5 to 1%, but a survey in our intensive therapy unit (ITU) in 1973-6 showed a mortality of 10% among severely self-poisoned patients. Death may be caused by the drugs themselves or by complications of treatment—for example, with pressor agents. And prolonged coma and mechanical ventilation produce significant mortality. Therefore, although supportive treatment is adequate for most patients, it may be desirable to remove the toxin from the circulation in very severe cases.

A means of treating severe self-poisoning would also reduce the occupancy of ITU beds, which in this district cost £120 per day, and so reduce the overall cost of treatment.

Treatment has included forced diuresis, peritoneal dialysis, and haemodialysis,[1 2] but the usefulness of these measures is limited. More recently drugs have been absorbed by perfusion through activated charcoal,[3] hydrogel-coated charcoal,[4 5] and various exchange resins.[6] Unfortunately, these techniques need high-dose anticoagulation and can damage formed elements of blood, particularly platelets.

A new technique must be efficient, safe, cost-effective, and simple. We report here the use of the R-004 haemoperfusion cartridge (Extracorporeal Medical Specialties Incorporated),