Care of the fetus during labor

1 Introduction
The principal aim of monitoring the fetus during labor is to identify fetal hypoxia, which, if uncorrected, might cause death or short-term or long-term morbidity. In theory at least, it should then be possible to avert the adverse outcomes by appropriate and timely measures.

Several methods of monitoring fetal well-being have been evaluated in randomized trials. Although these trials have generated consistent evidence about the effects of alternative methods of monitoring on fetal and maternal outcome, controversy still remains about how monitoring should be performed and about the appropriate response to an abnormal result.

2 Clinical methods of fetal monitoring during labor

2.1 Intermittent auscultation of the fetal heart
Intermittent auscultation (listening with a fetal stethoscope or hand-held Doppler ultrasound monitor) of the fetal heart has been the predominant method of monitoring the fetus during labor during most of this century. It is still widely used, despite a trend that began during the 1970s to replace it with continuous electronic monitoring.

As evaluated in the randomized trials, auscultation is performed every 15 min during the first stage of labor, and more often during the second stage. The criteria for fetal distress are a fetal heart rate above 160 or below 100–120, or an irregular heart beat. Although some authorities feel that changes in fetal heart rate during contractions might give an earlier warning sign, auscultation is usually performed after contractions.

2.2 Assessment of the amniotic fluid
Passage of meconium is associated with an increased risk of intrapartum death, neonatal death, and various measures of neonatal morbidity, such as low Apgar score or lowered acid-base status. Part, but by no means all, of this association is explained by respiratory problems due to meconium aspiration.

Thick meconium recognized at the onset of labor carries the worst prognosis, and is associated with a five to sevenfold increased risk of perinatal death. Thick, undiluted meconium also reflects reduced amniotic fluid volume at the onset of labor, which in itself is a significant risk factor. Slight staining of the liquor at the onset of labor probably reflects a small increase in risk, but this has been disputed.

Meconium-staining of the fluid at the onset of labor reflects events that occurred prior to the onset of labor. It may be a sign of impaired placental function that exposes the fetus to the risk of hypoxia during labor. Passage of meconium for the first time after the onset of labor is less common, and it seems to carry an associated risk intermediate between heavy and light early passage of meconium. Whatever the degree or time of passage of meconium, the risks associated are increased if fetal heart-rate abnormalities are also present.
Because of these associations between liquor status and adverse outcomes, routine assessment of the amniotic fluid in early labor, if necessary by amnioscopy or artificial rupture of the membranes, has been recommended as a screening test for identifying fetuses at increased risk. Unfortunately, no controlled evaluation of such a policy has been reported.

3 Continuous assessment of the fetal heart

The development in 1960 of an electrode that could be attached to the fetal scalp led to a great deal of research into the relationship between fetal heart-rate changes and events during labor. Various fetal heart-rate changes were deemed to indicate "fetal distress". These changes were of three types: changes in baseline rate, periodic changes related to uterine contractions, and changes in the variability of the baseline rate. Although tachycardia (abnormally rapid fetal heart rate) and bradycardia (abnormally slow fetal heart rate) were classical signs of "fetal distress", a distinction could be made between constant or "base-line" bradycardias, which were almost invariably associated with good fetal outcome, and bradycardias that represented a change in rate from a previously higher heart rate. Periodic changes included late fetal heart-rate decelerations that followed, repetitively, the peaks of contractions and which were thought to be due to uteroplacental insufficiency; and variable decelerations, which had a varying shape and relationship to contractions that were ascribed to umbilical cord compression. A reduction in the normal "beat to beat" variation of the fetal heart rate was attributed to fetal "depression", reflecting a reduced influence of the central nervous system on control of the heart.

Continuous electronic fetal heart monitoring during labor is now most commonly achieved either "externally" by Doppler ultrasound or "internally" by electrocardiography. Doppler ultrasound provides the most reliable method for monitoring the fetal heart rate during late pregnancy, and for external monitoring of the fetal heart rate during labor. Ultrasound fetal heart-rate monitors are satisfactory for determining the fetal heart rate, but may be less satisfactory for determining fetal heart-rate variability than the internal monitor. Problems that may arise are that a maternal heart rate may occasionally be counted in error (which may lead to an inappropriate diagnosis of fetal distress) and that, when the fetus or mother moves, the signal may be lost or artefactual, necessitating frequent repositioning of the transducer.

External monitoring is usually employed during early labor, particularly before the membranes have ruptured. In many centers internal monitoring by scalp electrode application is preferred later in labor because it provides a more reliable trace and allows the mother greater freedom of movement.

4 Fetal scalp blood acid-base assessment

The technique of sampling blood from the fetal scalp for assessment of the acid-base status during labor was first described in the early 1960s. A scalpel or stylette is passed through the cervical os to make a small incision in the fetal scalp. A sample of blood is then collected in a heparinized capillary tube and analyzed to determine its acid-base status. The technique has changed little since it was first described, requires readily
available blood gas machine availability, and remains somewhat cumbersome, time-consuming, and difficult and uncomfortable for the woman.

5 Comparison of auscultation and electronic fetal monitoring

The two broad approaches to fetal monitoring during labor currently practised are first, the use of electronic monitoring in as high a proportion of women as possible, and second, its use only in women whose pregnancies are deemed to be at high risk. Continuous electronic fetal heart-rate monitoring provides more information than intermittent auscultation with a fetal stethoscope. Listening for 1 min every 15 min between contractions, as is commonly employed with intermittent auscultation during the first stage of labor, samples the fetal heart rate for only about 7% of the time, and provides relatively little information about the relationship between changes in the fetal heart rate and uterine contractions, or about fetal heart-rate variability. The important question is whether or not the increased information provided by continuous electronic monitoring during labor leads to any improvement in outcome for the baby. Although continuous electronic fetal heart monitoring gives substantially more information about the fetal heart rate, the interpretation of fetal heart-rate traces is open to great variation. Tracings are often interpreted differently by different obstetricians, or even by the same obstetrician at different times. The problem with electronic fetal heart monitoring is not with its ability to measure, but in its interpretation.

5.1 Effects on labor and delivery

Twelve randomized, controlled trials comparing electronic fetal monitoring with intermittent auscultation of the fetal heart rate, involving over 58 000 women in 10 centers, have been reported. Cesarean section and operative vaginal delivery rates were both higher in all the electronically monitored groups. The increase in cesarean section rate is much greater when scalp pH estimations are not available. One concern about the use of continuous electronic monitoring (without telemetry, which allows the woman to be mobile), has been the possibility that it prolongs labor by restricting women's movement, but data from the trials, when considered together, do not support this. There is no clear effect of the monitoring method on either the use or the method of analgesia.

5.2 Effects on the fetus and neonate

There is little evidence that the extra cesarean sections associated with continuous electronic fetal monitoring lead to any substantive benefits for the baby. The number of perinatal deaths that occurred among the births in the trials of electronic fetal heart monitoring with fetal pH estimation were evenly distributed between the electronically monitored and control groups. There is no evidence that intensive fetal heart-rate monitoring, with or without fetal pH estimation, reduces the risk of Apgar score less than 7, or the rates of admission to special care nurseries. The one measure of neonatal outcome that does seem to be improved by more intensive intrapartum monitoring is neonatal seizures. This effect seems to be restricted to electronic fetal monitoring backed by fetal pH estimation. For babies monitored in this way, the odds of neonatal seizures appears to be reduced by about one-half. No effect was seen in preterm babies, and so the estimated protective effect may be even greater in
term babies. A secondary analysis of the largest trial suggested that the reduced risk of neonatal seizures was limited to labors that were induced or augmented with oxytocin, or that were prolonged. The finding of a 50% reduction in the risk of neonatal seizures, associated with continuous monitoring of the fetal heart and fetal acid-base estimation, is potentially very important. Indeed, between a

quarter and a third of babies who suffer neonatal seizures die, and a further quarter to a third are seriously impaired in childhood. Nevertheless, the follow-up data available suggest that the neonatal seizures prevented by intensive monitoring are not those associated with long-term impairment. Neonatal infection was uncommon in all the trials, but there is no evidence to suggest that intensive monitoring increased this risk. The data are insufficient to explore differences between types of electrode in this respect.

### 5.3 Mother's views

Most studies of women's opinions of intrapartum fetal monitoring have been uncontrolled surveys of their views. These surveys suggest that continuous monitoring is acceptable to most women, but that it can also have important adverse consequences for some. Many women reported that continuous monitoring and recording of the fetal heart rate was reassuring because it demonstrated that the baby was alive, and provided the information that caregivers need during labor. These feelings are enhanced if women are given a clear view of the monitor during labor. Women at relatively high risk of problems during labor, and those most knowledgeable about continuous monitoring, seem most likely to be reassured. Detailed information given just before the start of labor, however, appears to have little positive effect on women's perceptions of intrapartum monitoring. Continuous electronic monitoring of the fetal heart rate can generate anxiety in a number of ways that cannot be predicted in advance for individual women. Some women interviewed in the surveys reported discomfort and restriction of movement, or worries that an electrode would damage the baby's scalp. Others found the monitor a distraction that interfered with their relationships with caregivers and their companion in labor. The trace may become worrying, and this may be particularly disquieting if there is uncertainty about the significance of the abnormality among caregivers. It may be of poor quality or even artefactual, or the monitor itself may malfunction, sometimes repeatedly. An external abdominal transducer may become displaced or a scalp electrode detached. These problems are not uncommon.

How much weight should be given to the various maternal views of electronic fetal heart-rate monitoring revealed in these uncontrolled surveys? Three of the randomized, controlled trials included an assessment of women's views of the alternative approaches. There were no clear differences between the groups but there was a tendency for women allocated auscultation to have a more positive experience of labor. Women in the electronically monitored group tended to be left alone more often but nearly all women interviewed reported that they were able to get in touch with a nurse or doctor at any time. No difference was detected in the proportions of women who reported worries
or anxiesties during labor, or that labor had been unpleasant. In line with the observational studies, more women in the continuously monitored group felt too restricted during labor. Overall, the method of monitoring was less important to women than the support that they received from staff and companions during labor.

5.4 Technique of electronic fetal monitoring

Direct comparisons of electronic fetal monitoring, with and without fetal blood sampling as an adjunct, show that access to scalp sampling reduces the number of cesareans for fetal distress, with no clear differences in neonatal outcome. Data from indirect comparisons point both to better maternal and better neonatal outcome if fetal blood sampling is used.

Electronic fetal heart-rate monitoring is now often performed intermittently (e.g. for 15 min each hour). A randomized trial showed no evidence that intermittent cardiotocography was less safe than continuous monitoring.

One trial compared cardiotocography plus simultaneous analysis of the fetal electrocardiogram (ECG) waveform, with cardiotocography alone. Operative delivery for fetal distress was markedly reduced in the cardiotocography plus ECG waveform group, but this effect was to some extent attenuated by operative deliveries for other reasons; there was a lesser need for scalp sampling. Overall there is, as yet, little reason to recommend this approach and further evaluations are necessary.

Fetal pulse oximetry is, at present, being assessed in a randomized trial.

5.5 Comment

Although a number of trials of electronic monitoring have now been completed, these collectively have not been sufficiently large to remove uncertainty about the impact, if any, of this technique on the rare, but important, problems of intrapartum fetal death and cerebral palsy.

Evidence from the randomized comparisons of alternative methods of fetal heart-rate monitoring suggests that intrapartum death is prevented equally effectively by intermittent auscultation as by continuous electronic fetal heart-rate monitoring, provided that importance is attached to the prompt recognition of intrapartum fetal heart-rate abnormalities, whatever the monitoring policy is. (During the 2 years of the Dublin trial, for example, the intrapartum death rate was lower than in the preceding and following years.)

The reliability of intermittent auscultation may be increased by the use of a hand-held ultrasound monitor rather than conventional fetal stethoscopes. There are arguments for always using these devices, partly because they cause less maternal discomfort than a fetal stethoscope. Compliance with intermittent auscultation should be straightforward, if a caregiver has responsibility for only one woman during labor. Such individualized attention is likely to have other benefits for a woman. It is to be deplored that staffing and other policies for intrapartum care in many delivery wards make this ideal impossible to meet. The implication is that auscultation may not be performed as frequently or regularly as it should be to provide safe fetal surveillance in labor.

The complexity of continuous electronic monitoring makes it susceptible to technical and mechanical failures. Machine maintenance and replacement, and in-service training of personnel, are therefore important. Electronic fetal monitoring may also provide
suboptimal surveillance, if it reduces the frequency with which the caregiver formally checks the fetal heart rate. A fetal heart monitor should be an adjunct to, not a substitute for, personal care.

The wide variation in the interpretation of continuous fetal heart-rate records demonstrates that this is a major problem with current methods of continuous monitoring. Implications for policy depend on the importance attached to a reduction in the risk of neonatal seizures. Limited follow-up of the children in the Dublin trial who suffered neonatal seizures suggests that the neonatal seizures that are potentially preventable by more intensive monitoring are not associated with long-term problems. Nevertheless, some people will consider that neonatal seizures are sufficiently important in their own right for their prevention to form the basis for current policy. On this basis, there is a good case for using more intensive monitoring when labor ceases to be "physiological", for example, during induction or augmentation of labor, if labor is prolonged, if there is meconium-staining of the liquor, or with multiple pregnancy.

For the majority of labors for which no such indications apply, the current evidence suggests that more intensive monitoring increases obstetric intervention with no clear benefit for the fetus. Regular auscultation by a personal attendant, as used in the randomized trials, therefore seems to be the policy of choice in these labors. Such a policy will be difficult to re-implement in the many hospitals whose current policy is universal electronic monitoring. First, individualized care during labor is often perceived as not possible; and second, midwives and others may have lost the ability and confidence to monitor labor by intermittent auscultation.

The choice of technique for fetal heart monitoring has much wider implications than the direct effects on surveillance and physical health of the fetus. Depending on the prevailing system of care for women during childbirth, it may influence the roles and relationships of those involved. With intermittent auscultation, the midwife is the center of care giving, with the obstetrician playing a consultative role if the midwife is worried that there may be problems. In contrast, use of continuous electronic monitoring changes the delivery room into an intensive-care unit. The midwife takes on a more technical role with obstetricians becoming more centrally involved in routine care. The presence of a monitor may also change the relationships between the woman and her partner on the one hand, and the woman, midwife, and doctor, on the other. These wider implications must be recognized.

6 Other methods of fetal monitoring and diagnosis in labor
6.1 Admission test

Intrapartum fetal distress commonly reflects problems that predate the onset of labor. For this reason, there is a strong case for careful risk assessment at the beginning of labor. A short (15–20 min) period of external electronic fetal-heart monitoring upon admission in labor has been recommended as a screening test for women who are deemed to be at low risk. The rationale for this practice is that it would identify a subgroup of fetuses who would benefit from more intensive monitoring, and might identify major fetal problems that would be missed by intermittent auscultation.
In principle, a screening test on admission in labor as a basis for deciding on selective intensive monitoring is attractive, because it should identify fetuses that embark on labor in an already compromised state. There are, however, two other components of monitoring that must be fulfilled if the policy is to be effective: first, whether the test is interpreted accurately; and second, whether the test results are acted on appropriately when used in clinical practice. These questions can only be addressed satisfactorily in trials to compare the outcomes for women randomly allocated to a policy of screening test plus appropriate response or to a control group wherein the test is not used.

6.2 Intrapartum fetal stimulation tests

Fetal heart-rate acceleration is commonly accepted as an indicator of fetal well-being in antepartum non-stress testing. These accelerations in a non-stress test are commonly associated with fetal movements or uterine contractions, but may be evoked by other stimuli, such as sound. The observations that fetal heart-rate accelerations sometimes coincided with fetal scalp blood sampling, and that scalp blood pH tended to be normal if an acceleration occurred, has prompted consideration of intrapartum stimulation tests by applying a clamp to the scalp, or by using a sound stimulus. These tests could reduce the need for scalp blood sampling, or be used as an alternative when scalp sampling is either not available or technically impossible. They have not, however, been evaluated rigorously. On the basis of currently available evidence, a non-reactive stimulation test should be followed by fetal scalp blood acid-base estimation.

7 Conservative management of "fetal distress"

The most common treatment for intrapartum "fetal distress", diagnosed by persistent fetal heart-rate abnormalities or depressed fetal scalp blood pH, is prompt delivery. Many fetal heart-rate abnormalities, however, will resolve with simple conservative measures, such as a change in maternal position (to relieve aortocaval compression and pressure on the umbilical cord), interruption of oxytocin administration to increase uteroplacental blood flow and short-term maternal oxygen administration (to improve oxygen transport to the placenta). Maternal hypotension often follows the induction of epidural anesthesia, with consequent fetal heart-rate abnormalities. Preloading with intravenous fluids has been shown to counteract the relative hypovolemia that follows epidural block, and to reduce substantially the frequency of fetal heart-rate abnormalities. Intravenous betamimetics are a useful treatment for "buying time" when persistent fetal heart-rate abnormalities indicate a need for elective delivery. In a randomized, controlled trial involving 20 labors characterized by both ominous fetal heart-rate changes and a low fetal scalp blood pH, 10 of the 11 treated with intravenous terbutaline showed improvement in the heart-rate pattern, compared with none in the control group. At birth, the babies were less likely to be acidicotic and to have low Apgar scores. The results of this trial are supported by other less well-controlled studies. This short-term improvement could be very useful in situations where facilities for emergency cesarean section are not
immediately available. The improvement in the trace pattern is sometimes sustained. In these circumstances, labor may be allowed to continue without urgent delivery.

Another temporizing maneuver, amnio-infusion to correct oligohydramnios, may be useful as a method of preventing or relieving umbilical cord compression during labor. Saline or Ringers lactate is infused through a catheter into the uterine cavity. The technique has been used prophylactically in various conditions that are commonly associated with oligohydramnios, and therapeutically for repetitive variable fetal heart-rate decelerations during labor, which are attributed to umbilical cord compression. The use of amnio-infusion for intrapartum umbilical cord compression, potential or diagnosed by cardiotocography, or for meconium-stained liquor in labor, has been evaluated in several controlled trials. This procedure significantly decreases the rate of persistent variable decelerations of the fetal heart. It also improves more substantive outcomes, such as the rate of cesarean section (both overall and for &alpha;fetal distressâ€™) and postpartum endometritis for the mother, and results in fewer babies with birth asphyxia, low Apgar score, or low umbilical cord pH. In the presence of meconium stained liquor, amnio-infusion also reduces the incidence of meconium aspiration syndrome. No clear adverse effects of the procedure have been noted but the trials have not been sufficiently large to exclude the possibility of uncommon but serious maternal complications. The prophylactic use of amnio-infusion for women with intrapartum oligohydramnios but no cardiotocographic abnormalities has not shown any advantages over its therapeutic use triggered by the appearance of variable decelerations.

A third approach to the conservative treatment of persistent &alpha;fetal distressâ€™ has been to treat the fetus to prevent any adverse effects. Piracetam, a derivative of gamma-aminobenzoic acid given intravenously, is thought to promote the metabolism of the brain cells when they are hypoxic. It has been evaluated in a single placebo-controlled trial. The results suggest that piracetam treatment reduces the need for cesarean section, and improves neonatal outcome as judged by the Apgar score and neonatal respiratory problems and signs of hypoxia, but these results must be confirmed by other studies before the approach can be applied clinically. Pyridoxine administration during labor appears to decrease oxygen affinity in cord blood. This may have therapeutic implications, but no information is available as to its clinical importance.

Maternal oxygen administration is widely used for suspected &alpha;fetal distressâ€™ in labor but has not been subjected to randomized evaluation.

An interesting trial, reported in 1959, which compared operative with conservative policies of management for &alpha;fetal distressâ€™, may still be of more than historical interest. In this study, operative delivery rates for &alpha;fetal distressâ€™ were 61% in the operative group and 20% with the conservative policy. The rate of perinatal mortality was similar in the two groups. The changes in obstetric practice and methods of fetal evaluation since this trial was carried out make it difficult to relate the results to contemporary obstetric practice. For those working in situations without modern obstetric facilities, however, it is useful to note that the ready use of operative delivery in the event of meconium-stained liquor or slowing of the fetal heart causes a considerable increase in operative deliveries, and has not been shown to reduce perinatal mortality. While these
conclusions are not directly applicable today, they give cause to question the interventionist policies for the management of suspected "fetal distress", which have become accepted practice without being subjected to randomized evaluation.

8 Conclusions
Amniotic fluid that is sparse or contains meconium is associated with an increased risk of perinatal mortality and morbidity. The status of the liquor when the membranes have ruptured spontaneously should be assessed early in labor, and the presence of meconium or low liquor volume should prompt more intensive fetal surveillance. Whether or not routine amnioscopy or artificial rupture of the membranes to assess the liquor is justified is not clear from the available evidence.

In the majority of pregnancies, intrapartum death is prevented equally effectively by intermittent auscultation and by continuous electronic fetal heart-rate monitoring, provided that intrapartum fetal heart-rate abnormalities are promptly recognized and followed by an appropriate clinical response, whatever the monitoring policy. The use of electronic fetal monitoring with fetal scalp sampling is associated with a lower rate of neonatal seizures, but not with a lower rate of serious long-term neurological disability.

Continuous electronic monitoring results in an increase in cesarean section rates and postpartum morbidity for the mother, with no compensating benefits to the baby except a decreased incidence of neonatal seizures. Whether or not it should be used will depend on the importance attached to the prevention of seizures. Selective use of electronic fetal monitoring could be based on assessment of risk by clinical history, and possibly by early intrapartum assessment.

Despite its practical problems, fetal acid-base assessment is, on the basis of current evidence, an essential adjunct to fetal heart-rate monitoring and should be much more widely used, during the second stage as well as during the first stage of labor. When electronic monitoring is used, both false-positives (false alarms) and false-negatives (a misplaced sense of confidence in the baby's welfare) are reduced by the use of fetal blood sampling as an adjunct.

Intrapartum amnio-infusion is an effective treatment for cord compression abnormalities noted in the presence of oligohydramnios. Prophylactic amnio-infusion for "fetal distress" in labor may be a useful means of "buying time" to permit definitive management of the situation.

A number of lessons can be learned from the trials of intrapartum electronic fetal heart-rate monitoring. First, "more information" is not necessarily beneficial and can have harmful effects. Second, if a test result is predictive of an adverse outcome, it should not be taken as self-evident that intervention based on the results of that test will prevent or ameliorate that outcome. Third, the relationship between measures in the neonatal period and long-term outcome is not straightforward, and measures in the neonatal period may not be accurate surrogates of long-term outcome. Fourth, death and serious childhood morbidity are (thankfully) rare and very large numbers of labors must be studied if the evaluation is to be reliable. Fifth, there should be a healthy scepticism about new methods of intrapartum surveillance such that, when their development has reached
the point that they are considered ready for use in clinical practice, they are introduced into clinical practice only in the context of large-scale randomized controlled trials.

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Sources
Effective care in pregnancy and childbirth