Antepartum Fetal Surveillance

The goal of antepartum fetal surveillance is to prevent fetal death. Antepartum fetal surveillance techniques based on assessment of fetal heart rate patterns have been in clinical use for almost three decades. More recently, real-time ultrasonography and Doppler velocimetry have been used to evaluate fetal well-being. Antepartum fetal surveillance techniques are now routinely used to assess the risk of fetal death in pregnancies complicated by preexisting maternal conditions (eg, type 1 diabetes mellitus) as well as those in which complications have developed (eg, intrauterine growth restriction). This document will review the current indications for and techniques of antepartum fetal surveillance and outline management guidelines for antepartum fetal surveillance, consistent with the best contemporary scientific evidence.

Background

Physiology of Fetal Heart Response and Fetal Behavioral State Alteration

In both animals and humans, fetal heart rate pattern, level of activity, and degree of muscular tone are sensitive to hypoxemia and acidemia (1–4). Redistribution of fetal blood flow in response to hypoxemia may result in diminished renal perfusion and oligohydramnios (5). Surveillance techniques such as cardiotocography, real-time ultrasonography, and maternal perception of fetal movement can identify the fetus that is either suboptimally oxygenated or, with increasing degrees of placental dysfunction, acidemic. Identification of suspected fetal compromise provides the opportunity to intervene before progressive metabolic acidosis can lead to fetal death. However, acute, catastrophic changes in fetal status, such as those that can occur with abruptio placentae or an umbilical cord accident, are generally not predicted by tests of fetal well-being. Therefore, fetal deaths from such events are not as amenable to prevention.
In humans, the range of normal umbilical blood gas parameters has been established by cordocentesis performed in pregnancies in which the fetus ultimately proved to be healthy, and ranges vary by gestational age (6). Although the degree of hypoxemia and acidemia at which various indices of fetal well-being become abnormal is not known with precision, it can be estimated, based on data from published studies. In one investigation, the fetal biophysical profile (BPP) was performed immediately before cordocentesis. Fetuses with a non-reactive nonstress test (NST) were found to have a mean (± standard deviation) umbilical vein pH of 7.28 ± 0.11. Cessation of fetal movement appears to occur at lower pH levels; fetuses with abnormal movement were found to have an umbilical vein pH of 7.16 ± 0.08 (7). Thus, a reasonable correlation between certain measurable aspects of fetal heart rate and behavior and evidence of fetal metabolic compromise can be inferred.

However, when abnormal antepartum fetal surveillance results are compared with evidence of hypoxia or acidemia, the degree of acid–base disturbance may range from mild to severe. Furthermore, factors other than acid–base and oxygenation status (eg, prematurity, fetal sleep–wake cycle, maternal medication exposure, and fetal central nervous system abnormalities) can adversely affect biophysical parameters. Finally, neither the degree nor the duration of intrauterine hypoxemia and acidemia necessary to adversely affect short- and long-term neonatal outcome has been established with any precision.

Antepartum Fetal Surveillance Techniques

Several antepartum fetal surveillance techniques (tests) are in use. These include fetal movement assessment, NST, contraction stress test (CST), BPP, modified BPP, and umbilical artery Doppler velocimetry.

Fetal Movement Assessment

A diminution in the maternal perception of fetal movement often but not invariably precedes fetal death, in some cases by several days (8). This observation provides the rationale for fetal movement assessment by the mother ("kick counts") as a means of antepartum fetal surveillance.

Although several counting protocols have been employed, neither the optimal number of movements nor the ideal duration for counting movements has been defined. Thus, numerous protocols have been reported and appear to be acceptable. In one approach, the woman lies on her side and counts distinct fetal movements (9). Perception of 10 distinct movements in a period of up to 2 hours is considered reassuring. Once 10 movements have been perceived, the count may be discontinued. In another approach, women are instructed to count fetal movements for 1 hour three times per week (10). The count is considered reassuring if it equals or exceeds the woman’s previously established baseline count. In the absence of a reassuring count, further fetal assessment is recommended.

Contraction Stress Test

The CST is based on the response of the fetal heart rate to uterine contractions. It relies on the premise that fetal oxygenation will be transiently worsened by uterine contractions. In the suboptimally oxygenated fetus, the resultant intermittent worsening in oxygenation will, in turn, lead to the fetal heart rate pattern of late decelerations. Uterine contractions also may provoke or accentuate a pattern of variable decelerations caused by fetal umbilical cord compression, which in some cases is associated with oligohydranrnios.

With the patient in the lateral recumbent position, the fetal heart rate and uterine contractions are simultaneously recorded with an external fetal monitor. If at least three spontaneous contractions of 40 seconds’ duration each or longer are present in a 10-minute period, no uterine stimulation is necessary. If fewer than three contractions of at least 40 seconds’ duration occur in 10 minutes, contractions are induced with either nipple stimulation or intravenous administration of dilute oxytocin.

Nipple stimulation usually is successful in inducing an adequate contraction pattern and allows completion of testing in approximately half the time required when intravenous oxytocin is given (11). In one nipple stimulation technique, the woman is instructed to rub one nipple through her clothing for 2 minutes or until a contraction begins (11). If by that time the contraction frequency has not become adequate (as defined previously), stimulation is stopped and restarted again after 5 minutes. If nipple stimulation is unsuccessful, or if the use of oxytocin is preferred, an intravenous infusion of dilute oxytocin may be initiated at a rate of 0.5 mU/min and doubled every 20 minutes until an adequate contraction pattern is achieved (12).

The CST is interpreted according to the presence or absence of late fetal heart rate decelerations (13), which are defined as decelerations that reach their nadir after the peak of the contraction and that usually persist beyond the end of the contraction. The results of the CST are categorized as follows:

- Negative: no late or significant variable decelerations
• Positive: late decelerations following 50% or more of contractions (even if the contraction frequency is fewer than three in 10 minutes)
• Equivocal–suspicious: intermittent late decelerations or significant variable decelerations
• Equivocal–hyperstimulatory: fetal heart rate decelerations that occur in the presence of contractions more frequent than every 2 minutes or lasting longer than 90 seconds
• Unsatisfactory: fewer than three contractions in 10 minutes or an uninterpretable tracing

Relative contraindications to the CST generally include conditions associated with an increased risk of preterm labor and delivery, uterine rupture, or uterine bleeding. These include the following (12):

• Preterm labor or certain patients at high risk of preterm labor
• Preterm membrane rupture
• History of extensive uterine surgery or classical cesarean delivery
• Known placenta previa

Nonstress Test
The NST is based on the premise that the heart rate of the fetus that is not acidotic or neurologically depressed will temporarily accelerate with fetal movement. Heart rate reactivity is thought to be a good indicator of normal fetal autonomic function. Loss of reactivity is associated most commonly with a fetal sleep cycle but may result from any cause of central nervous system depression, including fetal acidosis.

With the patient in the lateral tilt position, the fetal heart rate is monitored with an external transducer. Ideally, the patient should not have smoked recently, because this may adversely affect test results (14). The tracing is observed for fetal heart rate accelerations that peak (but do not necessarily remain) at least 15 beats per minute above the baseline and last 15 seconds from baseline to baseline. It may be necessary to continue the tracing for 40 minutes or longer to take into account the variations of the fetal sleep–wake cycle. Acoustic stimulation of the nonacidotic fetus may elicit fetal heart rate accelerations that appear to be valid in the prediction of fetal well-being. Such stimulation offers the advantage of safely reducing overall testing time without compromising detection of the acidotic fetus (15–17). To perform acoustic stimulation, an artificial larynx (ideally one of the commercially available models especially designed for this purpose) is positioned on the maternal abdomen and a stimulus of 1–2 seconds is applied. This may be repeated up to three times for progressively longer durations of up to 3 seconds to elicit fetal heart rate accelerations.

Nonstress test results are categorized as reactive or nonreactive. Various definitions of reactivity have been used. Using the most common definition, the NST is considered reactive (normal) if there are two or more fetal heart rate accelerations (as defined previously) within a 20-minute period, with or without fetal movement discernible by the woman (18). A nonreactive NST is one that lacks sufficient fetal heart rate accelerations over a 40-minute period. The NST of the uncompromised preterm fetus is frequently nonreactive: from 24 to 28 weeks of gestation, up to 50% of NSTs may not be reactive (19), and from 28 to 32 weeks of gestation, 15% of NSTs are not reactive (20, 21).

Variable decelerations may be observed in up to 50% of NSTs (22). If nonrepetitive and brief (<30 seconds), they indicate neither fetal compromise nor the need for obstetric intervention (22). Repetitive variable decelerations (at least 3 in 20 minutes), even if mild, have been associated with an increased risk of cesarean delivery for a nonreassuring intrapartum fetal heart rate pattern (23, 24). Fetal heart rate decelerations during an NST that persist for 1 minute or longer are associated with a markedly increased risk of both cesarean delivery for a nonreassuring fetal heart rate pattern and fetal demise (25–27).

Biophysical Profile
The BPP consists of an NST combined with four observations made by real-time ultrasonography (28). Thus, the BPP comprises five components:

1. Nonstress test (which, if all four ultrasound components are normal, may be omitted without compromising the validity of the test results) (28)
2. Fetal breathing movements (one or more episodes of rhythmic fetal breathing movements of 30 seconds or more within 30 minutes)
3. Fetal movement (three or more discrete body or limb movements within 30 minutes)
4. Fetal tone (one or more episodes of extension of a fetal extremity with return to flexion, or opening or closing of a hand)
5. Determination of the amniotic fluid volume (a single vertical pocket of amniotic fluid exceeding 2 cm is considered evidence of adequate amniotic fluid) (29, 30)

Each of the five components is assigned a score of either 2 (normal or present as defined previously) or 0 (abnormal, absent, or insufficient). A composite score of 8
or 10 is normal, a score of 6 is considered equivocal, and a score of 4 or less is abnormal. Regardless of the composite score, in the presence of oligohydramnios (largest vertical pocket of amniotic fluid volume ≤ 2 cm), further evaluation is warranted (30).

**Modified Biophysical Profile**

In the late second- or third-trimester fetus, amniotic fluid reflects fetal urine production. Placental dysfunction may result in diminished fetal renal perfusion, leading to oligohydramnios (5). Amniotic fluid volume assessment can therefore be used to evaluate long-term uteroplacental function. This observation fostered the development of what has come to be termed the “modified BPP” as a primary mode of antepartum fetal surveillance. The modified BPP combines the NST (with the option of acoustic stimulation), as a short-term indicator of fetal acid–base status, with the amniotic fluid index (AFI), which is the sum of measurements of the deepest cord-free amniotic fluid pocket in each of the abdominal quadrants, as an indicator of long-term placental function (15). An AFI greater than 5 cm generally is considered to represent an adequate volume of amniotic fluid (31). Thus, the modified BPP is considered normal if the NST is reactive and the AFI is more than 5, and abnormal if either the NST is nonreactive or the AFI is 5 or less.

**Umbilical Artery Doppler Velocimetry**

Doppler ultrasonography is a noninvasive technique used to assess the hemodynamic components of vascular impedance. Umbilical artery Doppler flow velocimetry has been adapted for use as a technique of fetal surveillance, based on the observation that flow velocity waveforms in the umbilical artery of normally growing fetuses differ from those of growth-restricted fetuses. Specifically, the umbilical flow velocity waveform of normally growing fetuses is characterized by high-velocity diastolic flow, whereas with intrauterine growth restriction, there is diminution of umbilical artery diastolic flow (32–34). In some cases of extreme intrauterine growth restriction, flow is absent or even reversed. The perinatal mortality rate in such pregnancies is quite high (35). Abnormal flow velocity waveforms have been correlated histopathologically with small-artery obliteration in placental tertiary villi (36) and functionally with fetal hypoxia and acidosis (37), as well as with perinatal morbidity and mortality (35). Commonly measured flow indices, based on the characteristics of peak systolic frequency shift (S), end-diastolic frequency shift (D), and mean peak frequency shift over the cardiac cycle (A), include the following:

- Systolic to diastolic ratio (S/D)
- Resistance index (S-D/S)
- Pulsatility index (S-D/A)

Randomized studies (38–44) of the utility of umbilical artery Doppler velocimetry generally have defined abnormal flow as either absent end diastolic flow, or a flow index greater than two standard deviations above the mean for gestational age. To maximize interpretability, multiple waveforms should be assessed, and wall-filter settings should be set low enough (typically <150 Hz) to avoid masking diastolic flow.

**Clinical Considerations and Recommendations**

- **Is there compelling evidence that any form of antepartum fetal surveillance decreases the risk of fetal demise or otherwise improves perinatal outcome?**

There is a dearth of evidence from randomized controlled trials that antepartum fetal surveillance decreases the risk of fetal death (45). Moreover, in one comprehensive review, antepartum fetal surveillance was categorized as a form of care “likely to be ineffective or harmful” (46). In spite of its unproven value, antepartum fetal surveillance is widely integrated into clinical practice in the developed world. Therefore, a definitive evaluation of antepartum fetal surveillance (which would require the random allocation of gravidas to prenatal care that included some form of antepartum fetal surveillance versus prenatal care that did not include any form of antepartum fetal surveillance) is unlikely to be conducted in a setting that can be generalized to current U.S. obstetric practice. In the absence of a definitive, relevant randomized clinical trial, evidence for the value of antepartum fetal surveillance will remain circumstantial and rest principally on the observation that antepartum fetal surveillance has been consistently associated with rates of fetal death that are substantially lower than the rates of fetal death in both untested (and presumably lower-risk) contemporaneous pregnancies from the same institutions (15, 16, 47) and pregnancies with similar complicating factors that were managed before the advent of currently employed techniques of antepartum fetal surveillance (historic controls). However, these perceived benefits of antepartum fetal surveillance may be influenced by the low incidence of adverse fetal outcome in the general population. The lower the incidence of adverse outcomes, the more likely favorable outcomes will be achieved regardless of test performance.
What are the indications for antepartum fetal surveillance?

Because antepartum fetal surveillance results have not been definitively demonstrated to improve perinatal outcome, all indications for antepartum testing must be considered somewhat relative. In general, antepartum fetal surveillance has been employed in pregnancies in which the risk of antepartum fetal demise is increased. Accordingly, some of the conditions under which testing may be appropriate include the following:

• Maternal conditions
  —Antiphospholipid syndrome
  —Hyperthyroidism (poorly controlled)
  —Hemoglobinopathies (hemoglobin SS, SC, or S-thalassemia)
  —Cyanotic heart disease
  —Systemic lupus erythematosus
  —Chronic renal disease
  —Type 1 diabetes mellitus
  —Hypertensive disorders

• Pregnancy-related conditions
  —Pregnancy-induced hypertension
  —Decreased fetal movement
  —Oligohydramnios
  —Polyhydramnios
  —Intrauterine growth restriction
  —Postterm pregnancy
  —Isoimmunization (moderate to severe)
  —Previous fetal demise (unexplained or recurrent risk)
  —Multiple gestation (with significant growth discrepancy)

When during gestation should antepartum fetal surveillance be initiated?

Choosing the appropriate point in gestation to begin antepartum testing depends on balancing several considerations, including the prognosis for neonatal survival, the severity of maternal disease, the risk of fetal death, and the potential for iatrogenic prematurity complications resulting from false-positive test results. The importance of the last consideration is illustrated by the experience of one large center, in which 60% of infants delivered because of an abnormal antepartum test result had no evidence of short-term or long-term fetal compromise (16). Both theoretic models (48) and large clinical studies (49, 50) confirm that initiating testing at 32–34 weeks of gestation is appropriate for most at-risk patients. However, in pregnancies with multiple or particularly worrisome high-risk conditions (eg, chronic hypertension with suspected intrauterine growth restriction), testing might begin as early as 26–28 weeks of gestation.

What is the proper frequency of testing?

How frequently to perform fetal testing depends on several factors, including clinical judgment. If the indication for testing is not persistent (eg, a single episode of decreased fetal movement followed by reassuring testing in an otherwise uncomplicated pregnancy), it need not be repeated. When the clinical condition that prompted testing persists, the test should be repeated periodically until delivery to monitor for continued fetal well-being. If the maternal medical condition is stable and CST results are negative, the CST is typically repeated in 1 week (12). Other tests of fetal well-being (NST, BPP, or modified BPP) are typically repeated at weekly intervals (16), but in the presence of certain high-risk conditions, such as postterm pregnancy, type 1 diabetes, intrauterine growth restriction, or pregnancy-induced hypertension, some investigators have performed twice-weekly NST, BPP, or modified BPP testing. Any significant deterioration in the maternal medical status requires fetal reevaluation, as does any acute diminution in fetal activity, regardless of the amount of time that has elapsed since the last test.

How reassuring is a normal test result?

In most cases, a normal test result is highly reassuring, as reflected in the false-negative rate of antepartum fetal surveillance, defined as the incidence of stillbirth occurring within 1 week of a normal test result. The stillbirth rate, corrected for lethal congenital anomalies and unpredictable causes of demise, was 1.9 per 1,000 in the largest series of NSTs (5,861) versus 0.3 per 1,000 in 12,656 CSTs (13), 0.8 per 1,000 in 44,828 BPPs (51), and 0.8 per 1,000 in 54,617 modified BPPs (16). Based on these data, the negative predictive value of the NST is 99.8%, and greater than 99.9% for the CST, BPP, and modified BPP. Although similar data from a large series are not available for umbilical artery Doppler velocimetry, in one randomized clinical trial among women with pregnancies complicated by intrauterine growth restriction (38), no stillbirths occurred in 214 pregnancies in which umbilical artery Doppler velocimetry was the primary means of antepartum fetal surveillance (negative predictive value of 100%). The low false-negative rate of these tests depends on an appropriate response to any significant deterioration in the maternal clinical status, including retesting of the fetal condition. As mentioned previously, these tests generally do not predict stillbirths related to acute changes in maternal–fetal status, such as those that occur with abruptio placentae or an umbilical cord accident. Moreover, recent, normal antepartum fetal test
results should not preclude the use of intrapartum fetal monitoring.

**How should one respond to an abnormal test result?**

An abnormal fetal test result should always be considered in the context of the overall clinical picture, taking into account the substantial possibility that the test result is falsely positive. Certain acute maternal conditions (eg, diabetic ketoacidosis, pneumonia with hypoxemia) can result in abnormal test results, which generally will become normal as the maternal condition improves. In these circumstances, stabilizing the maternal condition and retesting the fetus may be appropriate.

In cases where an abnormal test result is not associated with any clinical evidence of worsening in the maternal status, a sequenced approach to the investigation of the fetal condition should be undertaken. Such an approach takes advantage of the high negative predictive value generally exhibited by all commonly used antepartum tests (see above), and minimizes the potential for unnecessary delivery based on a false-positive (ie, abnormal) test result. False-positive rates, in contrast to false-negative rates, have typically not been calculated using the outcome of stillbirth. This is because most antepartum tests were introduced into clinical practice before an unbiased evaluation of their sensitivity and specificity. In clinical practice, abnormal test results usually are followed by another test or delivery is effected, which obscures the relationship between a positive test result and the subsequent risk of stillbirth. Therefore, in the absence of unbiased evaluations, the positive predictive value of antepartum tests has been estimated using surrogate markers, such as the rate of positive follow-up test results when the primary test result is positive. For example, it has been observed that up to 90% of nonreactive NSTs are followed by a negative CST result (18). Based on this observation, the positive predictive value of an NST is only 10%. Another way that the false-positive rate of fetal testing has been estimated is to calculate the incidence of abnormal test results that prompt delivery but are not associated with evidence of fetal compromise, as manifested by a nonreassuring intrapartum fetal heart rate, meconium-stained amniotic fluid, 5-minute Apgar scores of less than 7, or birth weight greater than the 10th percentile for gestational age. By this latter definition, in one large series, a testing scheme in which abnormal modified BPPs were followed by full BPPs had a false-positive rate of 60% (positive predictive value = 40%) (18). In another study in which the physicians were blinded to test results, a CST was found to have a positive predictive value of less than 35% (52).

Therefore, the response to an abnormal test result should be tailored to the clinical situation. Maternal reports of decreased fetal movement should be evaluated by an NST, CST, BPP, or modified BPP; these results, if normal, usually are sufficient to exclude imminent fetal jeopardy. A nonreactive NST or an abnormal modified BPP generally should be followed by additional testing (either a CST or a full BPP). A positive CST result suggests that NST nonreactivity is a consequence of hypoxia-induced acidosis, whereas a negative result implies that the NST nonreactivity exists for another reason, such as a premature fetus, maternal exposure to certain drugs or medications, a fetal sleep cycle, or preexisting neurologic damage. In many circumstances, a positive CST result generally indicates that delivery is warranted. However, the combination of a nonreactive NST and a positive CST result is associated frequently with serious fetal malformation and justifies ultrasonographic investigation for anomalies whenever possible (53). Indeed, evaluation for grossly abnormal fetal anatomy should precede any intervention for suspected fetal compromise whenever possible.

A BPP score of 6 is considered equivocal; in the term fetus, this score generally should prompt delivery, whereas in the preterm fetus, it should result in a repeat BPP in 24 hours (30). In the interim, maternal corticosteroid administration should be considered for pregnancies of less than 34 weeks of gestation. Repeat equivocal scores should result either in delivery or continued intensive surveillance. A BPP score of 4 usually indicates that delivery is warranted, although in extremely premature pregnancies, management should be individualized. Biophysical profiles less than 4 should result in expeditious delivery. Regardless of the overall score, oligohydramnios always requires further evaluation.

In the absence of obstetric contraindications, delivery of the fetus with an abnormal test result often may be attempted by induction of labor, with continuous monitoring of both the fetal heart rate and contractions.

**Are there clinical circumstances in which one test is distinguished by its utility or lack thereof?**

A large-scale, definitive randomized trial comparing the relative efficacy of one technique of antepartum fetal testing to another has not yet been performed. Accordingly, in most clinical situations, no single antepartum fetal test can be considered superior to any other.

As mentioned previously, in certain clinical situations, the CST is considered relatively contraindicated (increased risk of preterm labor and delivery, uterine rupture, and uterine bleeding), although even in these situa-
Amniotic fluid volume is estimated using ultrasonography. One widely used definition of oligohydramnios is no measurable vertical pocket of amniotic fluid greater than 2 cm (29), and another is an AFI of 5 cm or less (31). Nevertheless, from a clinical standpoint, an ideal cutoff level for intervention using the AFI has yet to be established. Determining when to intervene for oligohydramnios depends on several factors, including gestational age, the maternal and fetal clinical condition as determined by other indices of fetal well-being, and the actual measured AFI value. Because rupture of the fetal membranes can cause diminished amniotic fluid volume, an evaluation for membrane rupture may be appropriate.

In postterm pregnancy, oligohydramnios is common and is associated with an increased risk of meconium staining of the amniotic fluid and cesarean delivery for nonreassuring fetal heart rate (54, 55). Thus, oligohydramnios has been considered an indication for delivery of the postterm pregnancy (15), although the effectiveness of this approach in improving perinatal outcome has not been established by randomized investigation.

In a term pregnancy complicated by oligohydramnios, delivery often is the most appropriate course of action. However, management should be individualized, and in certain situations, delivery may be safely postponed (eg, an uncomplicated pregnancy with an AFI of 5 cm but otherwise reassuring fetal testing and an unfavorable cervix at 37 weeks of gestation).

In the preterm fetus, depending on the maternal and fetal condition, expectant management may be the most appropriate course of action (eg, with preterm premature rupture of membranes or in the presence of fetal anomalies). Once oligohydramnios is diagnosed, if delivery is not undertaken, follow-up amniotic fluid volume and fetal growth assessments are indicated. If the oligohydramnios is persistent, close monitoring of the maternal condition and ongoing antepartum fetal surveillance should be performed to guide further management. If the oligohydramnios results from fetal membrane rupture, follow-up amniotic fluid volume assessment often may be safely omitted.

**What is the role of Doppler velocimetry?**

At least three randomized trials (38, 56, 57) have evaluated the utility of umbilical artery Doppler velocimetry as a technique of antepartum fetal surveillance in pregnancies complicated by suspected intrauterine growth restriction. In the first and largest of these trials (38), 214 pregnancies were allocated to Doppler umbilical artery velocimetry as the primary technique of fetal surveillance, and 212 were allocated to cardiotocography (NST). Overall, women in the Doppler group were significantly less likely to undergo obstetric intervention, including antepartum hospital admission, labor induction, and emergency cesarean delivery for nonreassuring fetal status. On average, women in the Doppler group underwent antenatal testing less frequently (4 times) than women in the cardiotocography group (8 times). Other perinatal outcomes, such as gestational age at birth, birthweight, Apgar scores, and cesarean birth rates, did not differ between the groups.

Subsequent trials (56, 57) have supported the findings of less frequent antenatal monitoring (56) and shorter durations of maternal hospitalization (56, 57) in the Doppler group. However, rates of obstetric interventions, such as antepartum admission and labor induction, were not lower in the Doppler groups, and perinatal outcome was not improved. On balance, the available evidence suggests that primary antepartum surveillance of suspected intrauterine growth restriction with umbilical artery Doppler velocimetry can achieve at least equivalent (and possibly better) fetal and neonatal outcomes as primary antepartum surveillance based on results of the NST. Furthermore, frequency of antepartum testing and certain aspects of obstetric intervention are reduced with use of Doppler (58). If umbilical artery Doppler velocimetry is used, decisions regarding timing of delivery should be made using a combination of information from the Doppler ultrasonography and other tests of fetal well-being, such as amniotic fluid volume assessment, NST, CST, and BPP, along with careful monitoring of maternal status.

No benefit has been demonstrated for umbilical artery velocimetry for conditions other than suspected intrauterine growth restriction, such as postterm gestation, diabetes mellitus, systemic lupus erythematosus, or antiphospholipid syndrome. Doppler ultrasonography has not been shown to be of value as a screening test for detecting fetal compromise in the general obstetric population, and its use for this purpose cannot be recommended (59). In addition to the umbilical artery, it is possible to evaluate blood flow in major fetal vessels. Multiple investigators have observed a correlation between increased flow resistance (elevated S/D ratio) in the umbilical artery and decreased resistance to flow (reduced S/D ratio) in the middle cerebral artery. This phenomenon has been attributed to a “brain sparing” adaptive response to fetal hypoxemia, and it has been suggested that the ratio of middle cerebral arterial S/D ratio to umbilical artery S/D ratio might serve as a useful predictor of fetal compromise (60). However, the only randomized clinical trial of
middle cerebral artery Doppler velocimetry failed to demonstrate any clinical benefit to assessing this parameter (61). Moreover, women in this trial who were allocated to standard fetal evaluation plus assessment of the ratio of middle cerebral artery or umbilical artery Doppler flow, or both, were delivered on average 5.7 days earlier after the institution of fetal testing than women who were allocated to standard fetal evaluation without assessment of middle cerebral artery blood flow. This suggests that incorporation of middle cerebral artery Doppler flow assessment into clinical practice might increase unnecessary intervention. Therefore, at present, middle cerebral artery Doppler flow measurement should be considered investigational.

**Should all women perform daily fetal movement assessment?**

Whether programs of fetal movement assessment actually can reduce the risk of stillbirth is not clear. Only two randomized trials have addressed this issue. The first was conducted in a mixed high-risk (39%) and low-risk (61%) population of 3,111 Danish women who, after 32 weeks of gestation, were randomly assigned to an experimental (counting) group or a control group (10). Women in the experimental group were asked to count fetal movements for 1 hour three times a week and to contact their hospital immediately if they detected fewer movements than their previously established baseline. The control group of women were given no special fetal movement assessment instructions but were asked about fetal movement at their prenatal visits. Of the 1,583 women in the counting group, three experienced stillbirths of normally formed infants weighing more than 1,500 g, versus 12 stillbirths among the 1,569 women in the control group (P<0.05). Of women allocated to the counting group, 80% complied well with the protocol for counting, and 4% were evaluated for decreased fetal movement. The rates of operative vaginal birth and cesarean delivery did not differ significantly between the groups. It should be noted that in the counting group, only 46% of women with decreased fetal movement alerted their care providers. Compliance for both recording fetal movements and reporting when they were diminished was even lower for women who experienced a stillbirth.

Consistent evidence that a formal program of fetal movement assessment will result in a reduction in fetal deaths is lacking. Moreover, whether fetal movement assessment adds benefit to an established program of regular fetal surveillance has not been evaluated. One of the two randomized studies of fetal movement assessment suggests that its use may reduce stillbirths; the other does not. Formal movement assessment may increase, by a small degree, the number of antepartum visits and fetal evaluations. In the randomized trials, however, this increased surveillance did not result in a higher rate of intervention (10, 62).

**Summary**

**The following recommendations are based on limited or inconsistent scientific evidence (Level B):**

- Women with high-risk factors for stillbirth should undergo antepartum fetal surveillance using the NST, CST, BPP, or modified BPP.
- Initiating testing at 32–34 weeks of gestation is appropriate for most pregnancies at increased risk of stillbirth, although in pregnancies with multiple or particularly worrisome high-risk conditions, testing may be initiated as early as 26–28 weeks of gestation.
- When the clinical condition that has prompted testing persists, a reassuring test should be repeated periodically (either weekly or, depending on the test used and the presence of certain high-risk conditions, twice weekly) until delivery. Any significant deterioration in the maternal medical status or any acute diminution in fetal activity requires fetal reevaluation, regardless of the amount of time that has elapsed since the last test.
- An abnormal NST or modified BPP usually should be further evaluated by either a CST or a full BPP. Subsequent management should then be predicated on the results of the CST or BPP, the gestational age, the degree of oligohydramnios (if assessed), and the maternal condition.
Oligohydramnios, defined as either no ultrasonographically measurable vertical pocket of amniotic fluid greater than 2 cm or an AFI of 5 cm or less, requires (depending on the degree of oligohydramnios, the gestational age, and the maternal clinical condition) either delivery or close maternal or fetal surveillance.

In the absence of obstetric contraindications, delivery of the fetus with an abnormal test result often may be attempted by induction of labor with continuous monitoring of the fetal heart rate and contractions. If repetitive late decelerations are observed, cesarean delivery generally is indicated.

Recent, normal antepartum fetal test results should not preclude the use of intrapartum fetal monitoring.

Umbilical artery Doppler velocimetry has been found to be of benefit only in pregnancies complicated by intrauterine growth restriction. If used in this setting, decisions regarding timing of delivery should be made using a combination of information from the Doppler ultrasonography and other tests of fetal well-being, along with careful monitoring of maternal status.

Middle cerebral artery Doppler velocimetry should be considered an investigational approach to antepartum fetal surveillance.

References


The MEDLINE database, the Cochrane Library, and ACOG’s own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985 and February 1999. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

I Evidence obtained from at least one properly designed randomized controlled trial.
II-1 Evidence obtained from well-designed controlled trials without randomization.
II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.
Level B—Recommendations are based on limited or inconsistent scientific evidence.
Level C—Recommendations are based primarily on consensus and expert opinion.