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PDF Format

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 (FHR) patterns have been in clinical use for almost four decades and are used along with real-time ultrasonography and umbilical artery Doppler velocimetry to evaluate fetal well-being. Antepartum fetal surveillance techniques are routinely used to assess the risk of fetal death in pregnancies complicated by preexisting maternal conditions (eg, diabetes mellitus) as well as those in which complications have developed (eg, fetal growth restriction). The purpose of this document is to provide a review of the current indications for and techniques of antepartum fetal surveillance and outline management guidelines for antepartum fetal surveillance that are consistent with the best scientific evidence.

Background

Physiology of Fetal Heart Response and Fetal Behavioral State Alteration

In animals and humans, FHR 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 may be

undergoing some degree of uteroplacental compromise. Identification of suspected fetal compromise provides the opportunity to intervene before progressive metabolic acidosis results in fetal death. However, acute, catastrophic changes in fetal status, such as those that can occur with placental abruption or an umbilical cord accident, are generally not predicted by tests of fetal well-being. Therefore, fetal deaths from such events are less 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 surveillance was performed immediately before cordocentesis. Fetuses with an abnormal test result were found to have a mean (± standard deviation) umbilical vein blood 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 a mean umbilical vein blood pH of 7.16 (± 0.08) (7). Thus, a reasonable correlation between certain measurable aspects of FHR and behavior and evidence of fetal metabolic compromise can be inferred.

Although abnormal fetal surveillance results may be associated with acidemia or hypoxemia, they reflect neither the severity nor duration of acid-base disturbance. The degree and duration of acidemia is weakly correlated with adverse short-term and long-term neonatal outcomes. Furthermore, factors other than acid-base and oxygenation status (eg, prematurity, fetal sleep-wake cycle, maternal medication exposure, maternal smoking, and fetal central nervous system abnormalities) can adversely affect biophysical parameters (8, 9).

Antepartum Fetal Surveillance Techniques

Several antepartum fetal surveillance techniques (tests) are in clinical use. These include maternal perception of fetal movement, contraction stress test (CST), nonstress test (NST), biophysical profile (BPP), modified BPP, and umbilical artery Doppler velocimetry.

Maternal-Fetal Movement Assessment

A decrease in the maternal perception of fetal movement may precede fetal death, in some cases by several days (10). 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 used, 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 was instructed to lie on her side and count distinct fetal movements (11). Perception of 10 distinct movements in a period of up to 2 hours was considered reassuring. The count was discontinued once 10 movements were perceived. The mean time interval to perceive 10 movements was 20.9 (± 18.1) minutes. In another approach, women were instructed to count fetal movements for 1 hour three times per week (12). The count was considered reassuring if it equaled or exceeded the woman's previously established baseline count. Thus, regardless of the fetal movement approach used, in the absence of a reassuring count, further fetal assessment is recommended.

Contraction Stress Test

The CST is based on the response of the FHR 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 FHR pattern of late decelerations. Uterine contractions also may produce a pattern of variable decelerations caused by fetal umbilical cord compression, which in some cases is associated with oligohydramnios.

With the patient in the lateral recumbent position, the FHR and uterine contractions are simultaneously recorded with an external fetal monitor. An adequate uterine contraction pattern is present when at least three contractions persist for at least 40 seconds each in a 10-minute period. Uterine stimulation is not necessary if the patient is having spontaneous uterine contractions of adequate frequency. If fewer than three contractions of 40 seconds' duration occur in 10 minutes, contractions are induced with either nipple stimulation or intravenous oxytocin. A spontaneous CST can be considered if the adequate number and strength of contractions are noted in the 10-minute time frame.

Nipple stimulation usually is successful in inducing an adequate contraction pattern and allows completion of testing in approximately one half of the time required than when intravenous oxytocin is used (13). The CST is interpreted according to the presence or absence of late FHR decelerations (14). A *late deceleration* is defined as a visually apparent and usually symmetrical gradual decrease and return to baseline FHR in association with uterine contractions, with the time from onset of the deceleration to its FHR nadir as 30 seconds or longer. The deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction. In most cases, the onset, nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively (15). The results of the CST are categorized as follows:

- Negative: no late or significant variable decelerations
- Positive: late decelerations after 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: FHR 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

The CST is a safe and effective method of investigating FHR nonreactivity in preterm gestations (16). Relative contraindications to the CST generally include conditions that also are contraindications to labor or vaginal delivery (17).

Nonstress Test

The NST is based on the premise that the heart rate of a 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 most commonly associated with a fetal sleep cycle but may result from any cause of central nervous system depression, including fetal acidemia.

The patient may be positioned in either the semi-Fowler position (sitting with the head elevated 30 degrees) or lateral recumbent position. In one small randomized study, it took less time to obtain a reactive NST when patients were placed in the semi-Fowler position (18). The FHR is monitored with an external transducer. The tracing is observed for FHR 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. The NST should be conducted for at least 20 minutes, but it may be necessary to monitor the tracing for 40 minutes or longer to take into account the variations of the fetal sleep-wake cycle. Vibroacoustic stimulation may elicit FHR accelerations that are valid in the prediction of fetal well-being. Such stimulation offers the advantage of safely reducing the frequency of nonreactive NSTs by 40% and the overall testing time by almost 7 minutes without compromising detection of the acidotic fetus (19–22). To perform vibroacoustic stimulation, the device is positioned on the maternal abdomen and a stimulus is applied for 1–2 seconds. If vibroacoustic stimulation fails to elicit a response, it may be repeated up to three times for progressively longer durations of up to 3 seconds.

Nonstress test results are categorized as reactive or nonreactive. Various definitions of reactivity have been used. The most common definition of a reactive, or normal, NST is if there are two or more FHR accelerations (as previously defined) within a 20-minute period (23). A nonreactive NST is one that lacks sufficient FHR accelerations over a 40-minute period. The NST of the normal preterm fetus is frequently nonreactive: from 24 weeks to 28 weeks of gestation, up to 50% of NSTs may not be reactive (24), and from 28 weeks to 32 weeks of gestation, 15% of NSTs are not reactive (15, 25, 26). Thus, the predictive value of NSTs based on a lower threshold for accelerations (at least 10 beats per minute above the baseline and at least 10 seconds from baseline to baseline) has been evaluated in pregnancies at less than 32 weeks of gestation and has been found to sufficiently predict fetal well-being (27, 28). Variable decelerations may be observed in up to 50% of NSTs (29). Variable decelerations that are nonrepetitive and brief (less than 30 seconds) are not associated with fetal compromise or the need for obstetric intervention (29). Repetitive variable decelerations (at least three in 20 minutes), even if mild, have been associated with an increased risk of cesarean delivery for a nonreassuring intrapartum FHR pattern (30, 31). 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 FHR pattern and fetal demise (32–34). In this setting, the decision to deliver should be made with consideration of whether the benefits outweigh the potential risks of expectant management.

Biophysical Profile

The BPP consists of an NST combined with four observations made by real-time ultrasonography (35). Thus, the BPP comprises five components:

1. Nonstress test—may be omitted without compromising test validity if the results of all four ultrasound components of the BPP are normal (35)
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 deepest vertical pocket greater than 2 cm is considered evidence of adequate amniotic fluid (36–38)

Each of the five components is assigned a score of either 2 (present, as previously defined) or 0 (not present). 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, oligohydramnios (defined as an amniotic fluid volume of 2 cm or less in the single deepest vertical pocket) should prompt further evaluation (37, 39).

Although oligohydramnios has been commonly defined as a single deepest vertical pocket of amniotic fluid of 2 cm or less (not containing umbilical cord or fetal extremities) and an amniotic fluid index of 5 cm or less, available data from randomized control trials (RCTs) support the use of the deepest vertical pocket of amniotic fluid volume of 2 cm or less to diagnose oligohydramnios (36–38, 40, 41).

Modified Biophysical Profile

In the late second-trimester or third-trimester fetus, amniotic fluid volume reflects fetal urine production. Placental dysfunction may result in diminished fetal renal per-fusion, leading to oligohydramnios (5). Amniotic fluid volume assessment can, therefore, be used to evaluate 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, as a short-term indicator of fetal acid-base status, with an amniotic fluid volume assessment, as an indicator of long-term placental function (19). Thus, the results of the modified BPP are considered normal if the NST is reactive and the amniotic fluid volume is greater than 2 cm in the deepest vertical pocket and are considered abnormal if either the NST is nonreactive or amniotic fluid volume in the deepest vertical pocket is 2 cm or less (ie, oligohydramnios is present).

Umbilical Artery Doppler Velocimetry

Doppler ultrasonography is a noninvasive technique used to assess the hemodynamic components of vascular resistance in pregnancies complicated by fetal growth restriction. Umbilical artery Doppler velocimetry has been adapted for use as a technique of fetal surveillance for the growth-restricted fetus, 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 in growth-restricted fetuses, there is decreased umbilical artery diastolic flow (42–44). In some cases of severe fetal growth restriction, diastolic flow is absent or even reversed. The perinatal mortality rate in such pregnancies is significantly increased (45). Abnormal flow velocity waveforms have been correlated histopathologically with small-artery obliteration in placental tertiary villi and functionally with fetal hypoxemia and acidemia as well as with perinatal morbidity and mortality (45–47). Commonly measured flow indices, based on the characteristics of peak systolic velocity and 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 on the utility of umbilical artery Doppler velocimetry generally have defined *abnormal flow* as either absent or reversed end-diastolic flow (48–56). To maximize interpretability, multiple waveforms should be assessed, and wall-filter settings should be set low enough (typically less than 150

Hz) to avoid masking diastolic flow. Currently, there is no evidence that umbilical artery Doppler velocimetry provides information about fetal well-being in the fetus with normal growth.

Clinical Considerations and Recommendations

- *How reassuring is a normal antepartum fetal surveillance result?*

  In most cases, a normal antepartum fetal test result is highly reassuring, as reflected in the low 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 fetal 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, 0.8 per 1,000 in 44,828 BPPs, and 0.8 per 1,000 in 54,617 modified BPPs (14, 20, 57). Based on these data, the negative predictive value is 99.8% for the NST and is 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 fetal growth restriction, 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%) (49). 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 previously mentioned, 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.

- *Is there evidence that antepartum fetal surveillance decreases the risk of fetal demise or otherwise improves perinatal outcomes?*

  Evidence for the value of antepartum fetal surveillance is circumstantial and rests 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 and pregnancies with similar complicating factors that were managed before the advent of currently used techniques of antepartum fetal surveillance (historic controls) (19, 20, 58). There is a lack of high-quality evidence from RCTs that antepartum fetal surveillance decreases the risk of fetal death (59, 60). A definitive evaluation of antepartum fetal surveillance in RCTs (which would require the random allocation of pregnant patients to prenatal care that included antepartum fetal surveillance versus prenatal care that did not include antepartum fetal surveillance) is unlikely to be conducted in a setting that can be generalized to current U.S. obstetric practice. In spite of its unproven value, antepartum fetal surveillance is widely integrated into clinical practice in the developed world.

- *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 used in pregnancies in which the risk of antepartum fetal demise is increased. Accordingly, some of the conditions for which testing may be indicated include, but are not limited to, those listed in Box 1.

- *When during gestation should antepartum fetal surveillance be initiated?*

Box 1. Indications for Antepartum Fetal Surveillance Testing ⇦

Maternal conditions

Pregestational diabetes mellitus
Hypertension
Systemic lupus erythematosus
Chronic renal disease
Antiphospholipid syndrome
Hyperthyroidism (poorly controlled)
Hemoglobinopathies (sickle cell, sickle cell–hemoglobin C, or sickle cell–thalassemia disease)
Cyanotic heart disease

Pregnancy-related conditions

Gestational hypertension
Preeclampsia
Decreased fetal movement
Gestational diabetes mellitus (poorly controlled or medically treated)
Oligohydramnios
Fetal growth restriction
Late term or postterm pregnancy
Isoimmunization
Previous fetal demise (unexplained or recurrent risk)
Monochorionic multiple gestation (with significant growth discrepancy)

Data from Liston R, Sawchuck D, Young D. Fetal health surveillance: antepartum and intrapartum consensus guideline. Society of Obstetrics and Gynaecologists of Canada, British Columbia Perinatal Health Program [published erratum appears in J Obstet Gynaecol Can 2007;29:909]. J Obstet Gynaecol Can 2007;29:S3–56. (Level III)

Choosing the appropriate point in gestation to begin antepartum fetal testing depends on several considerations, including the prognosis for neonatal survival, the risk of fetal death, the severity of maternal disease, 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 (20). Both theoretic models and large clinical studies suggest that initiating antepartum fetal testing no earlier than 32 0/7 weeks of gestation is appropriate for most at-risk patients (61–63). However, in pregnancies with multiple or particularly worrisome high-risk

conditions (eg, chronic hypertension with suspected fetal growth restriction), testing might begin at a gestational age when delivery would be considered for perinatal benefit (64–69).

- *What is the recommended frequency of testing?*

  There are no large clinical trials to guide the frequency of testing, and thus, the optimal frequency remains unknown; it depends on several factors and should be individualized and based on 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), testing need not be repeated. When the clinical condition that prompted testing persists, the test should be repeated periodically to monitor for continued fetal well-being until delivery. If the maternal medical condition is stable and test results are reassuring, tests of fetal well-being (NST, BPP, modified BPP, or CST) are typically repeated at weekly intervals (17, 20); however, in the presence of certain high-risk conditions, some investigators have performed more frequent testing, although the optimal regimen has not been established.

  In pregnancies complicated by fetal growth restriction, the optimal interval for fetal growth assessment and the optimal surveillance regimen have not been established. Most growth-restricted fetuses can be adequately evaluated with serial ultrasonography every 3–4 weeks; ultrasonographic assessment of growth should not be performed more frequently than every 2 weeks because the inherent error associated with ultrasonographic measurements can preclude an accurate assessment of interval growth (70–72). Any significant change in maternal or fetal status requires further reevaluation.

- *What is the recommended management of an abnormal antepartum fetal test result?*

  An abnormal antepartum fetal test result should always be considered in the context of the overall clinical picture. Certain acute maternal conditions (eg, diabetic ketoacidosis or pneumonia with hypoxemia) can result in abnormal test results, which generally will normalize as the maternal condition improves. In these circumstances, correcting the maternal condition and retesting the fetus may be appropriate.

  In cases in which an abnormal test result is not associated with any clinical evidence of acute and potentially reversible worsening in the maternal status, a stepwise approach to the investigation of the fetal condition should be undertaken. Because antepartum fetal surveillance tests have high false-positive rates and low positive predictive values, abnormal test results are usually followed by another test or delivery based on consideration of test results, maternal and fetal condition, and gestational age (23, 73). Such an approach takes advantage of the high negative predictive value generally exhibited by all commonly used antepartum tests and minimizes the potential for unnecessary delivery based on a single false-positive (ie, false-abnormal) test result. 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. Abnormal results from an NST or from a modified BPP generally should be followed by additional testing with either a CST or a BPP. A BPP score of 6 out of 10 is considered equivocal and should prompt further evaluation or delivery based on gestational age. In a fetus at or beyond 37 0/7 weeks of gestation, this score generally should prompt further evaluation and consideration of delivery, whereas in the fetus at less than 37 0/7 weeks of gestation, it should result in a repeat BPP in 24 hours (37). A BPP score of 4 usually indicates that delivery is warranted, although in pregnancies at less than 32 0/7 weeks of

gestation, management should be individualized, and extended monitoring may be appropriate. In most circumstances, a BPP score of less than 4 should result in delivery. If delivery is not planned (eg, given early gestational age), then antenatal surveillance should not be performed because the results will not inform management.

There are no definitive randomized clinical trials to guide the timing of delivery of the growth-restricted fetus on the basis of umbilical artery Doppler velocimetry. Guidelines from the Society for Maternal-Fetal Medicine suggest that with absent end-diastolic flow, delivery should be considered at or beyond 34 0/7 weeks of gestation, and with reversed end-diastolic flow, delivery should be considered at or beyond 32 0/7 weeks of gestation (after corticosteroid administration, if the maternal and fetal condition permit) (74, 75). When the S/D ratio is elevated (ie, greater than the 95th percentile) but diastolic flow is still present, delivery should be considered at or beyond 37 0/7 weeks of gestation. 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 intrapartum monitoring of the FHR and uterine contractions.

- *How should a finding of oligohydramnios affect the decision for delivery?*

Amniotic fluid volume is estimated using ultrasonography. Commonly used definitions of oligohydramnios include a single deepest vertical pocket of amniotic fluid of 2 cm or less (not containing umbilical cord or fetal extremities) and an amniotic fluid index of 5 cm or less (36, 37, 40). However, the use of a percentile of amniotic fluid should not be used in management decisions. The available data from RCTs indicate that the use of the deepest vertical pocket measurement, as opposed to the amniotic fluid index, to diagnose oligohydramnios is associated with a reduction in unnecessary interventions without an increase in adverse perinatal outcomes (38, 41).

Determining when to intervene for oligohydramnios depends on several factors, including gestational age, maternal condition, and fetal clinical condition as determined by other indices of fetal well-being. Because rupture of the fetal membranes can cause diminished amniotic fluid volume, an evaluation for membrane rupture in the setting of oligohydramnios may be appropriate; correspondingly, if membrane rupture is documented, a low amniotic fluid measurement can no longer be considered valid for prediction of diminished placental function. Based on expert opinion, in the setting of otherwise uncomplicated isolated and persistent oligohydramnios (deepest vertical pocket measurement less than 2 cm), delivery at 36–37 weeks of gestation is recommended (76). In pregnancies at less than 36 0/7 weeks of gestation with intact membranes and oligohydramnios, the decision to proceed with expectant management or delivery should be individualized based on gestational age and the maternal and fetal condition. If delivery is not undertaken, follow-up amniotic fluid volume measurements, NSTs, and fetal growth assessments are indicated. If the oligohydramnios results from fetal membrane rupture, follow-up amniotic fluid volume assessment often may be safely omitted.

- *What is the role of umbilical artery and other Doppler velocimetry studies?*

In growth-restricted fetuses, umbilical artery Doppler velocimetry used in conjunction with standard fetal surveillance, such as NSTs or BPPs, or both, is associated with improved outcomes (70, 77). Umbilical artery Doppler velocimetry has not been shown to be predictive of outcomes in fetuses without growth restriction. Investigation of other fetal blood vessels with umbilical artery Doppler velocimetry, including assessments of the middle cerebral artery and the precordial venous system, has been explored in the

setting of fetal growth restriction. However, these flow measurements have not been shown to improve perinatal outcome, and the role of these measures in clinical practice remains uncertain (see the American College of Obstetricians and Gynecologists Practice Bulletin Number 134, Fetal Growth Restriction) (70, 75, 78–83).

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

  Multiple studies have demonstrated that women who report decreased fetal movement are at an increased risk of adverse perinatal outcomes (84). Although fetal kick counting is an inexpensive test of fetal well-being, the effectiveness in preventing stillbirth is uncertain (see Practice Bulletin Number 102, Management of Stillbirth) (85, 86). Consistent evidence that a formal program of fetal movement assessment in low-risk women will result in a reduction in fetal deaths is lacking (87, 88). Moreover, whether fetal movement assessment adds benefit to an established program of regular fetal surveillance has not been evaluated. Formal fetal movement assessment may increase, by a small degree, the number of antepartum visits and fetal evaluations. In RCTs, however, this increased surveillance did not result in a higher rate of intervention (12, 86, 88). Although not all women need to perform a daily fetal movement assessment, if a woman notices a decrease in fetal activity, she should be encouraged to contact her health care provider, and further assessment should be performed.

Summary of Recommendations and Conclusions

The following conclusions are based on good and consistent scientific evidence (Level A):

- The use of the deepest vertical pocket measurement, as opposed to the amniotic fluid index, to diagnose oligohydramnios is associated with a reduction in unnecessary interventions without an increase in adverse perinatal outcomes.
- In growth-restricted fetuses, umbilical artery Doppler velocimetry used in conjunction with standard fetal surveillance, such as NSTs, or BPPs, or both, is associated with improved outcomes.

The following recommendation is based on limited or inconsistent scientific evidence (Level B):

- Abnormal results from an NST or from a modified BPP generally should be followed by additional testing with either a CST or a BPP.

The following recommendations are based primarily on consensus and expert opinion (Level C):

- Initiating antepartum fetal testing no earlier than 32 0/7 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 fetal growth restriction), testing might begin at a gestational age when delivery would be considered for perinatal benefit.
- When the clinical condition that prompted testing persists, the test should be repeated periodically to monitor for continued fetal well-being until delivery. If the maternal medical condition is stable and test results are reassuring, tests of fetal well-being (NST, BPP, modified BPP, or CST) are typically repeated at weekly intervals; however, in the presence of certain high-risk conditions, some investigators have performed more frequent testing, although the optimal regimen has not been established.
- 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 intrapartum monitoring of the FHR and uterine contractions.

- Based on expert opinion, in the setting of otherwise uncomplicated isolated and persistent oligohydramnios (deepest vertical pocket measurement less than 2 cm), delivery at 36–37 weeks of gestation is recommended. In pregnancies at less than 36 0/7 weeks of gestation with intact membranes and oligohydramnios, the decision to proceed with expectant management or delivery should be individualized based on gestational age and the maternal and fetal condition.

Proposed Performance Measure

Percentage of pregnant women with fetal growth restriction in whom a plan for assessment with umbilical artery Doppler and surveillance of fetal growth and well-being is initiated, if delivery is not pursued at the time of diagnosis

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The MEDLINE database, the Cochrane Library, and the American College of Obstetricians and Gynecologists' own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1990–May 2014. 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 Ob-

stetricians 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.