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Biophysical profile test for antepartum fetal assessment

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INTRODUCTION

The fetal biophysical profile (BPP) is a noninvasive, easily learned and performed antepartum test for evaluating fetal well-being. Ultrasound is used to assess four discrete biophysical parameters: fetal movement, fetal tone, fetal breathing, and amniotic fluid volume. A separate nonstress test of the fetal heart rate (FHR) can also be performed as a component of the BPP. Each of the four ultrasound parameters and the nonstress test are assigned a score of either 0 or 2 points (there is no 1 point), depending upon whether specific criteria are met (table 1). A total score ≥8 is a strong indicator that fetal oxygen levels and acid-base status are normal and the fetal brain is well perfused and oxygenated, whereas a score ≤4 can be a sign of fetal compromise. Ideally, identification of a compromised fetus will make it possible for the provider to perform interventions (often delivery) that prevent adverse fetal/neonatal sequelae.

The five biophysical parameters were chosen based upon their ease of measurement and the ability to evaluate them objectively using universally available equipment. Other fetal biophysical activities (eg, sucking, eye movements, swallowing, micturition) might serve equally well as markers of fetal health but are not included in the BPP because measurement is more difficult and assessment may be subjective.

Three fundamental principles guide the interpretation and application of the BPP score:

- Acute fetal biophysical variables do not occur randomly; they are regulated by functional regulatory centers in the fetal brain. The output of the regulatory centers is sensitive to normal modulation by fetal sleep-wake cycles and suppression by

pathologic conditions such as hypoxemia and acidemia. The sensitivity to suppression from hypoxemia or acidemia varies by regulatory center, a phenomenon described as the "gradual hypoxia concept."

- Amniotic fluid volume is a chronic variable and can be independent of acute variables. Oligohydramnios usually takes time to evolve (assuming normal kidneys, patent urinary tract, and intact membranes) and is often a consequence of fetal adaptation to chronic hypoxemia.

- The BPP score needs to be interpreted within the clinical setting, which includes gestational age/risk of neonatal mortality and morbidity associated with early delivery (figure 1), potentially treatable fetal conditions, and the maternal condition. The object is to manage the patient, not the test.

This topic will review issues related to the BPP. An overview of antenatal fetal surveillance and detailed information on the nonstress test and the contraction stress test are available separately. (See "Overview of antepartum fetal assessment" and "Nonstress test and contraction stress test".)

INDICATIONS

Antepartum fetal assessment with tests such as the BPP is indicated for pregnancies in the mid- to late-second and the third trimesters at increased risk of fetal demise. Specific conditions and clinical settings that are considered indications for antenatal fetal assessment are discussed separately, but the decision is ultimately based on the clinical judgment of the provider. (See "Overview of antepartum fetal assessment", section on 'Indications for fetal assessment'.)

Although the BPP is typically used for antepartum fetal assessment, it can also be performed intrapartum; however, its clinical utility in the intrapartum setting is unclear [1,2].

PHYSIOLOGIC BASIS OF THE BIOPHYSICAL PROFILE

- **The four 'acute' parameters –** Four of the five BPP parameters reflect acute fetal status: fetal breathing movements, generalized fetal movements, fetal tone, and fetal heart rate (FHR) accelerations in response to fetal movements (nonstress test). All of these fetal biophysical activities are regulated by discrete centers in the brain that are sensitive to both local factors and feedback from peripheral sensors. The fall in oxygen concentration necessary to affect the output of a specific central nervous system (CNS) regulatory center and thereby reduce fetal oxygen requirements varies by the regulatory center.

The two most oxygen-sensitive centers are the cardioregulatory neurons, which control FHR acceleration, and the fetal breathing center neurons, which control fetal breathing movements. Even mild hypoxemia can lead to reductions in these biophysical parameters. Fetal movement has a higher threshold before being affected by hypoxemia and fetal tone center has the highest threshold. As a result of the different sensitivities to hypoxemia, fetal biophysical activities respond to hypoxemia in a predictable, physiologically based cascade: loss of FHR accelerations and fetal breathing movements, followed by decreased fetal movement, and finally loss of fetal tone. This sequence is informative clinically since it allows for estimation of both the presence and severity of hypoxemia [3,4].

In a lamb model, the CNS regulatory centers were sensitive to modulation by sleep-wake cycles and noxious stimuli (eg, hypoxemia, acidemia) when studied at the human equivalent of approximately 26 weeks of gestation [5]. Although CNS regulatory centers have not been studied systematically before the human equivalent of 26 weeks, it seems likely that the ability of sleep-wake cycles and noxious stimuli to modulate the biophysical activities controlled by these centers would occur at the same time or shortly after developmental emergence of the biophysical activity.

- **The single 'chronic' parameter** – Amniotic fluid volume, the fifth parameter, is not an acute parameter since decreases in amniotic fluid volume in response to chronic uteroplacental insufficiency generally occur gradually. On average, in the absence of membrane rupture, it takes approximately 15 days for amniotic fluid volume to progress from normal to reduced and 23 days to progress to severe oligohydramnios [6]. However, acute changes in amniotic fluid volume and rapid deterioration of the BPP score have been reported [7].

  Fetal urine is the predominant source of amniotic fluid after approximately 16 weeks of gestation. It depends primarily upon renal perfusion, which in turn reflects selective distribution of cardiac output. The fetus responds to sustained hypoxemia by selective redistribution of its cardiac output, with preferential flow directed to the brain, heart, adrenals, and placenta at the expense of all other organ systems [8]. This protective mechanism is initiated by specialized chemoreceptors in the aortic arch and carotid arteries. Hypoxemia-induced reflex redistribution of cardiac output away from the kidneys results in diminished fetal urine production, ultimately leading to oligohydramnios and then anhydramnios [6]. Theoretically, a decrease in fetal swallowing, which removes amniotic fluid, could compensate for the decrease in urine production, but fetal swallowing is a vegetative reflex that is very resistant to the effects of hypoxemia. (See "Physiology of amniotic fluid volume regulation".)

Scoring for excessive amniotic fluid volume is not part of the BPP because hypoxia is not one of the many diverse etiologies for this finding.

DETERMINING THE BIOPHYSICAL PROFILE SCORE

Assigning points — Each of the five parameters in the composite BPP score has been evaluated independently and the normal characteristic defined (table 1) [9] (see 'Physiologic basis of the biophysical profile' above). The scoring method used for each parameter is binary (ie, the parameter is either normal or abnormal; gradations of abnormality are not used). A normal parameter is assigned a score of 2 and an abnormal parameter is assigned a score of 0. The maximum score is 10/10 and the minimum score is 0/10.

When assigning points, the clinician should be aware of some pitfalls. Decoupling of the CNS regulatory centers from the neurons generating a specific biophysical activity occasionally occurs and can result in pathological conditions that should not be confused with normal biophysical activity. For example [10-12]:

- Fetal breathing activity characterized by a very regular rate and excursion depth that is continuous and without apneic intervals ("picket-fence breathing") or gasping (slow intermittent excursions) should not be considered normal breathing movements.
- Seizures should not be counted as normal fetal limb movements.
- Sinusoidal fetal heart rate (FHR) pattern on the nonstress test should not be confused with normal long-term variability.

Duration of fetal observation — A parameter may be assigned a normal score (2) as soon as it is observed. Because the acute parameters are subject to fetal sleep-wake cycles, the fetus should be observed continuously for at least 30 minutes before assigning 0 points for any acute parameter. This time is based on ultrasound studies of fetuses from uncomplicated pregnancies. In one such study at 36 to 42 weeks of gestation, the mean duration of a fetal sleep (no somatic movements) was approximately 20 minutes, with an upper range of approximately 40 minutes [13].

The average time to obtain a normal BPP score (BPP 8/8) is 5.3 minutes, and the test can be stopped at that point. When all tests are considered (normal, equivocal, abnormal), the average testing time is approximately 18 minutes [14]. Fetal acoustic stimulation can decrease testing time [15,16]. Some caution in interpreting fetal biophysical responses to acoustic stimulation seems prudent since intense stimulation and particularly painful stimulation can overcome the suppressive effects of hypoxemia/acidemia. The effectiveness

of maternal glucose administration and change in position to shorten the average time to complete a BPP score has not been formally evaluated and is unproven.

Use of the nonstress test — A BPP of 8/8 as derived from the ultrasound variables alone without a nonstress test has the same high predictive accuracy as a BPP of 10/10 when a reactive nonstress test is included because the central nervous system (CNS) center regulating the interaction between fetal movement and FHR accelerations and the CNS center regulating fetal breathing movements have very similar sensitivity to hypoxia and acidemia. Thus, a reactive nonstress test or presence of fetal breathing movements, either alone or in combination, are equally good predictors of normal oxygenation of these regulatory centers [17]. The decision to add a nonstress test result to a BPP of 8/8 (ultrasound variables only) is a matter of clinician personal preference. An advantage of including the nonstress test is fetal arrhythmias and cord compression patterns (variable decelerations) are more readily detected. The disadvantage is extended testing time. We always include a nonstress test as part of the composite BPP when one or more acute variables is abnormal or oligohydramnios is identified, or when abnormalities such as fetal growth restriction or abnormal Doppler velocimetry are present.

A BPP of 8/10, where the absent variable is either a nonreactive nonstress test or absent fetal breathing movements, has the same high predictive accuracy of fetal well-being. In a prospective clinical study in which the nonstress test was only performed if one of the ultrasound variables (usually fetal breathing movements) was absent, a nonstress test was needed in less than 3 percent of tests and this approach reduced average testing time without reducing the predictive value of the BPP [17]. In a retrospective study of 3981 BPP tests among 985 high-risk pregnancies, the positive and negative predictive accuracy of an ultrasound variable-only BPP and a full BPP (including the nonstress test) were comparable [18].

Rarely, a nonstress test will be persistently nonreactive on serial testing. The most likely explanation is coincidence of sleep-wake cycles. However, the possibility of an intrinsic error in the integration of proprioceptor signals or expression of cardiac regulation is another possibility. If the ultrasound variables remain normal, then intervention based on a repetitive nonreactive nonstress test result is not necessary.

ALTERNATIVES

Modified biophysical profile — The modified BPP was developed to simplify the examination and reduce the time necessary to complete testing by focusing on those components of the BPP that are most predictive of outcome: nonstress test and amniotic fluid volume. Assessment of both the nonstress test and amniotic fluid volume appears to be as reliable a predictor of long-term fetal well-being as the full (ie, five component) BPP

[19,20]. The rate of stillbirth within one week of a normal modified BPP is the same as with the full BPP: 0.8 per 1000 patients tested [20].

Approximately 90 percent of pregnancies that undergo a modified BPP will have a normal result; the remainder will need to proceed to a full biophysical evaluation.

TESTING SCHEDULE

Initiation — Testing should begin as soon as an increased risk of fetal demise is identified and delivery for perinatal benefit would be considered if test results are abnormal. This may be as early as 22 weeks of gestation [21], but is more commonly by 32 to 36 weeks. Determining the gestational age to begin testing is discussed in more detail separately. (See "Periviable birth (limit of viability)" and "Overview of antepartum fetal assessment", section on 'Timing'.)

Frequency — As a general rule, a normal BPP score predicts fetal well-being for up to a week, so testing is commonly repeated weekly until delivery as long as the indication for testing persists and appears to be stable [22,23]. However, the type and severity of the clinical situation needs to be considered (ie, manage the patient, not the test) and thus varies from weekly, to two or more times per week, to daily, and even to multiple times daily. In particular, any significant deterioration in the clinical condition (eg, worsening preeclampsia, recurrent antepartum hemorrhage, poorly controlled diabetes) or decreased fetal activity requires reevaluation, regardless of the amount of time elapsed since the last test. For example, a severely growth-restricted fetus with absent or reversed Doppler velocimetry of the umbilical artery and oligohydramnios can quickly deteriorate from a BPP of 8/10 to a BPP of 2/10 [21,24,25]. (See "Fetal growth restriction: Pregnancy management and outcome".)

INTERPRETATION

As a general rule, the more variables that are absent, the more likely the absence is due to a pathologic rather than a physiologic cause. An acute variable(s) can be absent for any of the following reasons:

- Hypoxemia and acidemia.
- A deep stage of fetal quiet sleep, which is a benign physiological etiology. Fetal breathing is most affected by quiet sleep, fetal movement less so, and fetal tone is affected only at the deepest stages of quiet sleep [13]. Extending the time for BPP generally eliminates uncertainly between physiologic and pathologic etiologies since the fetus is likely to have at least one active (REM) cycle in a 30-minute period.

- Transplacental passage of a substance that causes general suppression of brain activity, such as a sedative, opioid, or alcohol.

Amniotic fluid volume can be decreased in response to chronic uteroplacental insufficiency, but also from prelabor rupture of membranes or a fetal upper or lower urinary tract anomaly that interferes with urination.

The normal score (10/10, 8/8, or 8/10) — A BPP of 10/10, 8/8, or 8/10 with normal amniotic fluid volume is a normal score, a powerful predictor of normal fetal acid-base status, and associated with a very low risk of fetal death within a week (false-negative death rate 0.8 per 1000). Fetal death within a week of a normal BPP score is usually the result of an acute complication such as abruption, fetomaternal hemorrhage, cord compression, or exacerbation of maternal disease (eg, eclampsia or ketoacidosis).

8/10 because of oligohydramnios — Oligohydramnios as the only abnormal variable in a BPP score is a rare finding in the absence of membrane rupture or fetal urinary tract anomaly, but may occur in postterm pregnancies and pregnancies complicated by fetal growth restriction. Management of oligohydramnios depends on the clinical scenario. (See "Postterm pregnancy" and "Fetal growth restriction: Pregnancy management and outcome", section on 'General approach to timing' and "Oligohydramnios: Etiology, diagnosis, and management in singleton gestations".)

The very abnormal score and abnormal score (0/10, 2/10, 4/10)

- A BPP of 0/10 is a fetal emergency and carries an extremely high risk of fetal death (600 per 1000 within seven days). A score of 0/10 is virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life.

- A BPP of 2/10 is very abnormal and associated with a high risk of fetal death within a week (125 per 1000 within seven days) and is virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life.

  In the extremely immature fetus (<28 weeks) with this score, extending the testing time or repeat testing over a short interval (four to six hours) is a consideration. A sustained or persistent BPP of 2/10 is virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life.

- A BPP of 4/10 is also very abnormal and associated with a risk of fetal death of 91 per 1000 within seven days.

  - Oligohydramnios – In a fetus with intact membranes and a functional patent genitourinary tract, a score of 4/10 with oligohydramnios is usually an indication for delivery if the gestational age is sufficiently advanced to sustain extrauterine life.

Before 34 weeks of gestation, it is reasonable to administer a course of antenatal corticosteroids and wait 24 to 48 hours before delivering the fetus, as long as the fetus remains under intense and often continuous fetal heart rate (FHR) surveillance. In the setting of membrane rupture or congenital anomalies that reduce urination, management must be individualized.

- Normal amniotic fluid – A score of 4/10 with normal amniotic fluid is usually an indication for delivery if the gestational age is sufficiently advanced to sustain extrauterine life. Before 34 weeks of gestation, it is reasonable to administer a course of antenatal corticosteroids and repeat the BPP 24 hours after the previous BPP; delivery is indicated if the repeat BPP is 6/10 or less.

Interim score (6/8) — A BPP of 6/8 is not an acceptable final BPP result. A nonstress test always needs to be performed to determine whether this interim score will change to 6/10 or 8/10. Interpretation and management depend on this final score. (See 'The normal score (10/10, 8/8, or 8/10)' above and '8/10 because of oligohydramnios' above and 'The equivocal score (6/10)' below.)

The equivocal score (6/10) — A BPP of 6/10 is equivocal.

- A BPP of 6/10 with oligohydramnios as one of the abnormal variables combined with any one abnormal acute variable (most commonly a nonreactive nonstress test or absent fetal breathing) is a concerning finding and is associated with a risk of fetal death of 89 per 1000 within seven days. Delivery for fetal indications is generally recommended if the gestational age is sufficiently advanced to sustain extrauterine life. In the setting of membrane rupture or fetal urinary tract abnormally, management must be individualized.

- A BPP of 6/10 with normal amniotic fluid volume is a truly equivocal result. In about two-thirds of cases, a repeat BPP within 24 hours will yield a normal result. Management is based upon the repeat result. If the BPP of 6/10 persists, delivery may be indicated if the gestational age is sufficiently advanced to sustain extrauterine life; management of these cases needs to be individualized. If the BPP score reverts to normal, then continued serial surveillance is appropriate.

FACTORS POTENTIALLY AFFECTING THE SCORE

- **Antenatal corticosteroids –** Administration of antenatal corticosteroids can be associated with transient fetal heart rate (FHR) and behavioral changes, but these changes typically return to baseline by day 4 after treatment [26]. The most consistent change is a decrease in FHR variability on days 2 and 3 after administration [27-31].

Fetal breathing and body movements are also commonly reduced, which may result in a lower BPP score or nonreactive nonstress test [31-34]. These findings should be considered within the total clinical scenario when considering delivery because of a nonreassuring fetal evaluation (nonstress test or BPP) after corticosteroid administration.

The behavioral changes may reflect a physiologic response of the brain to glucocorticoids. Alternatively, they may be a consequence of a transient increase in fetal vascular resistance and blood pressure, which has been demonstrated in animal studies. Fetal blood flow velocity waveform patterns in the umbilical artery, middle cerebral artery, and ductus venosus do not appear to be affected [33,35,36].

- **Subclinical infection –** The effect of subclinical infection on test results is controversial. Although intraamniotic infection in a patient with preterm prelabor rupture of membranes may be associated with a low BPP score in the absence of hypoxemia [37], most studies have found that the BPP score is an insensitive method for detecting subclinical infection [38-41]. (See "Preterm prelabor rupture of membranes: Management and outcome", section on 'Fetal monitoring'.)

- **Preterm labor –** Preterm labor may be associated with absence of fetal breathing movements, but absence of fetal breathing movements is not a good predictor of preterm delivery within 48 hours or seven days [42].

- **Fasting –** There are sparse data on the effect of fasting on fetal biophysical activities. A study that performed a BPP one hour after a meal and 10 to 12 hours after abstaining from food and drink in 30 patients with uncomplicated pregnancies reported scores were ≥8/10 for all postprandial BPPs, but two fasting BPPs were 4/10 and 6/10; both increased to 10/10 after the mother ate a meal [43]. Point reductions during fasting were primarily due to nonreactive nonstress tests and inadequate fetal breathing movements.

  It is difficult to draw any conclusion about the effect of fasting on the BPP score in the clinical setting, given the small size of this study and the absence of indications for antepartum fetal assessment. Some clinicians give the patient juice or another type of food/drink if a BPP shows inadequate breathing or the nonstress test is nonreactive. However, a meta-analysis found that maternal glucose administration did not significantly decrease the incidence of nonreactive test results related to quiet fetal sleep; the effect on BPP scores was not evaluated [44].

- **Other –** Mild maternal anemia does not appear to affect fetal biophysical activities [45].

EVIDENCE OF EFFICACY

Although the use of biophysical testing schemes to monitor high-risk pregnancies has become routine, this practice pattern has evolved with limited high-quality scientific evidence to support its use [46]. Moreover, there are no randomized trials on which to base recommendations for the best initial testing approach for specific types of high-risk pregnancies, the optimal timing of test initiation, the frequency of testing based on test results, conditions that may affect test results, and the effect of gestational age.

- **Meta-analysis of randomized trials –** In a meta-analysis of randomized trials comparing BPP with conventional fetal heart rate (FHR) monitoring (five trials involving 2974 high risk pregnancies), use of the BPP did not reduce perinatal death (relative risk [RR] 1.33, 95% CI 0.60-2.98) or the frequency of low Apgar scores (RR 1.27, 95% CI 0.85-1.92) [47]. Three of the trials were of low quality; the two higher-quality studies were small (n = 280 high-risk pregnancies) and results did not exclude the possibility of a small or modest benefit. Conventional FHR monitoring included the nonstress test, contraction stress test, and modified BPP.

- **Observational studies –** Observational studies have reported the BPP is accurate for predicting the absence of significant fetal acidemia [48] and comparable to the contraction stress test [49]. For example, in one observational study including almost 45,000 BPPs, the risk of fetal demise within one week of a normal test result was 0.8 per 1000 pregnant individuals tested (corrected for lethal congenital anomalies and unpredictable causes of demise) [50]. This result compares favorably with all other means of antepartum fetal assessment. In two observational studies including over 18,000 pregnant individuals, use of the BPP was associated with a 61 to 76 percent reduction in perinatal mortality (corrected) compared with historic controls [51].

  In other observational studies, as the last BPP score fell (figure 2), perinatal mortality (gross and corrected) and serious perinatal morbidity (nonreassuring FHR pattern in labor, low Apgar scores, neonatal seizures, admission to an intensive care unit, hypoxemic-ischemic encephalopathy, intrauterine growth restriction) increased significantly [52,53]. In addition, the cord blood pH of newborns delivered either vaginally or by cesarean had a direct relationship to the last BPP score (figure 3) [54]. An inverse relationship between last BPP score and incidence of cerebral palsy has also been observed and may be related to antepartum asphyxia (figure 4). Long-term asphyxia leading to adverse neurologic outcomes such as cerebral palsy and intellectual disability appears to be significantly reduced in high-risk patients managed by fetal BPP scoring compared with untested low-risk patients [55].

- **Physiologic data –** The advent of ultrasound-guided intrauterine fetal blood sampling (cordocentesis) made it possible to measure the direct and immediate relationship between the BPP score, fetal PO_2, and fetal pH [3,56]. These studies, which include over 1000 paired observations, reported a direct relationship between the BPP score and mean umbilical venous pH and suggest that, in the individual fetus, the BPP score accurately predicts both the probability and severity of existing acidemia [57,58]. Thus, the score appears to be an accurate proxy for fetal acidosis. In contrast, the relationship between the BPP score and fetal PO_2 is less precise, which is expected since PO_2 varies according to fetal compensatory adaptive responses.

ROUTE OF DELIVERY AFTER A LOW BIOPHYSICAL PROFILE SCORE

The route of delivery is an obstetric decision based on multiple variables including presentation, cervical findings, and maternal and fetal condition. In the absence of an obstetric contraindication, induction of labor with continuous intrapartum fetal heart monitoring is a reasonable option for most patients, regardless of BPP score. The positive predictive value of a low BPP score for intrapartum fetal compromise (eg, a nonreassuring fetal heart tracing, neonatal acidemia, or other markers of neonatal morbidity at the time of delivery) is approximately 50 percent, with a negative predictive value greater than 99.9 percent.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Fetal surveillance".)

SUMMARY AND RECOMMENDATIONS

- **Gestational age –** The minimum gestational age for initiating biophysical testing should reflect the lower limit that delivery would be considered for an abnormal test, which is typically 22 weeks. (See 'Initiation' above.)
- **Scoring**
  - **Assigning points –** The five fetal parameters used for determining the biophysical profile (BPP) score are heart rate accelerations in response to movement (nonstress test), breathing movement, body and limb movement, tone, and amniotic fluid volume, as described in the table (table 1). (See 'Assigning points' above.)

- **Duration of observation** – A parameter may be assigned a normal score as soon as it is observed. The acute parameters (movement, tone, breathing) are subject to fetal sleep-wake cycles; therefore, the fetus should be observed continuously for at least 30 minutes before the parameter is assigned 0 points. A BPP cannot be scored as abnormal if the testing time is less than 30 minutes. (See 'Duration of fetal observation' above.)

- **Use of the nonstress test** – A BPP of 8/8 has the same high predictive accuracy of fetal well-being as a BPP of 10/10 (ie, when a reactive nonstress test is included). A nonstress test can be omitted if the BPP score is 8/8 after ultrasound alone but should always be performed if any ultrasound monitored parameter is 0. (See 'Use of the nonstress test' above.)

- **Interpretation** – The general approach to interpretation of the BPP score is shown in the table (table 2). However, the BPP score always needs to be interpreted within the clinical setting, which includes gestational age/risk of neonatal mortality and morbidity associated with early delivery, potentially treatable fetal conditions, and the maternal condition. The object is to manage the patient, not the test.

- **Frequency of testing** – The type and severity of the clinical situation needs to be considered and thus varies from weekly, to two or more times per week, to daily, and even to multiple times daily. Any significant deterioration in the clinical condition (eg, worsening preeclampsia, recurrent antepartum hemorrhage, poorly controlled diabetes) or decreased fetal activity requires reevaluation, regardless of the amount of time elapsed since the last test. (See 'Frequency' above.)

- **Performance** – In observational studies, use of the BPP score as part of the management of high-risk obstetric patients has been associated with a significant reduction in perinatal mortality. However, randomized trials have not established superiority of the full (ie, five component) BPP compared with cardiotocography or the modified BPP (nonstress test plus amniotic fluid volume). (See 'Evidence of efficacy' above and 'Modified biophysical profile' above.)

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Topic 5392 Version 34.0

GRAPHICS

Components of the full biophysical profile test

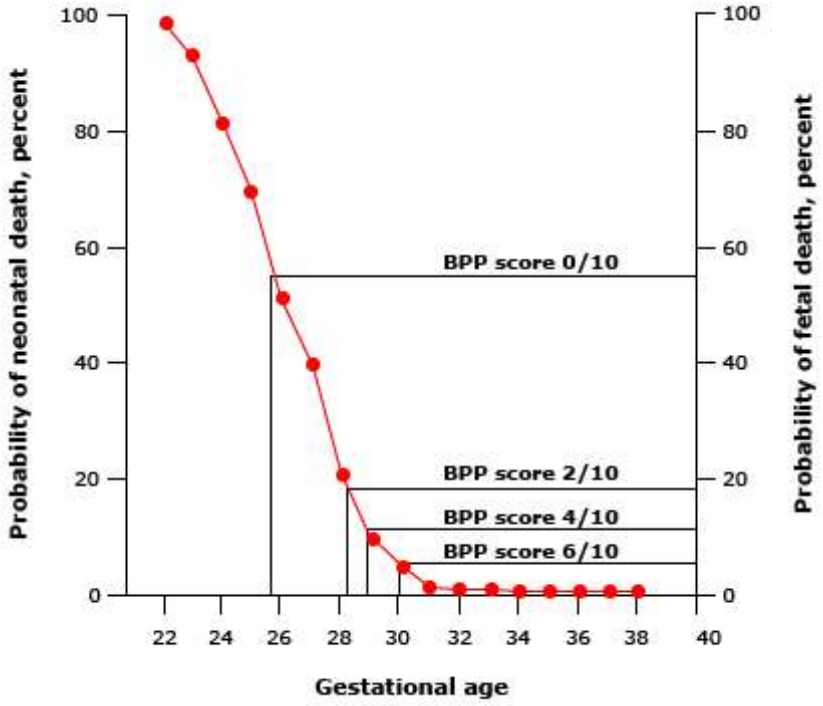
Fetal movement: 2 points if three or more discrete body or limb movements within 30 minutes of observation. An episode of active continuous movement is counted as one movement.
Fetal breathing movements: 2 points if one or more episodes of rhythmic breathing movements of ≥30 seconds within a 30-minute observation period.
Fetal tone: 2 points if one or more episodes of extension of a fetal extremity or fetal spine with return to flexion, or opening and closing of the fetal hand.
Amniotic fluid volume: 2 points if a single deepest vertical pocket ≥2 cm is present. The horizontal dimension should be at least 1 cm.
Nonstress test: 2 points if reactive, defined as at least 2 episodes of FHR accelerations of at least 15 bpm and at least 15 seconds duration from onset to return associated with fetal movement.

Zero points are assigned for any criteria not met (1 point is not an option). The BPP report should provide the number of points for each component and the total score. The NST is not always performed when the ultrasound portion of the BPP is 8/8. Refer to UpToDate content on the fetal biophysical profile for additional information.

FHR: fetal heart rate; bpm: beats per minute.

Graphic 79813 Version 12.0

Comparison of neonatal death rates as predicted by gestational age and fetal death rates as predicted by the fetal biophysical profile (BPP) score

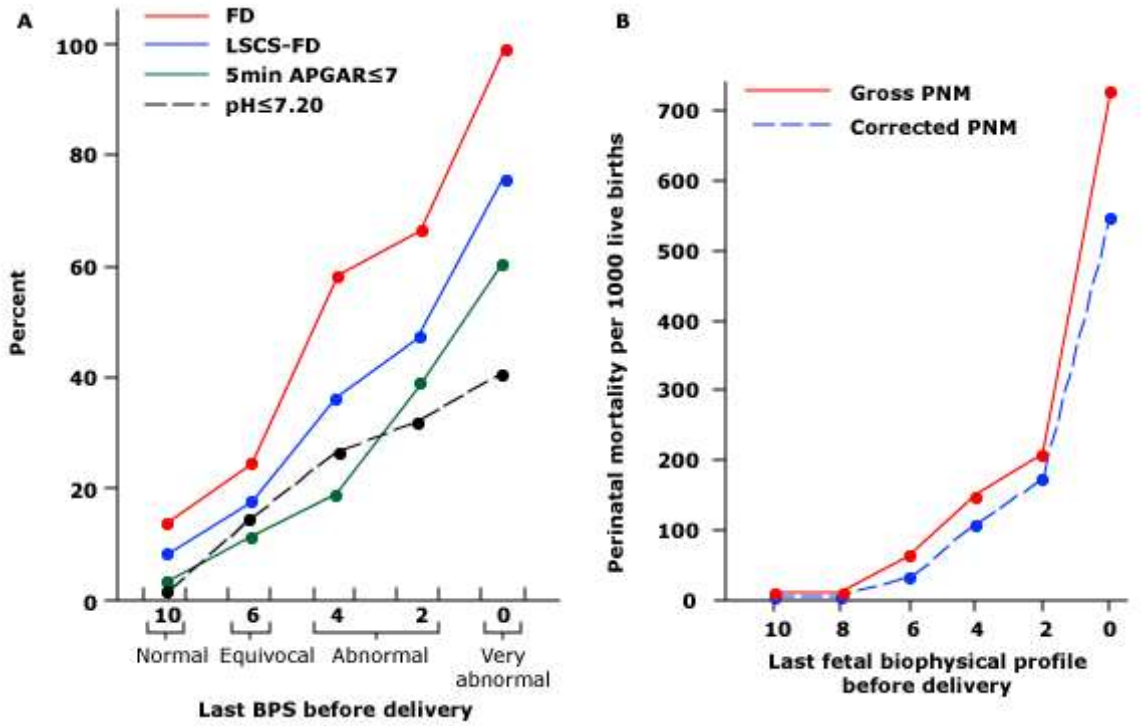


The red line represents the probability of neonatal death by gestational age. For example, the risk of fetal death with a BPP score of 2/10 is approximately 20%. Therefore, when the BPP score is 2/10, the risk of neonatal death is less than the risk of fetal death if the gestational age is greater than 28 weeks. This graph should be used for illustration only because the neonatal survival rate shown here from the University of Manitoba in 1995 will differ from other centers and more contemporary data. However, the predictive accuracy of the BPP score is unlikely to vary among centers.

Data from: Manning FA. Dynamic ultrasound-based fetal assessment: The fetal biophysical profile score. Clin Obstet Gynecol 1995; 38:26.

Graphic 78999 Version 3.0

Relationship between biophysical profile score and perinatal mortality and morbidity



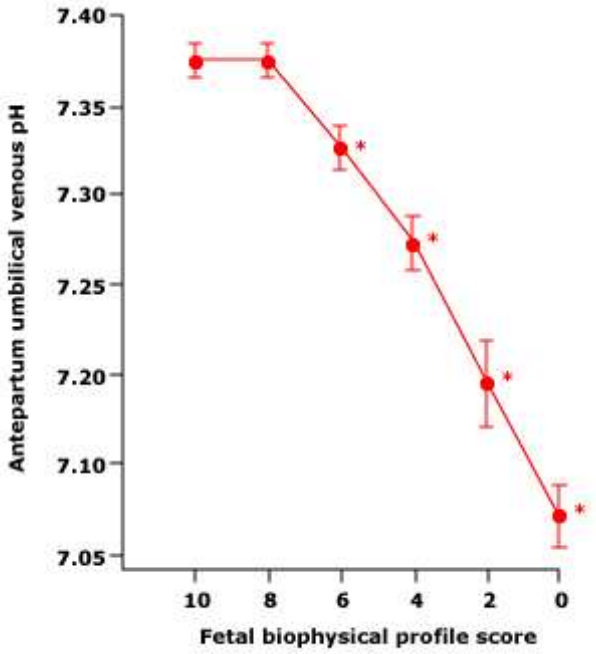
(A) The relationship betwen the biophysical profile (BPP) score result and the occurence of various perinatal morbidities. The incidence of fetal distress in labor (FD), cesarean delivery for fetal distress (LSCS-FD), low 5-minute Apgar score, and venous cord blood acidemia exhibit a very significant linear inverse relationship to test score. These data are based on observations made in more than 26,000 high-risk fetuses.

(B) The relationship betwen the BPP score and perinatal death (PNM), both gross and corrected for fatal anomalies. Unlike morbidity, the mortality rate increases in an inverse exponential fashion as the BPP score decreases.

Data from: Manning FA. Dynamic ultrasound-based fetal assessment: The fetal biophysical profile score. Clin Obstet Gynecol 1995; 38:26.

Graphic 78661 Version 4.0

The relationship between fetal umbilical venous pH (±2 SD) by cordocentesis and the fetal biophysical profile score



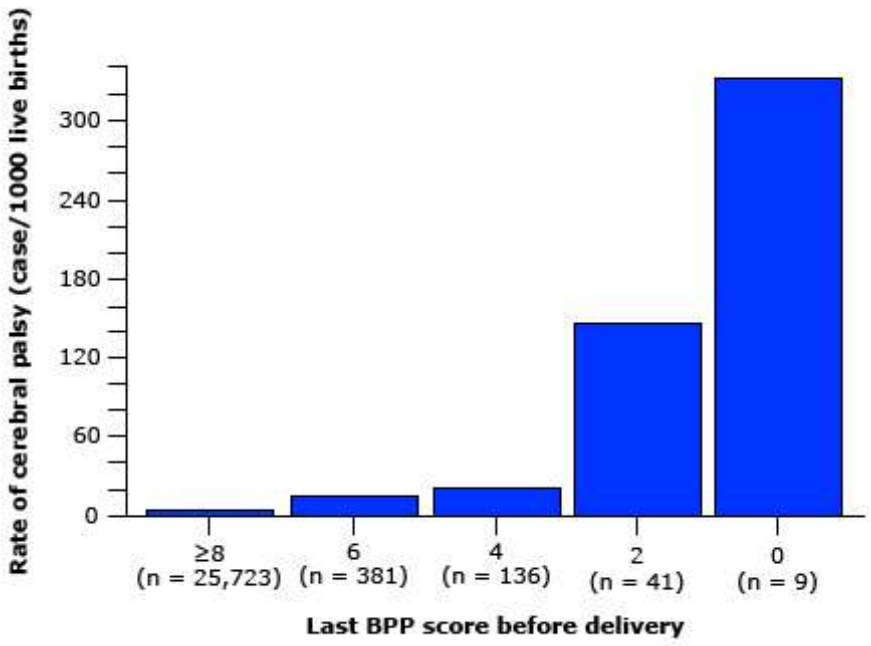
The correlation was linear, inverse, and very significant (R^2 0.912; p <0.01).

SD: standard deviation.

Data from: Manning FA. Dynamic ultrasound-based fetal assessment: The fetal biophysical profile score. Clin Obstet Gynecol 1995; 38:26.

Graphic 65562 Version 5.0

Inverse relationship between the last fetal biophysical profile (BPP) score and cerebral palsy (CP)



The relationship between the fetal BPP score and CP is inverse, exponential, and highly significant (R^2 = –0.096; $p<0.001$). Infants were followed for five years after birth.

Graphic 54595 Version 4.0

Approach to interpretation of the biophysical profile score

BPP score	Amniotic fluid volume	Interpretation	Next steps
10/10, 8/8, or 8/10	Normal	Normal score	Repeat once or twice weekly until delivery as long as the indication for testing persists and the condition appears to be stable
8/10	Oligohydramnios	Rare score in the absence of membrane rupture or fetal urinary tract anomaly, but may occur in postterm pregnancies and pregnancies complicated by fetal growth restriction	Management of oligohydramnios depends on the clinical scenario.
6/10	Normal	Equivocal	Repeat test within 24 hours. In about two-thirds of cases, a repeat BPP will yield a normal result. Management is based upon the repeat result. If the BPP score reverts to normal, then continued serial surveillance is appropriate. If the BPP of 6/10 persists, delivery may be indicated if the gestational age is sufficiently advanced to sustain extrauterine life; management of these cases needs to be individualized.
6/10	Oligohydramnios	Concerning because risk of fetal death is increased (89 per 1000 within seven days)	Repeat test within 24 hours. Management is based upon the repeat result. If the BPP of 6/10 persists, delivery may be indicated if the gestational age is sufficiently advanced to sustain extrauterine life; management of these cases needs to be individualized. If the BPP score reverts to normal (8/10), then management of oligohydramnios depends on the clinical scenario. Continued clinical surveillance is appropriate.
6/8	–	Not interpretable	A nonstress test always needs to be performed to determine whether this interim score will change to 6/10 or

			8/10. Interpretation and management depend on this final score.
4/10	Normal		A score of 4/10 with normal amniotic fluid is usually an indication for delivery if the gestational age is sufficiently advanced to sustain extrauterine life. Before 34 weeks, it is reasonable to administer a course of antenatal corticosteroids and repeat the BPP within 24 hours of the previous BPP; delivery at that time is indicated if the repeat BPP is 6/10 or less.
4/10	Oligohydramnios		In a fetus with intact membranes and a functional patent genitourinary tract, a score of 4/10 with oligohydramnios is usually an indication for delivery if the gestational age is sufficiently advanced to sustain extrauterine life. Before 34 weeks of gestation, it is reasonable to administer a course of antenatal corticosteroids and wait 24 to 48 hours before delivering the fetus, as long as the fetus remains under intense and often continuous FHR surveillance. In the setting of membrane rupture or congenital anomalies that reduce urination, management must be individualized.
2/10	–	High risk for fetal demise	Virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life. In the extremely immature fetus (<28 weeks) with this score, extending the testing time or repeat testing over a short interval (four to six hours) is a consideration. A sustained or persistent BPP of 2/10 is virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life.
0/10	–	High risk for fetal demise	Virtually always an indication for prompt delivery if the gestational age is sufficiently advanced to sustain extrauterine life

The BPP score should always be interpreted with regard to the clinical setting, which includes gestational age (ie, risk of neonatal mortality and morbidity associated with early delivery), potentially treatable fetal conditions, and the maternal condition. The object is to manage the patient, not the test.

BPP: biophysical profile; FHR: fetal heart rate.

Graphic 141378 Version 1.0

Contributor Disclosures

Frank A Manning, MD No relevant financial relationship(s) with ineligible companies to disclose. **Lynn L Simpson, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Deborah Levine, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Vanessa A Barss, MD, FACOG** No relevant financial relationship(s) with ineligible companies to disclose.

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