SCHOOL OF MEDICINE
DEPARTMENT OF OBSTETRICS & GYNECOLOGY

STANDARD OPERATING PROCEDURE- GUIDELINE

ANTEPARTUM FETAL SURVEILLANCE TECHNIQUES

SCOPE/APPLICABILITY:

Several antepartum fetal surveillance techniques (tests) include maternal perception of fetal movement (described in another SOP), contraction stress test (CST), nonstress test (NST), biophysical profile (BPP), modified BPP, and umbilical artery Doppler velocimetry. The primary source of information reported here is from the ACOG Practice Bulletin 145, July 2014 "Antepartum Fetal Surveillance." Most cited references reflect large, well-designed clinical trials that were published in the past 35 years. Evidence was obtained from well-designed multiple time series, controlled trials, or cohort or case-control analytic studies.

There is no "best test" to evaluate fetal well-being, since each technique has different end points to consider depending on the clinical situation. The most important considerations in deciding when to begin testing would be the neonatal survival chances and the severity of any maternal disease. Most authorities recommend testing to begin by 32-34 weeks but may require testing as early as 26 weeks. The frequency for repeating tests has been arbitrarily set at 7 days, but more frequent testing is often done for the following indications: diabetes requiring medication and postdates.

In practice, the CST is cumbersome to perform. Therefore, most antenatal testing will utilize either the NST plus deepest vertical pocket (the modified biophysical profile) or the four ultrasound parameter biophysical profile. While the NST plus deepest vertical pocket measurement and the four ultrasound parameter biophysical profile are generally considered equivalent in terms of test performance, in some cases it may be preferable to perform one rather than the other. For example, if there have been many variable decelerations on prior nonstress tests or continuous fetal heart rate monitoring one may wish to use the NST/DVP to monitor the prior abnormality. On the other hand, if a fetus demonstrates many atrial premature beats it may be difficult to perform the NST and the biophysical profile may be preferred; this also confers the additional benefit of facilitating screening for hydrops and effusions that might point toward undetected sustained supraventricular tachycardia. The MFM service would be happy to consult on these types of questions regarding optimal antenatal testing.

Contraction Stress Test (CST)

PURPOSE:

The CST is based on the response of the fetal heart rate (FHR) to uterine contractions. It relies on the premise that fetal oxygenation will be transiently worsened by uterine contractions. In the sub optimally 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.

DEFINITIONS:

- Negative: Add
- 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

PROCEDURE:

With the patient in the lateral recumbent position, the FHR and uterine contractions are simultaneously recorded with an extended 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 augmented 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 is sometimes 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. The CST is interpreted according to the presence or absence of late FHR decelerations. 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.

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

Nonstress Test (NST)

PURPOSE:

An NST is a simple, noninvasive test performed to determine fetal well-being by assessing FHR reactivity. The NST is based on the premise that the heart rate of a fetus that is neither acidotic nor neurologically depressed will temporarily accelerate with fetal movement. Heart rate reactivity is thought to be a good indicator of normal fetal autonomic function that is not affected by uterine hypoxia. 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 academia.

DEFINITIONS:
NST 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. 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 NST's may not be reactive, and from 28 weeks to 32 weeks of gestation, 15% of NSTs are not reactive. Thus, the predictive value of NSTs based on a lower threshold for accelerations (at least 10 beats for 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.

Variable decelerations may be observed in up to 50% of NSTs. Variable decelerations that are nonrepetitive and brief (less than 30 seconds) are not associated with fetal compromise of the need for obstetric intervention. 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. 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. In this setting, the decision to deliver should be made with consideration of whether the benefits outweigh the potential risks of expectant management.

PROCEDURE:
The patient may be positioned in either the semi-Fowler position (sitting with the head elevated 30 degrees) or lateral recumbent position. 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 at 32 weeks or beyond or at least 10 beats per minute above the baseline and last 10 seconds at less than 32 weeks. The NST should be conducted for at least 20 minutes, but it may be necessary to monitor the tracing for up to 40 minutes to take into account the variations of the fetal sleep-wake cycle. From 24 to 28 weeks' gestation, up to 50% of NSTs may be nonreactive and from 28 to 32 weeks, 15% may be nonreactive. If a nonstress test is nonreactive but no ominous fetal heart rate decelerations are observed and there is normal fetal heart rate variability, a biophysical profile should be performed. If all ultrasound components are present as noted below then the combination of these tests is considered a reassuring test result and does not need to be repeated prior to the standard interval.

Due to the high rate of false negativity when the NST is performed alone, it should always be accompanied by an ultrasound measurement of amniotic fluid volume. Normal deepest vertical pocket should be greater than 2 x 2 cm. If the pocket is less than this size the diagnosis of oligohydramnios is met and management should be based on that finding. The combination of these modalities used in this way is called a modified biophysical profile.

While some centers will attempt to reduce the duration of NST monitoring by the use of external vibroacoustic stimulation, this has been demonstrated to disrupt fetal behavioral patterns from prolonged periods of time as well as to alter cerebral cortical metabolism with the net cortical production of lactic acid. Therefore this modality is not utilized in our center.

Biophysical Profile (BPP)

PURPOSE:
The combined use of five fetal biophysical variables has been proposed as a more accurate means for assessing fetal health than a single element. It combines the assessment of immediate fetal acid-base balance and chronic placental function.

DEFINTIONS:
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 equivocal, and a score of 4 or less is abnormal. Regardless of the composite score, oligohydramnios (DVP 2 cm or less in) should prompt further evaluation.

PROCEDURE:
The BPP usually requires 30 to 60 minutes. It consists on an NST combined with four observations made by real-time ultrasonography. Thus, the BPP comprised five components.

Normal results are described below:

1. Nonstress test – reactive pattern (may be omitted without compromising test validity if the results of all four ultrasound components of the BPP are normal)
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 DVP greater than 2 x 2 cm

Because the four ultrasound parameters without the NST result in false negativity comparable to the full biophysical profile, in our unit the biophysical profile is usually performed without the NST and if the fetus achieves the four ultrasound diagnostic criteria the testing is considered reassuring and does not need to be repeated prior to the usual testing interval.

Umbilical Artery Doppler Velocimetry

PURPOSE:
Doppler ultrasonography is another noninvasive technique used to assess the hemodynamic components of vascular resistance. 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. The umbilical flow velocity waveform of normally growing fetuses is characterized by high-velocity diastolic flow, whereas in growth-restricted fetuses, there is a decreased umbilical artery diastolic flow.

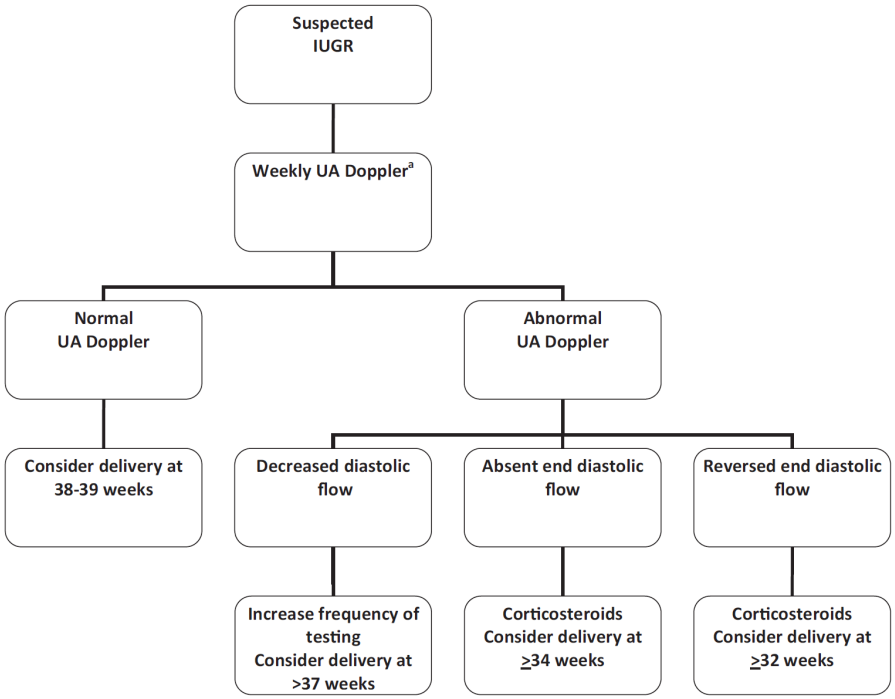
In some cases of severe fetal growth restriction, diastolic flow is absent or even reversed. The perinatal mortality rate in such pregnancies is significantly increased. Abnormal flow velocity waveforms have been correlated histopathologically with small-artery obliteration in placental tertiary villi and functionally with fetal hypoxemia and academia as well as with perinatal morbidity and mortality.

DEFINITIONS:
Randomized studies on the utility of umbilical artery Doppler velocimetry generally have defined abnormal flow as either absent or reversed end-diastolic flow. Currently, there is no evidence that umbilical artery Doppler velocimetry provides information in defining well-being of the fetus with normal growth.

PROCEDURE:
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. Commonly measured flow indices, based on the characteristic 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: 1) systolic to diastolic ratio (S/D), 2) resistance index (S-D/D), and 3) pulsatility index (S-D/A). The Society for Maternal and Fetal Medicine is recommending the utilization of the pulsatility index with abnormal being defined as greater than the 95th percentile for gestational age.

UA Dopplers are managed in general according to the following flowsheet:

FIGURE 5
Algorithm for clinical use of Doppler ultrasound in management of suspected IUGR



IUGR, intrauterine growth restriction; *UA*, uterine artery.

[a]In conjunction with antepartum testing.

SMFM. Doppler assessment of fetus with IUGR. Am J Obstet Gynecol 2012.

The MFM division recommends that if UA Doppler PIs are elevated that testing be increased to at least twice per week and that patients be admitted for absent or reversed diastolic flow. We will increase the frequency of follow-up when the diastolic flow is forward but with elevated PI and will inform the primary physician if absent or reversed diastolic flow is seen and will generally recommend admission for intensive monitoring and other workup.

References:

American College of Obstetricians and Gynecologists, Practice Bulletin #145, Antepartum Fetal Surveillance, July 2014, Reaffirmed 2016

Visser GH, Mulder HH, Wit HP, Mulder EJ, Prechtl HF, Vibro-acoustic stimulation of the human fetus: effect on behavioral state organization. Early Hum Dev. 1989 Jul;19(4):285-96.

Chao CR, Glenford PG, Karibo EJ, Salha SD, Sound stimulation increases the cerebral glucose:oxygen quotient in the fetal sheep, Exp Physiol. 1993 Sep;78(5):707-10

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APPROVALS:

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