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Antepartum Outpatient Fetal Testing

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INTRODUCTION

Antenatal fetal testing is defined as fetal surveillance used to indirectly evaluate the fetal status[1]. The goals of fetal testing are to identify fetuses at risk for stillbirth, assess for uterine asphyxia, and intervene to prevent adverse outcomes while minimizing maternal and neonatal morbidity. Since the 1970s-1980s, fetal surveillance techniques have consisted primarily of assessment of fetal heart rate patterns, along with ultrasonography and Doppler velocimetry of the umbilical artery.

The fetus responds to chronic hypoxemia in a predictable sequence that is correlated with acidemia from blood gas[2]. As fetal acidosis and hypoxia increase, fetal monitoring may demonstrate the cascade of 1) appearance of late decelerations, 2) disappearance of accelerations, 3) absence of breathing, 4) cessation of fetal movement, and 5) absence of fetal tone [3]. Fetal surveillance is designed to assess chronic or developing hypoxemia and acidosis, to reduce the risk of fetal death in pregnancies complicated by preexisting maternal conditions or pregnancy-related complications. It is challenging to predict an acute hypoxemic event.

The goal of this consensus statement is to standardize our clinical recommendations regarding antepartum testing. In this document we will review 1) common maternal and neonatal indications for testing, and 2) initiation, type and frequency of antenatal testing recommended. This consensus document should be used in conjunction with the Practice Bulletin 145[2] on *Antepartum Fetal Surveillance* from the American College of Obstetricians and Gynecologists (ACOG). Beyond the scope of this document is timing of delivery and unique conditions where testing would be recommended.

ANTEPARTUM FETAL SURVEILLANCE TECHNIQUES

FETAL MOVEMENT AWARENESS

The theory that slowing and cessation of fetal movement can occur prior to fetal death[3] was the rationale behind teaching fetal movement awareness (ie. “fetal kick counts”). However, there has been no study that confirms the optimal timing or quantity of a fetal “kick counting” protocol[2]. A 2015 Cochrane Review demonstrated no difference in stillbirth rate comparing scheduled routine counting vs. an undefined counting protocol (SMD 0.23, 95% CI 0.61-1.07)[4]. A randomized control trial of 68,000 women with non-anomalous fetuses determined the number needed to treat to prevent one stillbirth was 1250[5]. The 2018 AFFIRM trial[6] was a stepped wedge randomized control trial of 409,175 patients that created a formalized protocol to evaluate decreased fetal movements, increase patient and staff education, and define delivery criteria. The trial intervention produced no significant difference in the rate of stillbirth, adjusted odds ratio 0.90 (0.75-1.07). Although the AFFIRM trial did not demonstrate efficacy in reducing stillbirth, routine fetal kick counts have been associated with a decrease in maternal anxiety (SMD -0.22, 95% CI 0.35-0.1) and no change in maternal-fetal attachment (SMD 0.02, 95% CI 0.15-.011)[4]. There is an associated increase in antepartum admissions with fetal kick counts (SMD 2.72, 95% CI 1.34-5.52)[4]. Given the low cost and simple nature of the intervention, it is still standard practice to recommend fetal movement awareness. Given the varying literature, ACOG states that not

all women need to perform daily fetal movement assessments; however if a patient notices decreased fetal activity, further assessment should be performed[2].

NONSTRESS TEST (NST)

With in utero movement, the non-acidotic fetus temporarily accelerates the fetal heart rate. These accelerations should provide reassurance to providers that the fetus is not acidotic or neurologically depressed. ACOG supports the most common definition of a reactive, or normal, NST: continuous fetal heart rate (FHR) monitoring with two or more FHR accelerations (defined as 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 within a 20-minute period[7] A nonreactive NST is one that lacks sufficient FHR accelerations over a 40-minute period. As gestational age matures, the presence of accelerations should increase, with 50% of NSTs being nonreactive between 24-28 weeks, 15% of NSTs nonreactive between 28-32 weeks, and 5% nonreactive at greater than 34 weeks[2]. Variable decelerations may be present in up to 50% of NSTs. Three or greater variable decelerations in a 20 minute period is predictive of an increased risk of cesarean delivery for an indication of non-reassuring fetal heart tracing[2]. A prolonged deceleration greater than 1 minute predicts an increased risk of cesarean section for non-reassuring fetal heart tracing and fetal demise[2].

A Cochrane review on antenatal cardiotocography[8] reviewed 4 studies (1396 women) allocated to either traditional NST or to no testing. There was no difference in the risk of perinatal mortality (RR 2.05, 95% CI 0.95-4.42), risk of cesarean section (RR 1.06, 95% CI 0.88-2.8) or potentially preventable perinatal mortality (RR 2.46, 95% CI 0.96-6.30). The current common practice of twice weekly NSTs for various pregnancy comorbidities resulted primarily from a single study of 913 patients reporting that twice weekly NST decreased rates of stillbirth (5.8/1000) vs. once weekly NST (10.6/1000)[9].

Vibroacoustic stimulation can reduce the incidence of a non-reactive test (RR 0.62, 95% CI 0.48-0.81) and decrease testing time by an average of 6.93 minutes[10]. There is no clinical difference in the type or frequency of stimulation[10].

CONTRACTION STRESS TEST (CST)

Although not a practical test in the outpatient setting, the CST is based on the assumption that a compromised fetus will have late decelerations during times of decreased oxygenation from contractions[2]. A CST is defined as continuous FHR and uterine tocometry where at least three contractions persist for at least 40 seconds each in a 10-minute period. 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 spontaneous contractions are noted in the 10-minute time frame. The only contraindication to this test is a contraindication to a vaginal delivery[2]. In a study of 78 preterm pregnancies, there were no complications or neonatal demises associated with performance of a contraction stress test[11]. A case control study[12] of growth restricted fetuses greater than 34 weeks undergoing CST showed no difference in birth weight, APGAR <7 at 5 minutes or NICU admissions compared to fetuses without contraction stress testing.

Categorization of CST results are detailed in ACOG Practice Bulletin 145[2]. A positive CST, defined as late decelerations after >50% of contractions, is highly predictive of poor tolerance of labor. Braly and Freeman[13] allowed 27 patients with positive CST to labor under direct observation. 19 of the 27 (70%) had fetal intolerance of labor. Of those patients with a positive CST and nonreactive baseline, 100% had fetal intolerance of labor.

BIOPHYSICAL PROFILE (BPP)

As defined by ACOG, the BPP consists of an NST combined with four observations made by real-time ultrasonography. Thus, the BPP comprises five components:

1. Nonstress test
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

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[14-16]. The NST may be omitted for a maximum score of 8 without compromising test validity if the results of all four ultrasound components of the BPP are normal[17].

With the addition of ultrasound assessment, a BPP can be highly predictive of fetal asphyxia. Manning[18] reviewed the risk of perinatal mortality in the next week with each BPP score in a series of over 12,000 high-risk pregnancies. The subsequent 1-week stillbirth risk was 1/1000 with a score of 10/10, 89/1000 with a score of a 6/10, and 600/1000 with a score of 0/10. In a reviewed of over 26,000 pregnancies[9,19] with progressively lower BPP scores, the risk of fetal distress in labor, cesarean delivery for fetal distress, APGAR <7 and umbilical artery pH $\leq$7.20 increased.

A Cochrane review[20] of 5 studies comparing BPP vs. NST showed no difference in perinatal death rate (RR 1.33, 95% CI 0.5-2.98) or APGAR <7 at 5 minutes (RR 1.27, 95% CI 0.85-1.92). There were concerns of poor quality of the trials with issues in blinding and allocation.

MODIFIED BIOPHYSICAL PROFILE

The modified BPP combines an NST with a fluid assessment (deepest vertical pocket >2cm) as an evaluation of both short- and long term uteroplacental function[2]. The modified BPP is an adequate study to identify fetuses whom may be compromised due to placental dysfunction leading to oligohydramnios. ACOG considers a modified BPP to be normal if the NST is reactive and the amniotic fluid volume is greater than 2cm in the deepest vertical pocket. Comparing the modified BPP versus complete BPP, studies have reported similar rates of stillbirth following modified BPP versus complete BPP for antenatal surveillance (see Table 1 below)[21-23].

UMBILICAL ARTERY DOPPLER VELOCIMETRY

Doppler assessment of the umbilical artery has become standard of care for evaluation of vascular resistance in growth restricted fetuses. As diastolic flow decreases in fetal growth restriction (FGR), there is an increase in perinatal mortality. In a study[24] of umbilical artery Doppler assessment over time in FGR pregnancies, the rate of perinatal mortality was 4% with present (normal) diastolic flow and as high as 65% with reversed diastolic flow. The odds of perinatal mortality increase with decreasing gestational age and worsening diastolic flow.

In a review on umbilical artery Doppler[25], high risk pregnancies were categorized as FGR, post term, previous pregnancy loss, hypertension, diabetes and thrombophilia. Compared to pregnancies with no Doppler assessment, there was a decreased number of perinatal deaths (NNT=203, 95% CI 103-4252), fewer inductions of labor (RR 0.89, 95% CI 0.8-0.99) and a decreased cesarean section rate (RR 0.9, 95% CI 0.84-0.97). There was no change in the rate of operative vaginal deliveries (RR 0.95, 95% CI 0.8-1.14) or APGAR <7 at 5 minutes (RR 0.92, 95% CI 0.69-1.24).

There is no evidence than umbilical artery Doppler velocimetry provides information about fetal well-being in the fetus with normal growth[2]. Thus, the utility of umbilical artery Doppler in this document will be limited to fetuses diagnosed with FGR.

ANTEPARTUM FETAL SURVEILLANCE CONSIDERATIONS

EFFICACY

The goal of accurate fetal surveillance should be a low false negative rate, defined as the rate of stillbirth in the subsequent 7 days after a normal test result[2]. Table 1 lists the stillbirth rate, negative predictive value and false positive rate for NST, BPP, modified BPP and CST. As previously discussed, these tests do not evaluate for acute events such as placental abruption or umbilical cord accident.

There have been no randomized controlled trials that prove the effectiveness of any antepartum fetal surveillance[2]. Given the current practice in the United States, a randomized control trial is unlikely to occur given the need for randomization away from the normative practice. Implications on its clinical impact are therefore drawn from untested historical controls with the same indications for testing and the contemporary untested general low risk population[21-23].

Table 1. Efficacy of Antepartum Fetal Surveillance[21-23]

	Stillbirth rate/1000 patients within 1 week of a normal test	Negative predictive value	False positive rate
NST	1.9	99.8%	55-90%
BPP	0.8	>99.9%	40-50%
Modified BPP	0.8	>99.9%	60%
CST	0.3	>99.9%	33-65%

COST AND NEGATIVE IMPLICATIONS

When implementing a test as standard of care, awareness of both direct and indirect costs should be considered. In 2020 the direct costs of antepartum tests in the UW medical system are:

Nonstress test: $260 ($130 UWP professional fee + $130 facility fee)
Biophysical profile without NST: $938 ($664 UWP professional fee + $274 facility fee)
Biophysical profile with NST: $1273 ($898 UWP professional fee + $375 facility fee)
Amniotic fluid measurement billed as OB Sono Limited in radiology: $1003 ($744 UWP professional fee + $259 facility fee).

Indirect unmeasured costs include staff salaries and opportunity cost of lost time for the patient. These costs should be kept in mind when considering the options for testing. A false positive test can also cause additional stress and concern. False positive testing prompts subsequent testing with the potential for unnecessary interventions. This can lead to potential maternal or neonatal morbidity or iatrogenic preterm delivery. In a study evaluating maternal anxiety with antepartum testing[26], the mean Spielberger State-Trait Anxiety Inventory (STATI S) anxiety score increased after testing as compared to before testing (p=0.0001).

INDICATIONS FOR ANTEPARTUM FETAL SURVEILLANCE

The following section serves as a summary of ACOG and SMFM recommendations for common indications for antenatal surveillance. *It is important to keep in mind that societies provide guidance about indications that may benefit from antenatal surveillance to decrease the risk of stillbirth, however society recommendations rarely specify the ideal method or frequency of monitoring as there are no large trials to guide optimal frequency of testing.* The March 2020 ACOG Obstetric Care Consensus on "Management of Stillbirth" provides the below table regarding the estimated rate of stillbirth for various maternal or fetal conditions.

Table 2. Rate of Stillbirth With Maternal or Fetal Conditions[27]

	Stillbirth Rate*
All pregnancies	6.4/1000
Diabetes	
Treated with diet (A1)	6-10/1000
Treated with medications	6-35/1000
Hypertensive disorders	
Chronic hypertension	6-25/1000
Preeclampsia	
Without severe features	9-51/1000
With severe features	12-29/1000
Growth restricted fetus	10-47/1000
Multiple gestation	
Twin	12/1000
Triplets	34/1000
Oligohydramnios	14/1000
Late term pregnancy (greater than 41 weeks)	14-40/1000
Previous stillbirth	9-20/1000
Decreased fetal movement	13/1000
Systemic lupus erythematosus	40-150/1000
Renal disease	15-200/1000
Cholestasis of pregnancy	12-30/1000
Advanced maternal age	
35-39 years	11-14/1000
40 years or greater	11-21/1000
Black maternal race	12-14/1000
Maternal age less than 20 years	7-13/1000
Assisted reproductive technology	12/1000
Obesity (pre-pregnancy)	
BMI greater than or equal to 30kg/m^2	13-18/1000
Smoking greater than 10 cigarettes per day	10-15/1000

*Rate per 1000 live births. Adapted from Management of stillbirth. ACOG Obstetric Care Consensus No. 10. American College of Obstetricians and Gynecologists. Obstet Gynecol 2020;135:e110-32.

ADVANCED MATERNAL AGE

It is established that increasing maternal age increases the risk of adverse obstetrical outcomes. In a series of 5.5 million pregnancies, the risk of term antepartum stillbirth was 1:382 for women 35-39 years old, and 1:267 for women ≥40 years old[28]. This risk was present even accounting for medical diseases, parity and race/ethnicity. The nulliparous AMA patient may be at further increased risk of stillbirth compared to multiparous AMA patients. The stillbirth rate for a 40-year old nulliparous patient is estimated at 1:116, compared to 1:304 for a multiparous patient of the same age[28].

The addition of antepartum testing may help identify fetuses at risk for compromise to aid in timely intervention. Fretts et all, reported that in women ≥35 years old, initiation of weekly antepartum testing would avert 3.9 fetal deaths per 1000 pregnancies[29]. This would require 863 additional antepartum tests, 71 inductions of labor, and 14 additional cesarean sections to avert one death.

AMNIOTIC FLUID ABNORMALITIES

Oligohydramnios

ACOG supports the commonly used definitions for isolated oligohydramnios of an amniotic fluid index (AFI) <5cm or deepest vertical pocket (DVP) <2cm.The SAFE trial[30] in 2016 evaluated whether AFI <5cm or DVP <2cm for estimating amniotic fluid volume was superior for predicting adverse pregnancy outcome. The trial concluded that the AFI method increased the rate of diagnosis of oligohydramnios and labor induction for oligohydramnios without improving perinatal outcome. Thus, the Society of Maternal Fetal Medicine (SMFM) encourages use of the DVP <2cm for diagnosis of oligohydramnios in the 3rd trimester to avoid over diagnosis resulting in a greater number of obstetric interventions without a significant benefit in improving perinatal outcomes.

Based on expert opinion, ACOG recommends antenatal monitoring for expectant management of isolated, otherwise uncomplicated, persistent oligohydramnios in pregnancies less than 36-37 weeks, at which time delivery is recommended for this isolated indication.

Polyhydramnios

SMFM [31] defines polyhydramnios as total AFI ≥24.0cm or a deepest vertical pocket of ≥8.0cm. SMFM further delineates polyhydramnios into mild, moderate and severe (Table 3)

Table 3. SMFM polyhydramnios definitions

	Amniotic fluid index (cm)	Deepest vertical pocket (cm)	Incidence
Polyhydramnios, overall	≥24.0	≥8.0	0.3 – 1.0%
Mild	24.0 – 29.9	8-11	65-70% of total
Moderate	30.0 – 34.9	12-15	20% of total
Severe	≥35.0	≥16	<15% of total

The 2018 consensus statement from SMFM[31] recommended no antenatal surveillance for mild isolated polyhydramnios. There has been no concrete evidence that isolated polyhydramnios is associated with poor placental function, or that antenatal surveillance decreases mortality for this indication. The risk of

concurrent abnormalities with moderate or severe polyhydramnios is increased, thus antenatal surveillance for moderate-severe polyhydramnios should be considered.

DIABETES

Stillbirths are higher in women with pregestational diabetes, correlating with increased hemoglobin A1c values[32]. Gestational diabetes (GDM) requiring treatment is also associated with an increased risk of stillbirth, although there is debate in the literature regarding how much is related to glycemic control.

ACOG states that antenatal surveillance once to twice per week starting at 32 weeks is appropriate for patients with pregestational or medication –requiring gestational diabetes; however ideal overall timing and frequency has not been ascertained[32,33]. Well-controlled A1GDM has not demonstrated an increased risk of stillbirth prior to 40 weeks gestation[33] and thus antepartum testing may not be necessary in these patients.

HYPERTENSIVE DISORDERS

The risk of stillbirth in pregnancies complicated by chronic hypertension and preeclampsia is increased above normotensive pregnancies (Range 6-51/1000 births) [27]. ACOG Practice Bulletin 145[2] supports hypertension as an indication for antenatal surveillance. In the most recent taskforce on hypertension in pregnancy, ACOG[34] does not provide specific recommendations on the frequency, initiation, and type of antenatal testing needed for pregnancies affected by chronic hypertension. For patients meeting criteria for expectant management of preeclampsia without severe features, ACOG recommends amniotic fluid volume assessment at least once weekly in addition to an antenatal test one-to-two times per week.

FETAL GROWTH RESTRICTION

ACOG Practice Bulletin 204 defines fetal growth restriction as fetuses with an estimated fetal weight that is less than the 10th percentile for gestational age. Given the high risk of neonatal morbidity and mortality, fetal surveillance should be initiated in pregnancies affected by FGR, as early as 26-28 weeks. ACOG reminds clinicians that fetal surveillance should not begin prior to when delivery would not provide fetal benefit[35]. The recent SMFM Consult Series #52 encourages use of the term “Fetal Growth Restriction” rather than “Intrauterine growth restriction” and defines it as an estimated fetal weight <10th percentile or a fetal abdominal circumference < 10th percentile[36]. In these SMFM clinical guidelines, they conclude that routine umbilical artery Doppler assessment can decrease the rate of inductions of labor (RR 0.89, 95% CI 0.80 – 0.99), cesarean deliveries (RR 0.90, 95% CI 0.84 – 0.97), and perinatal deaths (RR 0.71, 95% CI 0.52– 0.98; 1.2% vs 1.7%; NNT 203; 95% CI, 103–4352) without increasing unnecessary interventions. There is no randomized trial with an adequate sample size to determine the optimal frequency of testing for fetal growth restriction. SMFM provides recommendations regarding frequency of NSTs and umbilical artery Doppler surveillance. These recommendations are summarized below in Table 4. FGR management is highly individualized based on the presence of additional comorbidities and assessment of viability in the mid-2nd trimester.

SMFM does not offer specific guidelines regarding surveillance of amniotic fluid volume in FGR, citing the paucity of data in this clinical scenario.

Table 4. SMFM Consult Series #52: FGR surveillance recommendations[36]

	NST	Umbilical artery Doppler
FGR with normal UA Doppler	Weekly	Every 1-2 weeks
FGR with elevated UA Doppler >95th%	Weekly	Weekly
FGR with absent end diastolic flow	More than weekly	2-3 times per week
FGR with reverse end diastolic flow	More than weekly	Hospitalization, 1-2 times per day

MULTIPLE GESTATION

The risk of stillbirth is greater in multiple gestations compared to singletons, with monochorionic pregnancies further increased compared to dichorionic pregnancies. Triplet and higher order pregnancies have a stillbirth rate of 30/1000 births. 71% of multiple gestation pregnancies will require antepartum testing for an additional indication. For dichorionic twin gestations, ACOG states that it is reasonable to reserve antenatal fetal surveillance for pregnancies complicated by additional maternal or fetal disorders that require antepartum testing[37]. However, many providers offer antenatal surveillance for dichorionic twin pregnancies with normal growth and no additional comorbidities. Given the increased complications of monochorionic twin pregnancies and higher order gestations, an individualized antenatal monitoring plan is often required with the guidance of a maternal fetal medicine specialist.

LATE-TERM AND POST-TERM PREGNANCIES

There are no RCTs demonstrating that antepartum fetal surveillance decreases perinatal morbidity or stillbirth in late-term (41 0/7 – 41 6/7 weeks gestation) and post-term pregnancies (≥42 0/7 weeks gestation) [38]. Similarly, there are no RCTs comparing various antepartum surveillance modalities in these groups. ACOG states that antenatal surveillance at or beyond 41 0/7 weeks of gestational may be indicated, supported by observational data that stillbirth is increased in this population. However ACOG does not provide guidance on the optimal type or frequency of testing. A large retrospective study of 7,582 high-risk pregnancies found that decreased amniotic fluid volume was associated with an increased risk of fetal demise[39]. Given this available evidence, ACOG recommends that if oligohydramnios is detected at ≥ 41 0/7 weeks gestation (optimally defined as a deepest vertical pocket of <2cm) [14,30], delivery is indicated, with cesarean section reserved for the usual obstetric indications.

PRIOR STILLBIRTH

Women with a history of prior stillbirth have an increased risk in subsequent pregnancies (OR 4.83, 95% CI 3.77-6.18), which may be even higher with particular maternal characterstics[27]. ACOG and SMFM[27] have released best practice guidelines regarding management of history of prior stillbirth. Although little data guides these recommendations, they recommend once to twice weekly antenatal testing at 32 weeks gestation or 1-2 weeks prior to previous stillbirth gestational age. For stillbirth that occurred prior to 32 weeks gestation, individualized surveillance plans should be created.

CHOLESTASIS

The mechanism of fetal death is poorly understood in cholestasis, and reports of fetal death after reassuring non stress testing occur frequently[40]. Current recommendations from SMFM regarding antenatal testing in pregnancies complicated by cholestasis are from expert opinion only; there is no current evidence of benefit in regards to stillbirth reduction[40]. ACOG currently has no recommendation for antenatal testing in pregnancies affected with cholestasis[2], but recommend a late preterm to early term delivery[38].

THYROID DISEASE

Women with pregnancies complicated by hyperthyroidism have increased risk of intrauterine growth restriction, fetal death and neonatal graves disease[41]. Given these increased complications in pregnancy, antenatal surveillance could be considered in the third trimester. There is no indication for antenatal surveillance in women with hypothyroidism or subclinical hypothyroidism[41].

HEMOGLOBINOPATHIES

Patients with sickle cell disease are at increased risk of IUGR and stillbirth. Given these risks, ACOG[42] recommends antenatal testing for women with sickle cell disease. Management of patients with sickle cell will be highly individualized with the assistance of maternal fetal medicine. Caution should be applied for women on narcotics and nonreactive testing. Fetal testing should be considered in patients with thalassemias only if growth restriction develops[42]. Inherited thrombophilias have not been associated with stillbirth[27], thus antenatal monitoring strictly for this indication is not required.

OTHER

The rates of stillbirth are increased for other maternal and fetal factors such as pre-pregnancy obesity[43], smoking, and assisted reproductive techniques. There are additional factors for which some providers consider antenatal surveillance such as substance abuse, methadone, and buprenorphine maintenance. However, ACOG currently does not have guidelines or recommendations specifically for or against antenatal surveillance for these indications.

DISCUSSION

The benefit of antenatal testing is to identify fetuses at risk for compromise and intervene prior to adverse outcomes. The ideal testing modality and schedule would combine the highest risk conditions with the greatest potential to improve fetal outcomes. Recommendations should account for the risk of false positive tests to limit potential harms, including additional need for testing, iatrogenic premature delivery, or unnecessary interventions that increase morbidity.

Throughout the literature, no single antenatal test demonstrates superior efficacy over others. As antenatal testing became standard of care within obstetric practice, it is no longer feasible to perform randomized testing to further explore the ideal testing modalities. The NST is feasible to perform at many outpatient clinics and can provide a generalized assessment of the fetal acid base status. Ultrasound assessment of amniotic fluid in addition to NST via a modified BPP may provide a more comprehensive view of fetal status and potentially decrease appointment frequency. The BPP allows providers to achieve a snapshot view on fetal well-being which can be performed by ultrasound only in settings where an NST is not available. In fetuses with growth restriction, umbilical artery Doppler velocimetry may help predict fetuses at further risk for compromise and mortality.

There is no consensus regarding timing of initiation and frequency of testing regimens. Data regarding individual medical complications of pregnancy and the benefit of antenatal surveillance is minimal. Therefore, through consensus review of national guidelines and the current literature, we propose the following testing schedule in the subsequent table. It should be noted that these recommendations should be individualized for the patient's medical condition and additional co-morbidities

DISCLAIMER

This consensus document is to be used as a guideline for practice management. It is generated by expert review from the Department of Obstetrics and Gynecology.

Individualization of testing is recommended based on clinical judgement. These guideless do not replace consideration of or recommendation for Maternal Fetal Medicine consult for additional guidance in high risk pregnancies.

University of Washington Outpatient Antepartum Testing Recommendations

Primary Condition	Initiation of Testing (weeks)	Testing Modality	Testing Frequency
Hypertensive disorders			
Chronic hypertension	32-34	NST+DVP§ *or* NST only	Weekly 2x weekly
Gestational hypertension	At diagnosis	NST+DVP *or* NST only	Weekly 2x weekly
Preeclampsia without severe features, managed expectantly as an outpatient	At diagnosis	NST *and* DVP	Twice weekly Once weekly
Diabetes Mellitus			
A1	None		
A2	32-34	NST+DVP *or* NST only	Weekly 2x weekly
Type I	32	NST+DVP *or* NST	Weekly 2x weekly
Type II	32-34	NST+DVP *or* NST only	Weekly 2x weekly
Hyperthyroidism	34	NST	Weekly
Renal disease/Transplant	32-34	NST+DVP	Weekly
SLE or Autoimmune disease on immunotherapy	32-34	NST+DVP	Weekly
Hemoglobinopathies	32-34	NST	Weekly
AMA 35-39 years old ≥40 years old	 36 36	 NST NST+DVP	 Weekly Weekly
Previous stillbirth	32 weeks gestation *or* 1-2 weeks prior to previous stillbirth	NST+DVP *or* NST	Weekly 2x weekly
Cholestasis	At diagnosis	NST	Weekly
Fetal growth restriction <28 weeks ≥ 28 weeks	 Individualized At diagnosis	 NST+DVP+ UAD NST+DVP+ UAD	Weekly at minimum, individualized based on UAD findings
Late Term	41	NST *and* DVP	Twice Weekly Weekly
Multiple Gestation Di/di twins Mo/di twins	 34-36 32	 NST+DVP NST+DVP	 Weekly Twice Weekly
Amniotic Fluid Abnormalities Oligohydramnios Polyhydramnios Mild (idiopathic, isolated) Moderate Severe	 At diagnosis None At diagnosis At diagnosis	 NST+DVP/AFI NST+DVP/AFI NST+DVP/AFI	 Weekly Weekly Weekly

DVP = deepest vertical pocket of amniotic fluid UAD = umbilical artery Doppler velocimetry
§ NST+DVP = modified BPP. Provider preference: A full BPP could be performed wherever a modified BPP is listed
Polyhydramnios: Mild (AFI 24.0-29.9, DVP 8-11), Moderate (AFI 30.0-34.9, DVP 12-15), Severe (AFI ≥35.0, DVP ≥16)

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