CHAPTER

1

Antenatal Fetal Monitoring

The antepartum fetal assessment aims to timely identify fetuses at risk of intrauterine death or other complications of intrauterine asphyxia and to prevent these adverse outcomes, if possible. An antepartum test needs to identify a compromised fetus such that the intervention is successful. The clinician must remember that no known assessment method can predict sudden events, such as a cord accident or placental abruption, which are frequent causes of fetal death.[1]

PHYSIOLOGICAL BASIS OF ANTEPARTUM FETAL MONITORING

A compromised fetus undergoes a series of detectable physiological changes, such as the redistribution of blood flow or decreasing unnecessary movements (Fig. 1.1). Other factors may modify the progression of these changes such as gestational age, maternal medication, and smoking. In addition, there may be acute incidents like abruption leading to acute hypoxemia, which may not be detected on routine antepartum testing.

Efficacy and Harms

Antepartum fetal assessment has been established in obstetrics since 1970s. However, its ability to improve pregnancy outcomes has not been evaluated by large, well-designed randomized trials. Various observational studies have reported lower fetal death rates in pregnancies that underwent fetal testing than among historical controls with the same indication for testing but no fetal testing or among the contemporary controls that were low-risk populations. The significant harm would be false-positive tests that lead to unnecessary additional fetal evaluation and intervention, particularly iatrogenic preterm birth. False-negative tests suggest a false sense of security and may again lead to potential harm.[2]

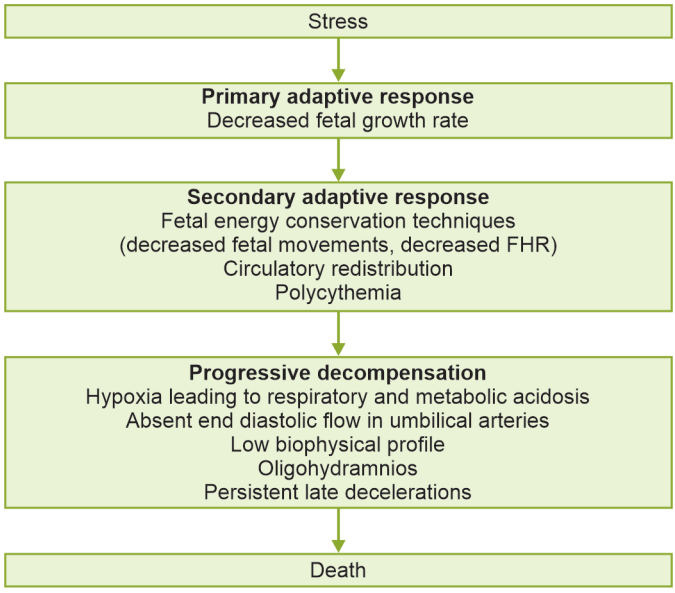


Fig. 1.1: Response of fetus to chronic hypoxia

Indications[1]

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
- Pre-eclampsia
- Decreased fetal movement
- Gestational diabetes mellitus (poorly controlled or medically treated)
- Oligohydramnios
- Fetal growth restriction

- Late-term or post-term pregnancy
- Isoimmunization
- Previous fetal demise (unexplained or recurrent risk)
- Monochorionic multiple gestations (with significant growth discrepancy)

Techniques[3]

The main techniques for fetal assessment are the fetal movement count, nonstress test, biophysical profile, modified biophysical profile, and contraction stress test. Evaluation of amniotic fluid volume and Doppler velocimetry provide additional information about the fetal status.

Fetal Movement Counting

It is a simple and inexpensive method of monitoring the fetus. There is a universal consensus that women with absent or reduced fetal movements should prompt the obstetrician for further fetal assessment, as decreased placental perfusion and fetal acidemia are associated with decreased fetal movements. However, available evidence does not support a clear fetal movement threshold or "alarm limit" indicating when the risk of fetal death or injury is increased. The fetal sleep cycle lasts about 20 to 40 minutes and practically never exceeds 90 minutes in a normal, healthy fetus. Hence, The American Congress of Obstetricians and Gynecologists (ACOG) recommends that less than ten movements within two hours are abnormal. There are two methods for fetal movement count:

a. The Cardiff method suggests a count to 10 movements in a fixed time frame (12 hours).
b. The Sadovsky method suggests counting movements in a specific time frame (usually 30 minutes to two hours).

Nonstress Test (NST)

Fetal Heart Rate (FHR) accelerations, spontaneous or provoked (e.g. by vibroacoustic stimulation), indicate normal fetal autonomic function and absence of acidosis and neurologic depression. The non-stress test is performed during the antenatal period when the uterus is relaxed. The woman should empty her bladder and be positioned on either a bed or a reclining chair in the left lateral recumbent position. The recording should last at least 20 minutes. The baseline fetal heart rate should be within the normal range of 110 to 160 bpm. Moderate variability of 6 to 25 bpm is expected.

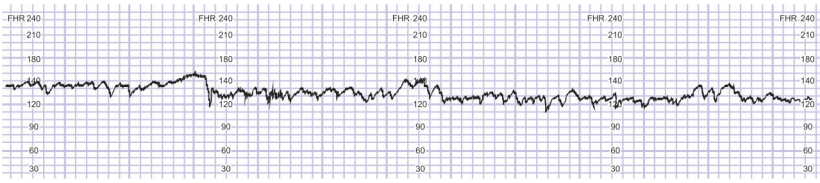


Fig. 1.2: Reactive non-stress test

A normal (reactive) non-stress test includes at least two accelerations from the baseline within the 20 minutes of testing that reach a peak of at least 15 bpm above the baseline and have a duration from onset to return to baseline of at least 15 seconds (Fig. 1.2).

A negative predictive value of the test for fetal and neonatal death is 99% within one week of testing. If the fetal heart acceleratory response does not meet the criteria after 20 minutes of testing, the recording should continue for another 20 minutes to account for the average period of non-rapid eye movement sleep when fetal movement and heart rate variability are reduced. If the criteria are still unmet, the test is reported as non-reactive NST, and a backup test, like a biophysical profile test, is performed.

Contraction Stress Test

The contraction stress test (CST)/oxytocin challenge test is based on the fetal response to a transient reduction in fetal oxygen delivery during uterine contractions, which may manifest clinically as late decelerations.

Drawbacks of CST include the need to stimulate contractions with intravenous oxytocin with its contraindications (e.g. placenta previa), and the high false-positive rate (fetus goes on to tolerate labor without FHR changes necessitating intervention). The false-negative rate (rate of antepartum stillbirth within one week of a negative test) is meager, thus providing reassurance of adequate fetal oxygenation after a normal test result. The CST is seldom performed given the wide availability of other tests (e.g. nonstress test, biophysical profile) that do not have these drawbacks.

Biophysical Profile[4]

The biophysical profile (BPP) combines the NST with fetal ultrasonographic assessment by assigning points to the following parameters: Amniotic fluid volume (AFV), fetal breathing movements, fetal body movements, and reflex/tone/flexion–extension movements (Tables 1.1 and 1.2). The modified biophysical

Table 1.1: Scoring criteria for biophysical profile (Manning 1995)		
Biophysical variable	*Normal (score=2)*	*Abnormal (score=0)*
Fetal breathing movements	1 episode of at least 30 sec in 30 mins	Absent or no episode >30 sec in 30 mins
Fetal movements	3 discrete body/limb movements in 30 mins	2 or less in 30 mins
Fetal tone	1 episode of active extension with return to flexion of limbs or trunk	Slow extension with return to partial flexion, or movement of limb in full extension, or no movement
Amniotic fluid	1 pocket measuring at least 2 cm in 2 perpendicular	Either no pocket or a pocket < 2 cm in two perpendicular planes
Non-stress test	Reactive	Non-reactive

Table 1.2: Interpretation of biophysical profile scores		
Result	*Interpretation*	*Action*
10/10 OR 8/8 or 8/10 with normal amniotic fluid	Normal	No intervention
6/10 with normal amniotic fluid (4 points for two of fetal movement, tone, and breathing, but +2 points for amniotic fluid)	Equivocal	The test is repeated within 24 hours to see if one of the absent acute variables returns to normal or, If the patient is at or near term, delivery is a reasonable option
6/10 or 8/10 with oligohydramnios (6/10 or 8/10 with 0 points for amniotic fluid)	Abnormal	The risk of fetal asphyxia within one week is 89/1000 with expectant management Scores should be interpreted within the context of gestational age and maternal and obstetric factors
0 to 4/10	Abnormal	The risk of fetal asphyxia within one week is 91 to 600/1000 Delivery is usually indicated

profile (mBPP) consists of the NST as a measure of acute oxygenation and the assessment of AFV as a measure of longer-term oxygenation.[5] Thus, this test assesses indicators of both acute hypoxia (NST, breathing, body movement, tone) and chronic hypoxia (AFV). The BPP score has a direct linear correlation with

fetal pH. The false-negative rates for the BPP and mBPP are meager, but the false-positive rates are high (a false-negative BPP or mBPP is when an antepartum stillbirth occurs within one week of a high score; a false positive is a low score that is followed by a normal backup test and no fetal compromise).[6]

Amniotic Fluid Volume

The rationale behind including AFI as a method of fetal assessment is that cardiac output is redirected to the brain, heart, and adrenals and away from less vital organs, such as the kidney, as a response to hypoxemia; the reduction in renal perfusion leads to decreased fetal urine production, which may result in reduced amniotic fluid volume (oligohydramnios) over time.

Various techniques can assess the amniotic fluid volume. One of them is the maximal vertical pocket depth. This approach identifies a pocket depth of 2 to 8 cm as normal, 1 to 2 cm as marginal, <1cm as decreased, and > 8 cm as increased. The second technique is the AFI. The AFI assesses amniotic fluid volume more broadly by summing the deepest vertical pocket of fluid in the four quadrants of the uterus. The AFI uses the 5th and 95th percentiles for gestational age to signify oligohydramnios and polyhydramnios, respectively. AFI, rather than pocket size, increases intervention frequency without improving outcomes.

Doppler Velocimetry[7]

Measuring blood flow velocities in the maternal and fetal vessels provides information about uteroplacental blood flow and fetal responses to physiologic challenges. The important vessels studied are described in Table 1.3.

Monitoring and Frequency

Antenatal fetal surveillance should start at $32^{0/7}$ *weeks* of gestation or later for most patients. However, for individuals with particularly worrisome high-risk conditions (e.g. chronic hypertension with suspected fetal growth restriction), antenatal fetal surveillance might begin at a gestational age when delivery would be considered for perinatal benefit.

Frequency of Tests

The optimal frequency remains unknown; however, it is suggested that the frequency of antenatal fetal surveillance for each condition should be based on the approach of testing. It should be done at least

Table 1.3: Doppler velocimetry and interpretation		
Vessel	*Relevance*	*Remark*
Umbilical artery	Placental resistance, fetal cardiac afterload	Increased resistance correlates with the risk of hypoxia, and absent or reversed diastolic flow indicates a high risk of acidosis.
Middle cerebral artery	Cerebral hypoxia	Low pulsatility index indicates brain sparing effect and possible fetal hypoxia
Ductus venosus	The inflow of oxygenated blood to the fetus	Absent or reversed a wave associated with risk of fetal mortality and morbidity
Aortic Isthmus	The interface of oxygenated and deoxygenated blood—indicates oxygenation in the cranial supply	Abnormal flows indicate compromise of cerebral oxygenation—increased risk of neurological injury
Maternal uterine artery[8]	Placental resistance from the maternal side	High resistance indicates high placental resistance and suggests the etiology of poor uteroplacental perfusion

weekly unless additional information is available that supports more frequent antenatal fetal surveillance (like abnormal Doppler results).

The follow-up to an Abnormal Antepartum Surveillance Test Result

These tests have high false-positive rates and low positive predictive values. Hence, abnormal antepartum fetal surveillance test results should be often followed by another test to evaluate fetal status. A holistic approach should be executed, including the antenatal fetal surveillance test results, overall maternal and fetal condition, and gestational age, if the decision for delivery has to be taken. Antenatal fetal surveillance must be interpreted with caution if performed before 32 weeks of gestation because the non-stress test of a normal preterm fetus is non-reactive in up to 50% of fetuses between 24 and 28 weeks and 15% of fetuses between 28 and 32 weeks gestation.

Decision for Delivery Based on Doppler Monitoring in Growth Restricted Fetuses[9]

The monitoring in growth-restricted fetuses is depicted in Table 1.4, and the decision to deliver is based on Doppler velocimetry (Fig. 1.3). Delivery timing should consider short-term and long-term

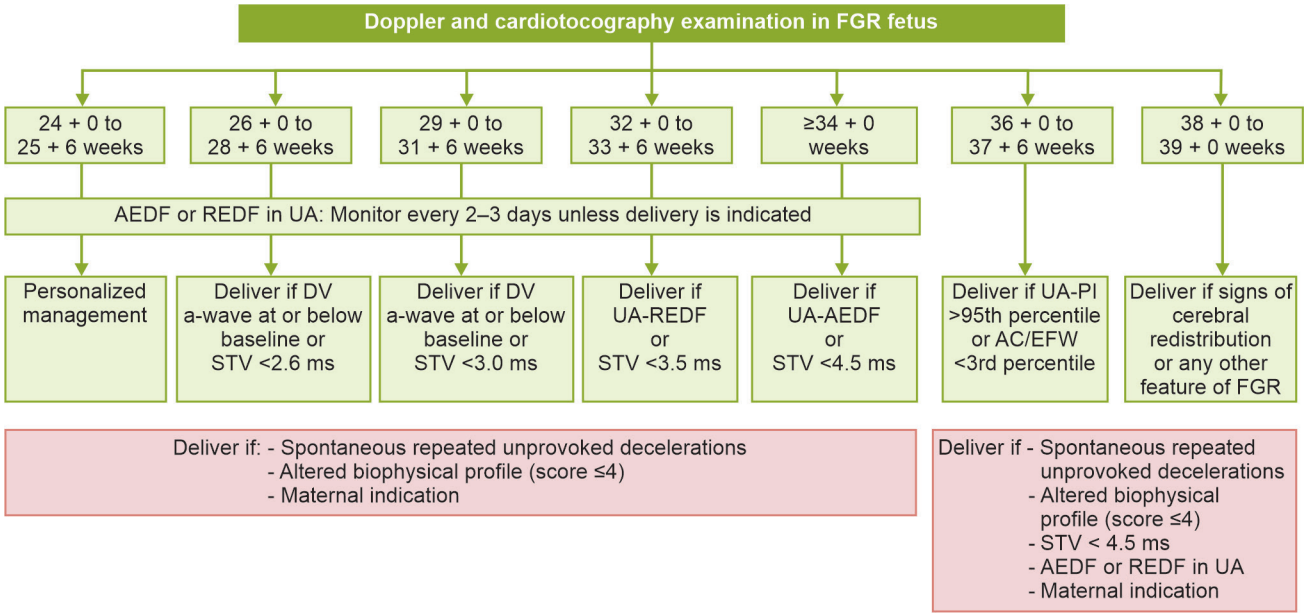
Table 1.4: Monitoring in growth-restricted fetuses

Category	*Risk of stillbirth*	*Monitoring*
SGA (EFW at 3rd–10th percentile, normal fluid, and Doppler studies)	Low	• Growth scan every two weeks • Doppler (UA, MCA) every 1–2 weeks, BPP/NST once a week • At ≥37 weeks, consider BPP/NST 1–2 times per week.
Uncomplicated FGR at <3rd Percentile or fall of AC/EFW by two quadrantile (normal liquor and normal Doppler studies)	Low	• Growth scan every two weeks • Doppler (UA, MCA) 1–2 times per week, BPP/ NST 1–2 times per week
FGR with mild abnormalities: 1. Early Doppler changes: UA PI > 95th percentile, OR MCA PI <5th percentile OR CPR < 5th percentile OR UtA PI >95th percentile 2. Oligohydramnios 3. Suboptimal interval growth	Low	Consider inpatient monitoring, especially if other co-morbidities • Consider steroids for fetal lung maturation if at risk of prematurity • BPP/NST 2 times per week • Doppler (UtA, UA, MCA, DV) 2 times per week • Growth scan every two weeks
FGR with umbilical artery AEDF/REDF	Moderate with a median time of deterioration of 2–5 days	• Inpatient monitoring • Steroids for fetal lung maturation *Consider $MgSO_4$ if gestation is below 32 weeks.* • BPP/NST once per day • Doppler (UA, DV) every day. *Consider delivery if a neonatal backup facility is available based on POG*

(*Contd.*)

Table 1.4: Monitoring in growth-restricted fetuses (*Contd.*)		
Category	*Risk of stillbirth*	*Monitoring*
FGR with abnormal ductus venosus Doppler	High	• Inpatient monitoring • Consider delivery if a neonatal backup facility is available based on POG • Steroids for fetal lung maturation • Consider $MgSO_4$ if gestation is below 32 weeks. • BPP/NST twice per day • Daily Doppler

SGA: Small for gestational age; *EFW:* Estimated fetal weight; *MCA:* Middle cerebral artery; *UA:* Umbilical artery; *Ut A:* Uterine artery; *BPP:* Biophysical profile; *NST:* Non-stress test



FGR: Fetal growth restriction; *AEDF:* Absent end diastolic flow; *REDF:* Reversed end diastolic flow; *UA:* Umbilical artery; *PI:* Pulsatility index; *STV:* Short-term variability (on computerized cardiotocography); *DV:* Ductus venosus; *EFW:* Estimated fetal weight; *AC:* Abdominal circumference

Fig. 1.3: Decision for delivery based on Doppler monitoring in growth-restricted fetuses

outcomes.[10] In most instances, all growth-restricted fetuses should be delivered by approximately 38 weeks.

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