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# No. 197a-Fetal Health Surveillance: Antepartum Consensus Guideline

**This guideline has been reviewed and approved by the Maternal-Fetal Medicine Committee, the Clinical Obstetrics Committee, and the Executive and Council of the Society of Obstetricians and Gynaecologists of Canada.**

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**Key Words:** Fetal surveillance, intermittent auscultation, electronic fetal monitoring, umbilical Doppler, uterine artery Doppler, contraction stress test, biophysical profile, fetal movement, antepartum, intrapartum, non-stress test

## Abstract

**Objective:** This guideline provides new recommendations pertaining to the application and documentation of fetal surveillance in the antepartum period that will decrease the incidence of birth asphyxia while maintaining the lowest possible rate of obstetrical intervention. Pregnancies with and without risk factors for adverse perinatal outcomes are considered. This guideline presents an alternative classification system for antenatal fetal non-stress testing to what has been used previously. This guideline is intended for use by all health professionals who provide antepartum care in Canada.

**Options:** Consideration has been given to all methods of fetal surveillance currently available in Canada.

**Outcomes:** Short- and long-term outcomes that may indicate the presence of birth asphyxia were considered. The associated rates of operative and other labour interventions were also considered.

**Evidence:** A comprehensive review of randomized controlled trials published between January 1996 and March 2007 was undertaken, and MEDLINE and the Cochrane Database were used to search the literature for all new studies on fetal surveillance antepartum. The level of evidence has been determined using the criteria and classifications of the Canadian Task Force on Preventive Health Care (Table 1).

**Sponsor:** This consensus guideline was jointly developed by the Society of Obstetricians and Gynaecologists of Canada and the British Columbia Perinatal Health Program (formerly the British Columbia Reproductive Care Program or BCRCP) and was partly supported by an unrestricted educational grant from the British Columbia Perinatal Health Program.

**Recommendation 1: Fetal Movement Counting:**

1. Daily monitoring of fetal movements starting at 26 to 32 weeks should be done in all pregnancies ***with*** risk factors for adverse perinatal outcome (I-A).
2. Healthy pregnant women ***without*** risk factors for adverse perinatal outcomes should be made aware of the significance of fetal movements in the third trimester and asked to perform a fetal movement count if they perceive decreased movements (I-B).
3. Women who do not perceive six movements in an interval of two hours require further antenatal testing and should contact their caregivers or hospital as soon as possible (III-B).

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4. Women who report decreased fetal movements (<6 distinct movements within 2 hours) should have a complete evaluation of maternal and fetal status, including non-stress test and/or biophysical profile. Prior to considering an intervention for fetal well-being, an anatomical scan to rule out a fetal malformation should be done, if one has not already been done. Management should be based upon the following:
   - Non-stress test is normal and there are no risk factors: the woman should continue with daily fetal movement counting (III-B).
   - Non-stress test is normal and risk factors or clinical suspicion of intrauterine growth restriction intrauterine growth restriction/ oligohydramnios is identified: an ultrasound for either full biophysical profile or amniotic fluid volume assessment within 24 hours. The woman should continue with daily fetal movement counting (III-B).
   - Non-stress test is atypical/abnormal: further testing (biophysical profile and/or contraction stress test and assessment of amniotic fluid volume) should be performed as soon as possible (III-B).

**Recommendation 2: Non-Stress Test:**

1. Antepartum non-stress testing may be considered when risk factors for adverse perinatal outcome are present (III-B).
2. In the presence of a normal non-stress test, usual fetal movement patterns, and absence of suspected oligohydramnios, it is not necessary to conduct a biophysical profile or contraction stress test (III-B).
3. A normal non-stress test should be classified and documented by an appropriately trained and designated individual as soon as possible, (ideally within 24 hours). For atypical or abnormal non-stress tests, the nurse should inform the attending physician (or primary care provider) at the time that the classification is apparent. An abnormal non-stress test should be viewed by the attending physician (or primary care provider) and documented immediately (III-B).

**Recommendation 3: Contraction Stress Test:**

1. The contraction stress test should be considered in the presence of an atypical non-stress test as a proxy for the adequacy of intrapartum uteroplacental function and, together with the clinical circumstances, will aid in decision making about timing and mode of delivery (III-B).
2. The contraction stress test should ***not*** be performed when vaginal delivery is contraindicated (III-B).
3. The contraction stress test should be performed in a setting where emergency Caesarean section is available (III-B).

**Recommendation 4: Biophysical Profile:**

1. In pregnancies at increased risk for adverse perinatal outcome and where facilities and expertise exist, biophysical profile is recommended for evaluation of fetal well-being (I-A).
2. When an abnormal biophysical profile is obtained, the responsible physician or delegate should be informed immediately. Further management will be determined by the overall clinical situation (III-B).

**Recommendation 5: Uterine Artery Doppler:**

| | |
|---|---|
| Previous obstetrical history | • Previous early onset gestational hypertension<br>• Placental abruption<br>• Intrauterine growth restriction<br>• Stillbirth |
| Risk factors in current pregnancy | • Pre-existing hypertension<br>• Gestational hypertension<br>• Pre-existing renal disease<br>• Long-standing type I diabetes with vascular complications, nephropathy, retinopathy<br>• Abnormal maternal serum screening (hCG or AFP > 2.0 MOM)<br>• Low PAPP-A (consult provincial lab for norms) |

1. Where facilities and expertise exist, uterine artery Doppler may be performed at the time of the 17 to 22 weeks' gestation detailed anatomical ultrasound scan in women with the following factors for adverse perinatal outcome (II-A).
2. Women with a positive uterine artery Doppler screen should have the following:
   - A double marker screen (for alpha-fetoprotein and beta hCG) if at or before 18 weeks' gestation (III-C).
   - A second uterine artery Doppler at 24 to 26 weeks. If the uterine artery Doppler is positive at the second scan, the woman should be referred to a maternal-fetal medicine specialist for management (III-C).

**Recommendation 6: Umbilical Artery Doppler:**

1. Umbilical artery Doppler should not be used as a screening tool in healthy pregnancies, as it has not been shown to be of value in this group (I-A).
2. Umbilical artery Doppler should be available for assessment of the fetal placental circulation in pregnant women with suspected placental pathology (I-A). Fetal umbilical artery Doppler assessment should be considered (1) at time of referral for suspected growth restriction, or (2) during follow-up for suspected placental pathology.
3. Depending on other clinical factors, reduced, absent, or reversed umbilical artery end-diastolic flow is an indication for enhanced fetal surveillance or delivery. If delivery is delayed to improve fetal lung maturity with maternal administration of glucocorticoids, intensive fetal surveillance until delivery is suggested for those fetuses with reversed end-diastolic flow (II-1B).

**Table 1. Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care**

| Quality of Evidence Assessment[a] | Classification of Recommendations[b] |
|---|---|
| I: Evidence obtained from at least one properly randomized controlled trial | A. There is good evidence to recommend the clinical preventive action |
| II-1: Evidence from well-designed controlled trials without randomization | B. There is fair evidence to recommend the clinical preventive action |
| II-2: Evidence from well-designed cohort (prospective or retrospective) or case–control studies, preferably from more than one centre or research group | C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making |
| II-3: Evidence obtained from comparisons between times or places with or without the intervention . Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in this category | D. There is fair evidence to recommend against the clinical preventive action |
| III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees | E. There is good evidence to recommend against the clinical preventive action |
| | L. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making |

Adapted from: Woolf SH, et al. Canadian Task Force on Preventive Health Care. New grades for recommendations from the Canadian Task Force on Preventive Health Care. Can Med Assoc J 2003;169(3):207-8.

[a]The quality of evidence reported in these guidelines has been adapted from the Evaluation of Evidence criteria described in the Canadian Task Force on Preventive Health Care.

[b]Recommendations included in these guidelines have been adapted from the Classification of Recommendations criteria described in the Canadian Task Force on Preventive Health Care.

## INTRODUCTION

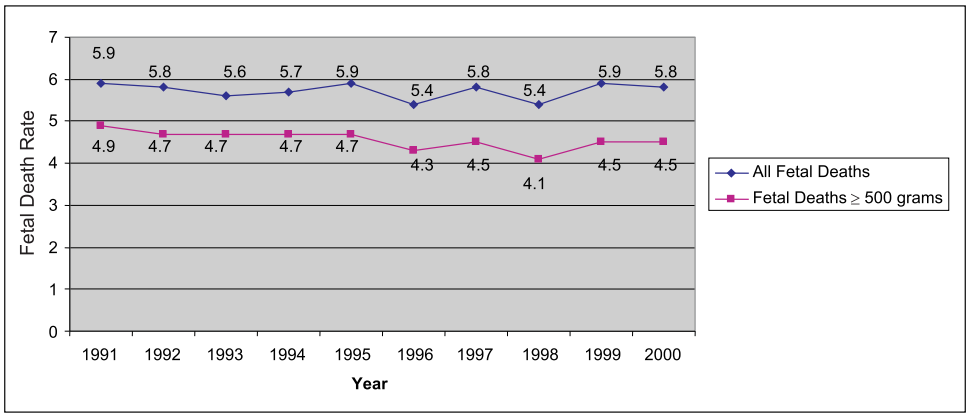
This document reflects the current evidence and national consensus opinion on fetal health surveillance during the antenatal and intrapartum periods. It reviews the science behind, the clinical evidence for, and the effectiveness of various surveillance methods available today. Research has shown that improvements in fetal outcomes as a result of surveillance are very difficult to document because of (1) variations in the interpretation of fetal surveillance tests, especially electronic fetal heart monitoring; (2) variations in interventions applied when abnormal results are present; and (3) the lack of standardization of the important outcomes.[1] Although antenatal fetal surveillance using various modalities is an integral part of perinatal health care across Canada, there is limited Level I evidence to support such a practice. Indeed, the only testing modality for which there is Level I evidence for effect is the use of umbilical artery Doppler as a means of surveillance of growth restricted fetuses.[2] Although specific patient populations with risk factors for adverse perinatal outcome have been identified, large randomized trials establishing the benefits of antenatal testing in the reduction of perinatal morbidity and mortality have not been performed. In Canada, antenatal and intrapartum deaths are rare. Between 1991 and 2000, the crude fetal mortality rate (the number of stillbirths per 1000 total live births and stillbirths in a given place and at a given time/during a defined period) fluctuated between 5.4 per 1000 total births and 5.9 per 1000 total births.[3] In 2000, the rate was 5.8 per 1000 total births (Figure 1). The fetal mortality rate for = 500 g ranged from a high of 4.9 per 1000 total births in 1991 to a low of 4.1 per 1000 total births in 1998. In 2000, the rate was 4.5 per 1000 total births.[3]

These rates are some of the lowest worldwide and are a reflection of overall population health, access to health services, and provision of quality obstetric and pediatric care across the nation.[3,4] Despite the low fetal mortality rate in Canada, a portion of deaths remain potentially preventable. However, antenatal and intrapartum testing strategies appropriately applied to all women (with and without risk factors for adverse perinatal outcome) will still not prevent all adverse perinatal outcomes. This may be because the effectiveness of a testing modality requires timely application, appropriate interpretation, recognition of a potential problem, and effective clinical action, if possible. Because of the relatively low prevalence of fetal and perinatal mortality, it is

## ABBREVIATIONS

| | |
|---|---|
| AFI | amniotic fluid index |
| AFP | alpha-fetoprotein |
| BPP | biophysical profile |
| CST | contraction stress test |
| IUGR | intrauterine growth restriction |
| IUT | intrauterine transfusion |
| MCA | middle cerebral artery |
| NICU | neonatal intensive care unit |
| NST | non-stress test |
| PSV | peak systolic velocity |
| RCT | randomized controlled trial |

**Figure 1. Rate of fetal death: Canada (excluding Ontario).**




The crude fetal mortality rate is defined as the number of stillbirths per 1000 total births (live births and stillbirths), in a given place and time. The fetal mortality rate for > 500 g is based on the exclusion of all stillbirths and live births with a birth weight of < 500 g or, if the birth weight is unknown, those with a gestational age of < 22 weeks. Ontario data is excluded because of data quality concerns (Health Canada, 2003).

estimated that large randomized controlled trials with at least 10 000 women would be required to adequately assess any benefits from antenatal fetal assessment.[5] In the absence of conclusive evidence, and in the presence of suggestive theoretic, animal, and clinical data, these guidelines are designed for two purposes: (1) to outline appropriate antenatal and intrapartum fetal surveillance techniques for healthy women *without* risk for adverse perinatal outcome, and (2) to identify specific patient populations expected to benefit from antenatal and intrapartum testing and to outline available testing techniques that could be appropriate. Antenatal and intrapartum fetal testing for women with risk factors should take place only when the results will guide decisions about future care, whether that is continued observation, more frequent testing, hospital admission, or need for delivery. It is recommended that each hospital adapt its own protocols suggesting the indications, type, and frequency of antenatal and intrapartum testing, and the expected responses to abnormal results.

This guideline presents an alternative classification system for antenatal fetal non-stress testing and intrapartum electronic fetal surveillance to what has been used previously. Anecdotal evidence suggested opportunity for confusion in communication and lack of clarity in treatment regimens using "reassuring/non-reassuring" or "reactive/non-reactive" terminology. This guideline presents an alternative classification system designed to (1) promote a consistent assessment strategy for antenatal and intrapartum cardiotocography, (2) promote a consistent classification system for antenatal and intrapartum cardiotocography, and (3) promote clarity and consistency in communicating and managing electronic fetal heart tracing findings. To accomplish this, a three-tier classification system is used for antenatal and intrapartum cardiotocography, with the following categories: normal, atypical, and abnormal. This system was partly derived from principles and terminology presented in the guidelines Intrapartum Fetal Surveillance,[6] and The Use of Electronic Fetal Monitoring.[7] The specific criteria defining each category for non-stress testing and intrapartum electronic fetal monitoring are outlined in the respective sections of this guideline. It should be emphasized that an understanding of the antenatal and intrapartum maternal-fetal physiological processes underlying electronic fetal surveillance are crucial for the appropriate application, interpretation, and management of clinical situations where normal, atypical, or abnormal tracings are identified.

## ANTENATAL FETAL TESTING TECHNIQUES

Antenatal fetal testing techniques described in this guideline fall into six categories and may be used simultaneously or in a hierarchical fashion. They are (1) fetal movement counting, (2) non-stress test, (3) contraction stress test, (4) biophysical profile and/or amniotic fluid volume, (5) maternal uterine artery Doppler, and (6) fetal umbilical artery Doppler. The only antenatal surveillance technique recommended for *all* pregnant women, with and without risk factors, is maternal awareness of fetal movements.

A successful antenatal fetal testing program would ideally reduce the fetal and neonatal outcomes of asphyxia listed in Table 2.

Figure 2 depicts the:

> *progressive deterioration in fetal cardiovascular and behavioural variables seen with declining metabolic status. Doppler abnormalities progress from the arterial to the venous side of the circulation. Although cardiac adaptations and alterations in coronary blood flow*

**Table 2. Adverse fetal and neonatal outcomes associated with antepartum asphyxia[a]**

| Fetal outcomes | Neonatal outcomes |
|---|---|
| Stillbirth | Mortality |
| Metabolic acidosis at birth | Metabolic acidosis<br>Hypoxic renal damage<br>Necrotizing enterocolitis<br>Intracranial hemorrhage<br>Seizures<br>Cerebral palsy<br>Neonatal encephalopathy |

[a]Asphyxia is defined as hypoxia with metabolic acidosis.

*dynamics may be operational for a variable period, overt abnormalities of cardiac function and evidence of markedly enhanced coronary blood flow usually are not seen until the late stages of disease. The decline in biophysical variables shows a reproducible relationship with the acid-base status. If adaptation mechanisms fail, stillbirth ensues.*[8]

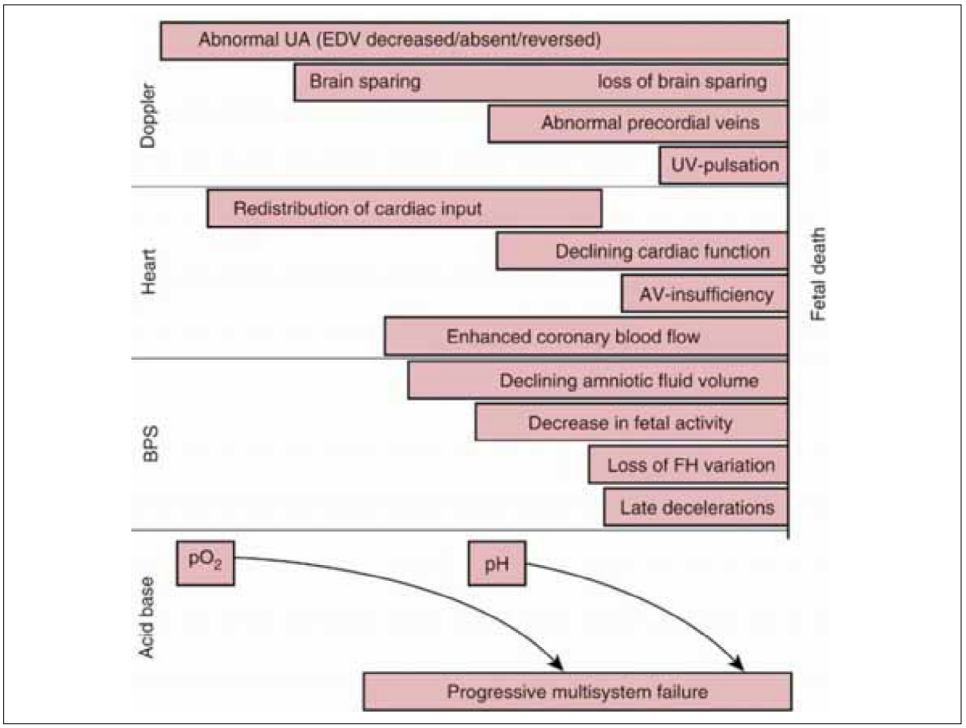
## PATIENTS AT RISK

Perinatal morbidity and/or mortality due to fetal asphyxia have been shown to be increased among women with conditions identified in Table 3. Some form of antenatal fetal testing may be beneficial in the ongoing care of women with these problems. Evidence to support the use of any of the testing parameters currently available in Canada is presented in the following sections. However, the only testing modality that has clearly been shown beneficial in randomized controlled trials is Doppler velocity wave form analysis of the fetal umbilical artery in pregnancies complicated by fetal growth restriction. Apart from some evidence that maternal perception of fetal movement may be beneficial in all pregnancies, there is no support for routine application of antenatal fetal testing in the management of uncomplicated pregnancies less than 41 weeks' gestation. There is little point initiating fetal testing before neonatal viability and in situations where there are fetal abnormalities that are incompatible with life, and this should be discussed with the patient, and the risks of increased anxiety leading to inappropriate and harmful intervention made clear.

## WHEN TO INITIATE ANTENATAL TESTING

Prenatal assessment of the fetal condition has two objectives: (1) to exclude fetal abnormality (done predominantly in the first half of pregnancy) and (2) to monitor the

**Figure 2. Progressive deterioration in fetal cardiovascular and behavioural variables.**




Progressive deterioration in fetal cardiovascular and behavioral variables seen with declining metabolic status. In most fetuses with intrauterine growth restriction. Doppler abnormalities progress from the arterial to the venous side of the circulation. Although cardiac adaptations in coronary blood flow dynamics may be operational for a variable period, overt abnormalitlies of cardiac function and evidence of marketdly enhanced cornoray blood flow usually are not seen until the late stages of disease. The decline in biophysical variables shows a reproducible relationship with the acid-base status. If adaptation mechanisms fail, stillbirth ensues AV, atrioventricular; EDV end-diastolic velocity; FH, fetal heart rate; UV,umbilical vein. This figure was published in High Risk Pregnancy: Management Options, 3rd edition. James et al. Copyright Elsevier (2006).

**Table 3. Obstetrical history and current pregnancy conditions associated with increased perinatal morbidity/mortality where antenatal fetal surveillance may be beneficial**

| | |
|---|---|
| Previous obstetrical history | |
| Maternal | Hypertensive disorder of pregnancy<br>Placental abruption |
| Fetal | Intrauterine growth restriction<br>Stillbirth |
| Current pregnancy | |
| Maternal | Post-term pregnancy (>294 days, > 42 weeks)[9,10]<br>Hypertensive disorders of pregnancy[11]<br>Pre-pregnancy diabetes[12]<br>Insulin requiring gestational diabetes[13]<br>Preterm premature rupture of membranes[14]<br>Chronic (stable) abruption[15]<br>Iso-immunization[8]<br>Abnormal maternal serum screening (hCG or AFP > 2.0 MOM) in absence of confirmed fetal anomaly[16]<br>Motor vehicle accident during pregnancy[17]<br>Vaginal bleeding<br>Morbid obesity[18,19]<br>Advanced maternal age<br>Assisted reproductive technologies |
| Fetal | Decreased fetal movement[20,21]<br>Intrauterine growth restriction[22]<br>Suspected Oligohydramnios/Polyhydramnios<br>Multiple pregnancy<br>Preterm labour |

condition of the presumed normal fetus, with a view of determining the optimal time for delivery.[8] The decision to initiate antenatal fetal testing should be individualized and reflect the risk factor(s) associated with an individual pregnancy. The maternal obstetrical history, severity of maternal and fetal disorders in the current pregnancy, and the gestational age at onset should be taken into account in determining the appropriate time to initiate antenatal fetal testing. For instance, maternal awareness of fetal movements should be encouraged in *all* pregnant women, with or without risk factors for adverse perinatal outcome, starting between 26 and 32 weeks' gestation. Fetal umbilical artery Doppler assessment should be considered (1) at the time of diagnosis of suspected fetal growth restriction or (2) as a follow-up for suspected severe placental pathology or known fetal growth restriction. Non-stress testing and amniotic fluid volume assessment in otherwise healthy postdates pregnancies should begin between 287 and 294 days (41 and 42 weeks),[23] or two weeks before the time of an adverse event in a previous pregnancy. Antenatal fetal testing should be performed without delay for women who present with decreased fetal movement. Antenatal testing in insulin dependent or insulin-requiring pregnancies that are well controlled and otherwise uncomplicated should begin at 32 to 36 weeks' gestation.[24] Perinatal morbidity and mortality is increased further in women with poorly controlled diabetes, and the gestational age at initiation of antenatal fetal assessment should reflect the clinical suspicion of increased risk, once the fetus has reached viability.

## FREQUENCY OF TESTING

The frequency of antenatal fetal testing should be individualized to reflect the risk factor(s) associated with an individual pregnancy and should correspond to the perceived risk of fetal asphyxia evidenced by testing results. Antenatal testing frequency should reflect the degree of risk in cases where the perceived risk persists, and testing will usually be performed once to twice weekly. However, antenatal fetal testing may be required daily or even more frequently to aid in the timing of delivery to maximize gestational age while avoiding significant intrauterine morbidity in the preterm fetus.[25] With either individual or combined forms of testing, consideration should be given to the entire clinical picture, including gestational age, maternal age, previous obstetrical history, and the presence or absence of underlying current medical conditions and/or obstetrical complications in planning ongoing antenatal care.

## METHODS OF ANTENATAL FETAL SURVEILLANCE

### 1. Fetal Movement Counting

Decreased placental perfusion and fetal acidemia and acidosis are associated with decreased fetal movements.[21] This is the basis for maternal monitoring of fetal movements or "the fetal movement count test." The concept of counting fetal movements is attractive, since it requires no technology and is available to all women.

#### Review of the evidence

In a review of the literature since 1970 on fetal movement counting in western countries, Froen[26] analyzed 24 studies and performed several meta-analyses on the data. His major findings included the following.

- In high-risk pregnancies, the risk for adverse outcomes in women with decreased fetal movements increased: mortality, OR 44 (95% CI 22.3–86.8); IUGR, OR 6.34(95% CI 4.19–9.58); Apgar < 7 at 5 minutes, OR 10.2 (95% CI 5.99–17.3); need for emergency delivery, OR 9.40 (95% CI 5.04–17.5).
- There was a trend to lower fetal mortality in low-risk women in the fetal movement groups versus controls, although this difference was not statistically significant (OR

0.74; 95% CI 0.51–1.07). Fetal mortality among fetal movement counters versus controls was OR 0.64 (95% CI 0.41–0.99). Note that this analysis is skewed by the inclusion of the large study by Grant et al.,[27] discussed below.
- Fetal mortality during the studies on fetal movement counts (in both the study and the control groups) was lower than in the immediate previous periods OR 0.56 (95% CI 0.40–0.78). The odds of fetal mortality had a similar decrease between the two periods OR 0.49, (95% CI 0.28–0.85).
- The frequency of extra alarms due to reduced movements was 3% in observational studies. In the case-control studies, the increase was 2.1% (from 6.7% to 8.8%). Therefore, monitoring of fetal movements will increase the number of antenatal visits in pregnancy by 2 to 3 per hundred pregnancies.

These analyses provide support for the use of fetal movement counting in pregnancies with or without risks factors for adverse perinatal outcomes. A large RCT may be necessary to confirm these observations. Other literature providing no evidence to support the use of fetal movement counting was also reviewed, specifically the trial conducted by Grant et al.,[27] which is the largest RCT performed to date on the use of fetal movement counts. Since the study population was larger (N = 68 000) than all previous studies combined, and the study is unlikely to be replicated, it requires special attention. The study, which was conducted mainly in the UK, and at a few centres in Sweden, Belgium, and the USA, compared antenatal fetal deaths in women who were asked to perform daily fetal movement counts with those in women who were not asked to perform counts. The study also looked at unexplained stillbirths (the target group of fetal movement counts). The authors' main conclusion was that a formal protocol for fetal movement counts had no advantage over no formal protocol in reducing stillbirths. The authors stated that 1250 women would have to perform fetal movement counts to prevent one stillbirth.

In reviewing this study, several methodological issues were identified that lead to questions about the validity of the results and conclusions. These issues include the following.

**Delayed response**
Other studies on fetal movement counts required reporting of reduced fetal movements within 1 to 12 hours. In contrast, admission for reduced fetal movements was delayed by up to 48 hours in this study. Furthermore, 14% of these women were managed by telephone advice alone. This may explain the high stillbirth rate on admission (85%, 100/117). Therefore, the outcomes of the study may reflect the inadequate management protocol in cases of reduced fetal movement, rather than the test's inherent usefulness.

**Inadequate and inconsistent management protocol**
The management of women with decreased fetal movements was not standardized. For instance, ultrasound scans were performed in only 11% of women with fetuses alive on admission. Many of the women who presented with decreased movements and a living fetus (30%, 11/36) were falsely reassured and were sent home only to have a subsequent stillbirth. These data also suggest that with decreased fetal movement counts, electronic fetal heart monitoring alone may not be sufficient to ensure fetal well-being.

**Poor reporting of outcome**
No data on neonatal deaths or perinatal morbidity were collected.

**Blinding of patients**
Approximately 60% of the controls signed a consent form, possibly prejudicing outcomes, as these patients were aware of formal fetal movement counting.

**Crossover of patients**
Approximately 6.9% of the control groups filled in fetal movement count charts.

**Reporting decreased movements**
Controls had a lower reporting rate (65 vs. 84; $P < 0.05$). However, the reporting rate in these women was still quite high, suggesting possible contamination of results.

**Compliance**
Only 60% of patients complied with charting and only 50% reacted to the study threshold of decreased movements.

**Validity of fetal movement count charts**
The average time to achieve 10 movements in most previous studies was about 20 minutes. In this study it was 162 minutes.

The concerns identified in study methodology and subsequent conclusions, significantly discount the role of this Grant et al.[27] RCT in formulating the fetal movement count recommendations in this guideline.

There are a number of issues relevant to fetal movement counting, as outlined in Table 4.

**Which method of fetal movement count should be used?**
A variety of methods have been described, which are usually variations on the methodologies of two early studies.

- The Cardiff method, first reported by Pearson and Weaver[45] suggests a count to 10 movements in a fixed time frame. The original study required counting for 12 hours.

**Table 4. Issues relevant for fetal movement counts[28,29]**

| | |
|---|---|
| Gestational age | Fetal movements are perceived by women regularly after 24 weeks in a constant fashion.[30] Most studies initiated fetal movements at 28–32 weeks.[26] In extremely early gestational age, iatrogenic preterm delivery may have grave consequences. Therefore, fetal movement counting should not be encouraged prior to viability and possibly should start at 26–32 weeks based on the facilities available. |
| Non-perception of fetal movements | Women perceived 87–90% of fetal movements.[31,32] A small percentage of women do not perceive fetal movements. Fetal movement counting can not be used in these women. Perception may improve with looking at movements during ultrasound scanning.[33] |
| Optimal time for testing | Fetal movements were found to be increased at evening time.[34,35] |
| Position | Fetal movements are perceived best when lying down.[36] |
| Activity | Maternal exercise was not shown to alter fetal activity.[37] |
| Food | Most studies did not show an increase of movements following food or glucose.[35,38–41] |
| Smoking | Smoking reduces fetal movements temporarily by increasing carboxyhemoglobin levels and reducing fetal blood flow.[42] |
| Drug effect | Most drugs have no effect on fetal movements. Depressant drugs and narcotics may reduce fetal movements.[43] Notably, antenatal corticosteroids may have the same effect for two days.[44] |
| Anxiety and stress | Fetal movement counting does not increase maternal stress or anxieties.[26,27] |

Modified protocols include those of Liston (count to 6 hours)[28] and Moore (count to 2 hours).[46]

- The Sadovsky method suggests a count of movements in a specific time frame (usually 30 minutes to two hours).[47]

There are no studies comparing the effect on outcome of using different fetal movement count charts. A vigilant and perceptive woman probably does not need to do a formal fetal movement count. In addition, all studies, with the exception of that by Grant et al.,[27] showed that any of the methods outlined above resulted in a reduction of stillbirth rate. Ideally, the testing should be performed for the shortest time possible to identify fetuses at risk. A short observation period allows women to concentrate on the fetal movement count while minimizing any imposition on routine daily activity. The following testing approach is recommended: women should count distinctive fetal movements until they reach a count of six movements. If the count does not reach six movements in two hours, the woman should have further antenatal testing. Optimally, the woman should perform the count in the early evening when she is lying down, tilted, or semi-recumbent.

The rationale for this recommendation comes from data generated from research on fetal activity and previous studies on fetal movement counting, specifically those of Sadovsky,[47] Moore,[46] and Neldam,[48] and research data derived from studies on fetal behaviour. In most pregnancies, 10 fetal movements occurred within a 20-minute window.[46,49,50] Patrick et al.[51] showed that the fetal sleep cycle normally lasts about 20 to 40 minutes and practically never exceeds 90 minutes in the normal, healthy fetus. Sadovsky[52] suggested that three movements per hour were abnormal. In Nedlam's study,[48] 4% of women perceived three movements or fewer per hour for two consecutive hours; in Rayburn and McKean's[53] study, this rate was 5%.

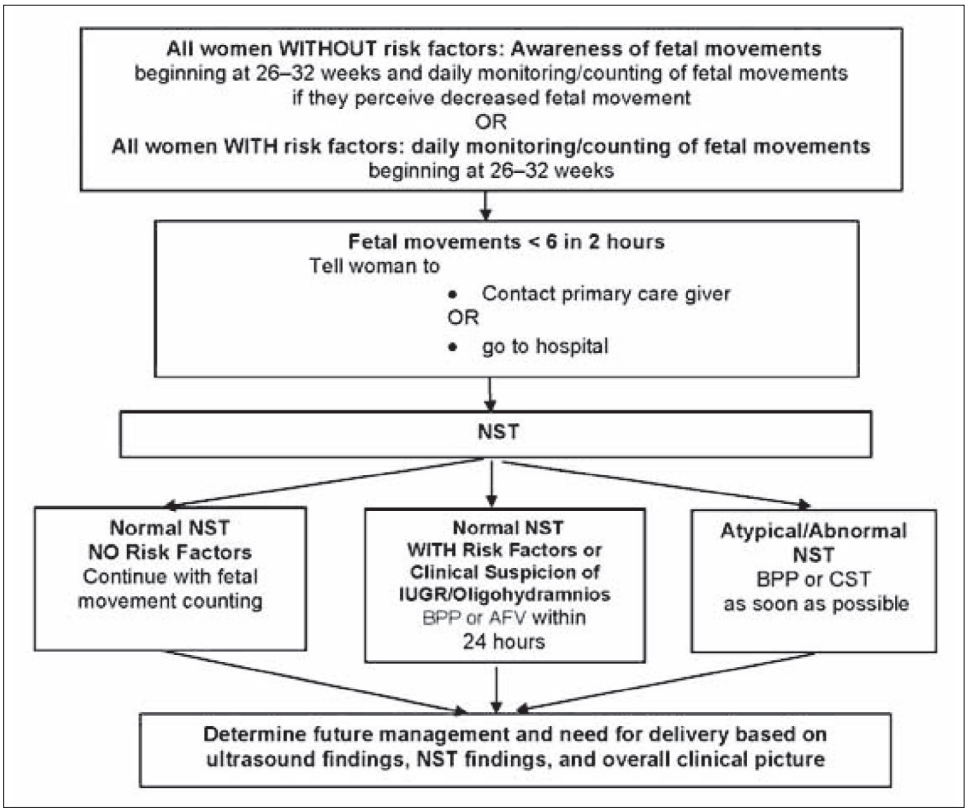
Therefore, counting up to six movements in a two-hour period offers short test duration, a proven track record, and a relatively low rate of alarm. Women should be informed that in most fetuses with a positive test (fewer than 6 movements in 2 hours), the result is often a false positive, and a good outcome ensues. However, ancillary fetal surveillance should be undertaken.

**Purpose of fetal movement counting**

The purpose of fetal movement counting is to evaluate three types of fetus: (A) the healthy fetus, (B) the structurally normal, at risk fetus that may benefit from intense monitoring or delivery, and (C) the anomalous fetus.

A. The healthy fetus is identified by exclusion. Fetuses with normal activity of six or more movements in the interval of two hours are almost invariably healthy. Women who report a general reduction of movements, although the specific target of six movements is reached, may desire or benefit (through reduction of anxiety) from further antenatal testing.
B. The structurally normal fetus at risk for adverse outcome due to either maternal diseases or fetal conditions, such as IUGR, should have daily fetal movement counts. In these pregnancies, additional testing is usually prescribed in the form of interval non-stress testing or ultrasound scanning for amniotic fluid volume, biophysical profile, estimated fetal weight, or Doppler flow studies, as indicated and as available.
C. Fetuses with anatomical malformation often have abnormal behaviour. Sadovsky et al.[52] showed that reduced

**Figure 3. Fetal movement algorithm.**




fetal movement was found in 16.5% of babies with anomalies, compared with 1% of those with normal movements. Rayburn and Barr[54] found that 28% of anomalous fetuses had decreased fetal movements compared with 4% in non-anomalous fetuses. Therefore, a fetus with decreased movements on which an anatomical ultrasound has not been done requires a scan to rule out a fetal malformation prior to considering an intervention for fetal well-being.

**SOGC Clinical Tip**

Optimally, the technique for fetal movement counting is performed with the woman concentrating on the movements and in a reclined (not supine) position.

**Clinical management of decreased fetal movement**

There are no studies comparing different algorithms for diagnosis and management of decreased fetal movements. Most studies have relied on electronic fetal heart rate monitoring and ultrasound scans. The ultrasound scan can identify a fetal anomaly, decreased amniotic fluid volume, poor biophysical score, and IUGR. One study found ultrasound scans to be superior to fetal heart rate monitoring (Figure 3).[55]

Women who report decreased fetal movements (<6 distinct movements within two hours) should have an evaluation of maternal and fetal status. The first-line fetal tests include the non-stress test and biophysical profile. There is no specific recommended time frame for testing; however, in most studies with reduction in stillbirth rate, this testing was performed within 1 to 12 hours. When the non-stress test is normal and there are no risk factors, women should continue with daily fetal movement counting. If the non-stress test is normal and risk factors are identified, e.g., gestational hypertension or suspicion of small for gestational age fetus or oligohydramnios, further testing within 24 hours (ultrasound or biophysical profile) is recommended. Women should continue with daily fetal movement counting. In situations where the non-stress test is atypical/abnormal, further testing (biophysical profile or contraction stress test) should be performed as soon as possible. It is prudent to ensure that an anatomical scan to rule out a fetal malformation has been done prior to intervening for fetal well-being.

**Recommendation 1: Fetal Movement Counting**

1. Daily monitoring of fetal movements starting at 26 to 32 weeks should be done in all pregnancies *with* risk factors for adverse perinatal outcome (I-A).
2. Healthy pregnant women *without* risk factors for adverse perinatal outcomes should be made aware of the

significance of fetal movements in the third trimester and asked to perform a fetal movement count if they perceive decreased movements (I-B).

3. Women who do not perceive six movements in an interval of two hours require further antenatal testing and should contact their caregivers or hospital as soon as possible (III-B).
4. Women who report decreased fetal movements (<6 distinct movements within 2 hours) should have a complete evaluation of maternal and fetal status, including non-stress test and/or biophysical profile. Prior to considering an intervention for fetal well-being, an anatomical scan to rule out a fetal malformation should be done, if one has not already been done. Management should be based upon the following:
   - Non-stress test is normal and there are no risk factors: the woman should continue with daily fetal movement counting (III-B).
   - Non-stress test is normal and risk factors or clinical suspicion of intrauterine growth restriction/oligohydramnios is identified: an ultrasound for either full biophysical profile or amniotic fluid volume assessment within 24 hours. The woman should continue with daily fetal movement counting (III-B).
   - Non-stress test is atypical/abnormal: further testing (biophysical profile and/or contraction stress test and assessment of amniotic fluid volume) should be performed as soon as possible (III-B).

## 2. Non-Stress Test

Despite widespread use, there is poor evidence that antenatal non-stress testing can reduce perinatal morbidity or mortality.[56] In fact, the four blinded randomized trials evaluating the non-stress test, although small, demonstrated a trend to an increase in perinatal deaths in the cardiotocography group (OR 2.85; 95% CI 0.99–7.12).[56] There is a need for further study and evaluation of the non-stress test. Despite the evidence from these RCTs, the NST is embedded in clinical practice and for this reason discussion of this testing modality and recommendations about its use are included in this guideline. If it is to be used, it should be used in women with risk factors for adverse perinatal outcome. There is no good evidence on which to base a recommendation for frequency of non-stress testing. In most cases a normal NST is predictive of good perinatal outcome for one week (providing the maternal-fetal condition remains stable), except in women with insulin dependent diabetes or with a post-dates pregnancy, in which case NSTs are recommended at least twice weekly.[23,57,58]

When used, the non-stress test is performed during the antenatal period when the uterus is relaxed, i.e., the fetus is not exposed to the "stress" of uterine contractions. The woman should empty her bladder and be positioned on either a bed or a reclining chair in the left lateral recumbent position.[59] 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, but variability assessment was not the original objective of the NST. Historically, a normal (reactive) non-stress test includes at least two accelerations from the baseline within the 20-minute period of testing that reach a peak or acme of at least 15 bpm above the baseline and have a duration from onset to return to baseline of at least 15 seconds.[60] A negative predictive value of the test for fetal and neonatal death is 99% within one week of testing.[61] Therefore, a normal tracing meeting the acceleration criteria is sufficient for assurance of fetal well-being and does not warrant any other testing.[62] 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 subsequently heart rate variability are reduced. Note that this criterion applies to the term or near-term fetus. In particular, caution should be used in applying the usual acceleratory (reactive) criteria in the interpretation of the non-stress test in the premature fetus. For fetuses less than 32 weeks' gestation, accelerations would be expected to increase 10 bpm for at least 10 seconds.[63] Neither the administration of glucose nor the performance of manual stimulation is recommended as a technique to encourage fetal heart rate accelerations in the fetus. Studies in which the NST was used as the primary screening tool have demonstrated that up to 40% of fetuses will not meet the acceleration criteria within 40 minutes of testing. The majority of these fetuses are healthy; nevertheless, Brown and Patrick[64] demonstrated that the length of time that the fetus lacks accelerations is strongly correlated with fetal compromise. They concluded that if the fetus lacks accelerations for greater than 80 minutes, then the fetus is likely compromised and will continue to lack accelerations. These findings have been confirmed by Leveno et al.[65] If the fetus lacks accelerations after 40 minutes of testing, the primary care provider should be informed, and the electronic fetal monitoring should be continued. A decision should be made to proceed either to amniotic fluid assessment and or to multiple parameters testing (such as a biophysical profile or contraction stress testing). Although the use of vibroacoustic stimulation has demonstrated a decrease in both testing time and number of non-reactive antenatal cardiotocographs, its use is not recommended to stimulate fetal heart accelerations, because the predictive reliability and safety of this modality are still unknown.[66]

**Table 5. Antepartum classification: non-stress test**

| Parameter | Normal NST (Previously "Reactive") | Atypical NST (Previously "Non-Reactive") | Abnormal NST (Previously "Non-Reactive") |
|---|---|---|---|
| Baseline | 110–160 bpm | • 100–110 bpm<br>• > 160 bpm < 30 min.<br>• Rising baseline | • Bradycardia < 100 bpm<br>• Tachycardia > 160 for > 30 min.<br>• Erratic baseline |
| Variability | • 6–25 bpm (moderate)<br>• ≤ 5 (absent or minimal) for < 40 min. | • ≤ 5 (absent or minimal) for 40–80 min. | • ≤ 5 for ≥ 80 min.<br>• ≥ 25 bpm > 10 min.<br>• Sinusoidal |
| Decelerations | • None or occasional variable < 30 sec. | • Variable decelerations 30–60 sec. duration | • Variable decelerations 60 sec. duration<br>• Late deceleration(s) |
| Accelerations Term Fetus | • ≥ 2 accelerations with acme of ≥ 15 bpm, lasting 15 sec. < 40 min. of testing | • ≤ 2 accelerations with acme of ≥ 15 bpm, lasting 15 sec. in 40–80 min. | • ≤ 2 accelerations with acme of ≥ 15 bpm, lasing 15 sec. in > 80 min. |
| Preterm Fetus (<32 weeks) | • ≥ 2 accelerations with acme of ≥ 10 bpm, lasting 10 sec. < 40 min. of testing | • ≤ 2 accelerations of ≥ 10 bpm, lasting 10 sec. in 40–80 min. | • ≤ 2 accelerations of ≥10 bpm, lasting 10 sec. in > 80 min. |
| ACTION | FURTHER ASSESSMENT OPTIONAL, based on total clinical picture | FURTHER ASSESSMENT REQUIRED | URGENT ACTION REQUIRED<br>An overall assessment of the situation and further investigation with U/S or BPP is required. Some situations will require delivery. |

**Classification of non-stress tests**

Although non-stress tests originally assessed the "reactive or non-reactive" fetus according to whether or not the acceleration criteria were met, the other parameters of electronic fetal heart assessment including baseline rate, variability, and the presence or absence of decelerations should also be assessed. If uterine activity is present, then strictly speaking this is no longer a non-stress test, but a spontaneous contraction stress test. These spontaneous contractions may not be of a frequency sufficient to meet the requirements of a formal "contraction stress test"; nevertheless, decelerations of the fetal heart in association with such uterine activity must be evaluated.

For the purposes of classification, the National Institute of Child Health and Human Development definitions are used.[63] For accelerations, this means that the acme of the acceleration is ≥ 15 beats/minute above the baseline, and the acceleration lasts ≥ 15 seconds and < 2 minutes from the onset to return to baseline. Before 32 weeks' gestation, accelerations are defined as having an acme ≥ 10 beats/min above the baseline with a duration of ≥ 10 seconds from onset to the return to baseline.

For the purpose of clarity and consistency in interpretation, communication, and management, this guideline classifies non-stress tests as (1) normal, (2) atypical, or (3) abnormal (Table 5). A classification of normal refers to what was previously described as a "reactive" NST, and further testing would be undertaken according to the presence of risk factors and the overall clinical situation.

An atypical classification may result from a baseline fetal heart rate of (1) 100 to 110 bpm, (2) > 160 bpm for up to 30 minutes, or (3) a rising baseline. An atypical tracing would also include absent or minimal variability for 40 to 80 minutes, or the presence of variable decelerations of 30 to 60 seconds in duration. The occurrence of two accelerations in 40 to 80 minutes of monitoring is also considered atypical. Atypical tracings require further evaluation of the total clinical picture and of the fetal status. The individual carrying out the test should inform the primary care provider prior to discontinuing the testing, and the primary care provider should arrange for or perform further assessment.

An abnormal tracing is one that persistently lacks accelerations after 80 minutes or one that contains significant abnormality of baseline heart rate or variability and/or shows evidence of significant deceleration. The presence of an abnormal non-stress test demands immediate further investigation and possibly delivery. All facilities where testing is carried out should have clearly stated, readily accessible protocols in place for interdisciplinary communication and action in the presence of an abnormal non-stress test. Such action would include the initiation of intrauterine resuscitation, consultation or communication with an obstetrician and/or MFM sub-specialist, and arrangement for further testing and/or consideration of delivery and/or transport.

**Maternal glucose administration**

Maternal glucose administration has been used in clinical practice in an attempt to stimulate the fetus to alter the results

of a non-reactive NST. A Cochrane review of two trials with a total of 708 participants examined the efficacy of this practice.[66] The authors concluded that antenatal maternal glucose administration did not decrease the incidence of non-reactive antenatal cardiotocography tests, and it is not recommended.

**Manual fetal manipulation**

Manual fetal manipulation has also been used in clinical practice in an attempt to stimulate a fetus to alter the results of a non-reactive NST. A Cochrane review of three trials with a total of 1100 women with 2130 episodes of participation examined the efficacy of this practice.[67] The authors concluded that manual fetal manipulation did not decrease the incidence of non-reactive antenatal cardiotocography test (OR 1.28; 95% CI 0.94–1.74), and it is not recommended.

**Recommendation 2: Non-Stress Test**

1. Antepartum non-stress testing may be considered when risk factors for adverse perinatal outcome are present (III-B).
2. In the presence of a normal non-stress test, usual fetal movement patterns, and absence of suspected oligohydramnios, it is not necessary to conduct a biophysical profile or contraction stress test (III-B).
3. A normal non-stress test should be classified and documented by an appropriately trained and designated individual as soon as possible, (ideally within 24 hours). For atypical or abnormal non-stress tests, the nurse should inform the attending physician (or primary care provider) at the time that the classification is apparent. An abnormal non-stress test should be viewed by the attending physician (or primary care provider) and documented immediately (III-B).

## 3. Contraction Stress Test

The contraction stress test, or oxytocin challenge test, is a test of fetal well-being first described by Ray et al. in 1972.[68] It evaluates the response of the fetal heart rate to induced contractions and was designed to unmask poor placental function.[68,69] In a time when uteroplacental function is often evaluated by biophysical variables (e.g., biophysical profile) or vascular flow measurements (e.g., Doppler interrogation of uterine or fetal vessels), the contraction stress test is now being performed much less frequently.[69,70]

The CST may still be used when the fetus is at risk for the consequences of uteroplacental pathology. This includes maternal conditions such as diabetes or hypertension and fetal conditions such as growth restriction or postdates.[69] The CST should not be used in any woman for whom vaginal delivery is contraindicated (i.e., women with placenta previa or previous classical Caesarean section).[69] The CST should not be performed below the gestational age at which intervention would be made on behalf of the fetus if abnormal (generally 24 weeks).[69,71] This test should be performed in hospital where emergency Caesarean section is available,[70] and the woman should be fully informed of the risks and benefits of the test. The objective is to induce three contractions, lasting one minute each, within a ten minute period,[70] so that the fetal heart response to the contractions can be evaluated.

The CST may be performed using maternal nipple stimulation or an oxytocin infusion. For nipple stimulation, the woman is instructed to rub one nipple through her clothing with the palmar surface of her fingers rapidly, but gently, for two minutes and then to stop for five minutes. Uterine activity is then evaluated. If contractions are inadequate, a second cycle of two minutes of stimulation is recommended.[72] Bilateral nipple stimulation may then be considered. Nipple stimulation is associated with no greater risk of uterine hyperstimulation and has a shorter average testing time than oxytocin infusion.[73–75] Should nipple stimulation fail to induce contractions that meet the test criteria, then oxytocin infusion should be considered.

For oxytocin-induced contractions, the woman is place in semi-recumbent position with an intravenous line in place.[69,72] An NST is performed prior to the CST. If then considered appropriate, uterine contractions are induced using exogenous oxytocin, commencing at 0.5 to 1 mU/min, and increasing every 15 to 30 minutes by 1 mU/min, until three contractions lasting one minute each within a 10-minute period are achieved.[70] Hyperstimulation may occur; Freeman reported hyperstimulation of up to 10% in tests in which oxytocin was increased every 15 minutes. Therefore, increasing at longer intervals, e.g., every 30 minutes, may be wise.[76]

The tracing is evaluated for baseline rate, baseline variability, and decelerations.[69,70] A CST is considered positive if late decelerations occur with more than 50% of the induced contractions (even if the goal of three contractions in 10-minutes has not yet been reached). A negative CST has a normal baseline fetal heart rate tracing without late decelerations.[68] An equivocal test is defined as repetitive decelerations, not late in timing or pattern.[70] A CST is deemed unsatisfactory if the desired number and length of contractions is not achieved or if the quality of the cardiotocography tracing is poor.

The oxytocin stress test requires a lengthy observation period and IV access and has a high rate of equivocal results.[77] It

has been almost completely replaced by the other tests of fetal well-being described in this guideline. The advantage of the CST is that it most closely approximates intrapartum surveillance of the fetus at risk.[69] There is still a place for the CST in a modern obstetrical unit where a fetus with other abnormal testing parameters is to be delivered that might be a candidate for a vaginal delivery if contractions are tolerated. A fetus demonstrating an atypical/abnormal NST and a positive CST is less likely to tolerate labour and will require careful intrapartum observation.[71,78] The test may also provide information supporting prolongation of the pregnancy when the fetus is at risk at a gestational age remote from term.

The CST has a high negative predictive value (99.8%).[79] Its positive predictive value for perinatal morbidity however is poor (8.7–14.9%).[70] It should never be used alone to guide clinical action.[69] The corrected perinatal mortality rate within one week of a negative contraction stress test is 1.2/1000 births.

**Recommendation 3: Contraction Stress Test**

1. The contraction stress test should be considered in the presence of an atypical non-stress test as a proxy for the adequacy of intrapartum uteroplacental function and, together with the clinical circumstances, will aid in decision making about timing and mode of delivery (III-B).
2. The contraction stress test should not be performed when vaginal delivery is contraindicated. (III-B).
3. The contraction stress test should be performed in a setting where emergency Caesarean section is available (III-B).

### 4. Sonographic Assessment of Fetal Behaviour and/or Amniotic Fluid Volume

Sonography allows the simultaneous assessment of several fetal behavioural and physiologic characteristics. The BPP is an evaluation of current fetal well-being. It is performed over 30 minutes and assesses fetal behaviour by observing fetal breathing movement, body movement, tone, and amniotic fluid volume.[80] In the presence of intact membranes, functioning fetal kidneys, and unobstructed urinary tract, decreased amniotic fluid reflects decreased renal filtration due to redistribution of cardiac output away from the fetal kidneys in response to chronic hypoxia.[81]

The sonographic components[80] of the fetal BPP are shown in Table 6.

Each of these individual ultrasound assessed variables is scored 0 (if absent) or 2 (if present) and summed for a maximum score of 8. The inclusion of the NST brings the maximum possible score to 10 when the NST is normal. The original BPP included all five components in every pregnancy assessment. A more recent approach is to carry out the ultrasound components, reserving the NST for pregnancies in which one of the ultrasound components is absent. A score of 10 or 8 (including 2 for fluid present) is considered normal, 6 is considered equivocal, and 4 or less is abnormal. (Reassessment of a patient with an equivocal result, 6 of 10 [normal fluid], will be reassuring in 75% of cases.[80]) Representative perinatal mortality and suggested clinical management are shown in Table 7.

**Table 6. Components of fetal biophysical profile**

| Component | Criteria |
|---|---|
| 1. Breathing movements | At least one episode continuing more than 30 seconds. |
| 2. Movements | At least three body or limb movements. |
| 3. Tone | An episode of active extension with return to flexion of a limb or trunk,<br>*or*<br>opening and closing of the hand. |
| 4. Amniotic fluid volume | At least one cord and limb-free fluid pocket which is 2 cm by 2 cm in two measurements at right angles. |

The BPP identifies less than a 2 cm by 2 cm pocket of amniotic fluid as oligohydramnios.[80] There are two other commonly used techniques for quasi-quantitative evaluation of amniotic fluid volume. The first is the maximal vertical pocket depth.[82] This approach identifies a pocket depth of 2 to 8 cm as normal, 1 to 2 cm as marginal, < 1 cm as decreased, and > 8 cm as increased. The second technique is the AFI. The AFI attempts to assess amniotic fluid volume more broadly by summing the deepest vertical pocket of fluid in the four quadrants of the uterus.[83] The AFI uses the 5th and 95th percentiles for gestational age to signify oligohydramnios and polyhydramnios respectively.[84] Dye dilution techniques at amniocentesis have not shown one method of sonographic prediction of amniotic fluid volume to be better at determining true amniotic fluid volume.[85] There is evidence from recent RCTs that use of AFI, rather than pocket size, increases intervention frequency without improving outcomes.[86–89] This is despite a well-conducted blinded prospective cohort[90] that found AFI as a more sensitive, but still poor, predictor of adverse pregnancy outcome.

A systematic review[5] of four RCTs using the biophysical profile for fetal assessment in high-risk pregnancies concluded that there is not enough evidence to clearly inform providers' care decisions. Retrospective and prospective reports of large cohorts indicate that lower BPP score is

**Table 7. Perinatal mortality within one week of biophysical profile by BPP score***

| Test Score Result | Interpretation | PNM within 1 week without intervention | Management |
|---|---|---|---|
| 10/10<br>8/10 (normal fluid)<br>8/8 (NST not done) | Risk of fetal asphyxia extremely rare | 1/1000 | Intervention for obstetric and maternal factors. |
| 8/10 (abnormal fluid) | Probable chronic fetal compromise | 89/1000 | Determine that there is evidence of renal tract function and intact membranes. If so, delivery of the term fetus is indicated. In the preterm fetus < 34 weeks, intensive surveillance may be preferred to maximize fetal maturity.[30] |
| 6/10 (normal fluid) | Equivocal test, possible fetal asphyxia | Variable | Repeat test within 24 hr |
| 6/10 (abnormal fluid) | Probable fetal asphyxia | 89/1000 | Delivery of the term fetus. In the preterm fetus < 34 weeks, intensive surveillance may be preferred to maximize fetal maturity.[30] |
| 4/10 | High probability of fetal asphyxia | 91/1000 | Deliver for fetal indications. |
| 2/10 | Fetal asphyxia almost certain | 125/1000 | Deliver for fetal indications. |
| 0/10 | Fetal asphyxia certain | 600/1000 | Deliver for fetal indications. |

*Modified from Manning FA, Dynamic ultrasound-based fetal assessment: The fetal biophysical score[80].

associated with more frequent fetal acidosis,[91,92] perinatal morbidity and mortality,[93,94] and cerebral palsy.[95] This level II evidence is the basis of BPP use for assessment of antenatal health surveillance. It should be acknowledged that the amniotic fluid criterion definition has varied somewhat in this data.[96]

Some centres carry out a "modified" BPP as the primary screen of antenatal surveillance. The modified BPP consists of a non-stress test and an AFI (>5 cm is considered adequate). If either assessment measure is of concern, then the complete BPP is performed. There is less level II evidence supporting this approach.[25,97]

### Recommendation 4: Biophysical Profile

1. In pregnancies at increased risk for adverse perinatal outcome and where facilities and expertise exist, biophysical profile is recommended for evaluation of fetal well-being (I-A).
2. When an abnormal biophysical profile is obtained, the responsible physician or delegate should be informed immediately. Further management will be determined by the overall clinical situation (III-B).

**SOGC Clinical Tip**

Assessments of amniotic fluid volume by the amniotic fluid index increases care provider intervention rates without demonstrating improved outcomes, when compared with the single largest pocket (maximal vertical depth) approach.

## 5. Uterine Artery Doppler

**Background information**

In normal pregnancy, the developing placenta implants on maternal decidua, and the trophoblast invades the maternal spiral arteries, destroying the elastic lamina and transforming these vessels into low resistance shunts in order to improve blood supply to the fetoplacental unit. Impaired trophoblastic invasion is associated with pre-existing hypertension and subsequent development of hypertensive disorders of pregnancy, IUGR, placental abruption, and intrauterine fetal demise. Doppler ultrasound of the uterine arteries is a non-invasive method of assessing the resistance of vessels supplying the placenta. In normal pregnancies, there is an increase in blood flow velocity and a decrease in resistance to flow, reflecting the transformation of the spiral arteries. In pregnancies complicated by hypertensive disorders, Doppler ultrasound of the uterine artery shows increased resistance to flow, early diastolic notching, and decreased diastolic flow.

Several studies[98–101] have examined the potential value of uterine artery Doppler in predicting pregnancies at risk of complications related to impaired placentation. Studies can be divided into unselected and selected populations. "Selected populations" refers to women who are at higher risk of developing complications, e.g., chronic hypertension, previous gestational hypertension, or previous pregnancy affected by intrauterine growth restriction. Each of these studies used different Doppler indicators, such as resistance index or pulsatility index greater than the 95$^{th}$ centile, unilateral or bilateral early diastolic notching in the wave form,

and varying clinical end points such as development of gestational hypertension, preterm birth, or intrauterine growth restriction. However, the findings can be summarized as follows:

- Approximately 1% of at-risk pregnancies have abnormal uterine artery Doppler resistance and/or notching after 26 weeks' gestation.
- The likelihood of development of gestational hypertension and/or growth restriction in these pregnancies is increased fourfold to eightfold.
- Conversely, normal uterine artery pulsatility index or resistance index significantly reduces the likelihood of these pregnancy complications (negative predictive value varying between 80% and 99%).

Data on the use of uterine artery Doppler screening in healthy or unselected populations without risk factors for adverse outcome is less well substantiated. Nevertheless, even in this population abnormal (positive) uterine artery Doppler is a better predictor of the onset of gestational hypertension than any other single maternal characteristic (e.g., age, race, height, weight, smoking, alcohol consumption, past medical history, previous gestational hypertension or abruption, and new partner). Once again, normal uterine artery Doppler pulsatility or resistance index is highly correlated with the likelihood of a completely uncomplicated pregnancy outcome.[100]

In centres utilizing uterine artery Doppler, this testing modality has been incorporated into routine ultrasound screening (18–22 weeks). In the small number of women demonstrating a positive uterine artery Doppler, a second evaluation is carried out at 24 to 26 weeks, and if the abnormality persists, increased maternal and fetal surveillance is implemented for the duration of the pregnancy. It should be understood that uterine artery Doppler assessment is not yet established for routine use in Canada.

A positive uterine artery Doppler screen consists of mean resistance index of > 0.57, pulsatility index > 95th centile, and/or the presence of uterine artery notching.

### Recommendation 5: Uterine Artery Doppler

1. Where facilities and expertise exist, uterine artery Doppler may be performed at the time of the 17 to 22 weeks' gestation detailed anatomical ultrasound scan in women with the following factors for adverse perinatal outcome (II-A).
2. Women with a positive uterine artery Doppler screen should have the following:
   - A double marker screen (for alpha feto-protein and beta hCG) if at or before 18 weeks' gestation (III-C).
   - A second uterine artery Doppler at 24 to 26 weeks. If the uterine artery Doppler is positive at the second scan, the woman should be referred to a maternalfetal medicine specialist for management (III-C).

## 6. Umbilical Artery Doppler

The following will serve as an adjunct and update to the SOGC Clinical Practice Guideline "The Use of Fetal Doppler in Obstetrics."[102]

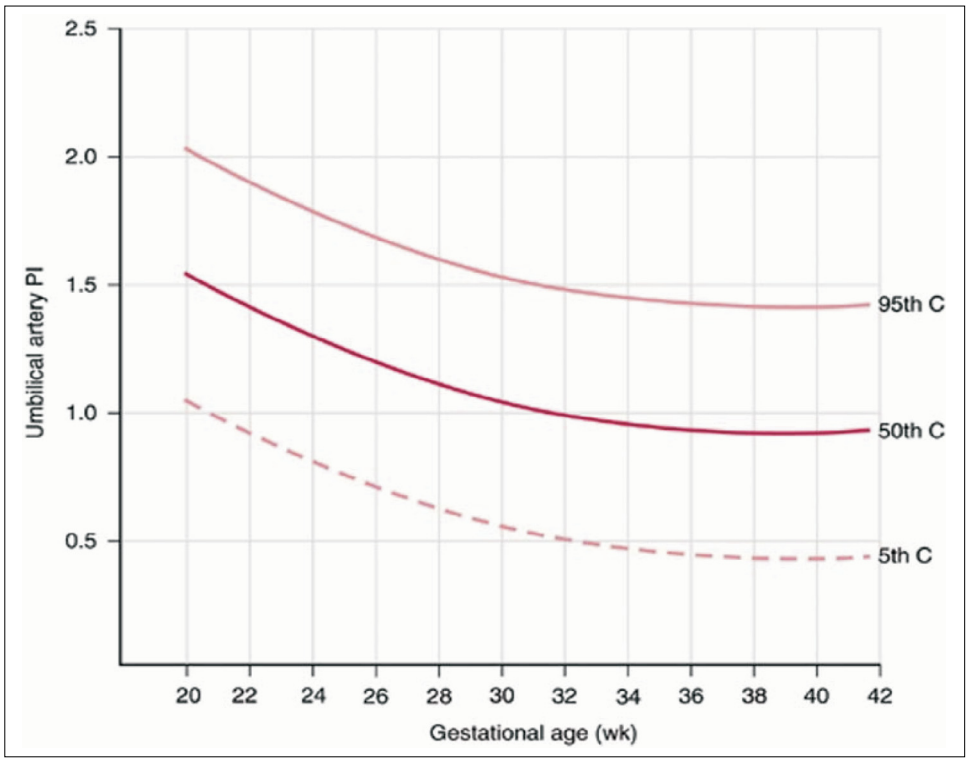
In normal pregnancy, the fetal umbilical circulation is characterized by continuous forward flow, i.e., low resistance, to the placenta, which improves with gestational age as primary, secondary, and tertiary branching of the villus vascular architecture continue to develop. Resistance to forward flow therefore continues to decrease in normal pregnancy all the way to term.[103,104] Increased resistance to forward flow in the umbilical circulation is characterized by abnormal systolic to diastolic ratio, pulsatility index (PI) or resistance index (RI) greater than the 95th centile and implies decreased functioning vascular units within the placenta (see Table 8).[8] Embolization experiments in the sheep placenta suggest that absent end-diastolic flow velocities are not achieved until more than 50% of functional will have been obliterated (Figure 4).[105–107]

A number of randomized trials using umbilical artery Doppler velocimetry to assess pregnancies at risk of placental insufficiency have demonstrated improved perinatal outcome when umbilical Doppler is used to assess fetal well-being. Furthermore, the Cochrane meta-analysis of randomized trials[108] on the use of umbilical artery Doppler in pregnancies with risk factors for adverse perinatal outcome demonstrates a clear reduction in perinatal mortality in

**Table 8. Indications for uterine artery Doppler at 17 to 22 weeks**

| | |
|---|---|
| Previous obstetrical history | • Previous early onset gestational hypertension<br>• Placental abruption<br>• Intrauterine growth restriction<br>• Stillbirth |
| Risk factors in current pregnancy | • Pre-existing hypertension<br>• Gestational hypertension<br>• Pre-existing renal disease<br>• Longstanding Type I diabetes with vascular complications, nephropathy, retinopathy<br>• Abnormal maternal serum screening (hCG or AFP > 2.0 MOM)<br>• Low PAPP-A (consult provincial lab for norms) |

**Figure 4. Umbilical artery pulsatility Index: 20 to 42 weeks.**




Umbilical artery pulsatility index (5th, 50th, and 95th percentiles) from a cross-sectional study of 1556 healthy pregnancies at 20 to 42 weeks' gestation. All fetuses were singletons, andgestational age was confirmed by early ultrasound measurements of crown-rump length. Recordings from umbilical artery were madein the absence offetal body breathing movements. The pulsatility index was calculated as (systolic velocity - diastolic velocity/mean velocity). This figure was published in High Risk Pregnancy: Management Options, 3rd edition. James et al. Copyright Elsevier (2006).

normally formed fetuses. This is the only form of fetal surveillance that has been shown to improve perinatal mortality in randomized controlled trials.

### Recommendation 6: Umbilical Artery Doppler

1. Umbilical artery Doppler should not be used as a screening tool in healthy pregnancies, as it has not been shown to be of value in this group (I-A).
2. Umbilical artery Doppler should be available for assessment of the fetal placental circulation in pregnant women with suspected placental insufficiency (I-A). Fetal umbilical artery Doppler assessment should be considered (1) at time of referral for suspected growth restriction, or (2) during follow-up for suspected placental pathology.
3. Depending on other clinical factors, reduced, absent, or reversed umbilical artery end-diastolic flow is an indication for enhanced fetal surveillance or delivery. If delivery is delayed to improve fetal lung maturity with maternal administration of glucocorticoids, intensive fetal surveillance until delivery is suggested for those fetuses with reversed end-diastolic flow (II-1B).

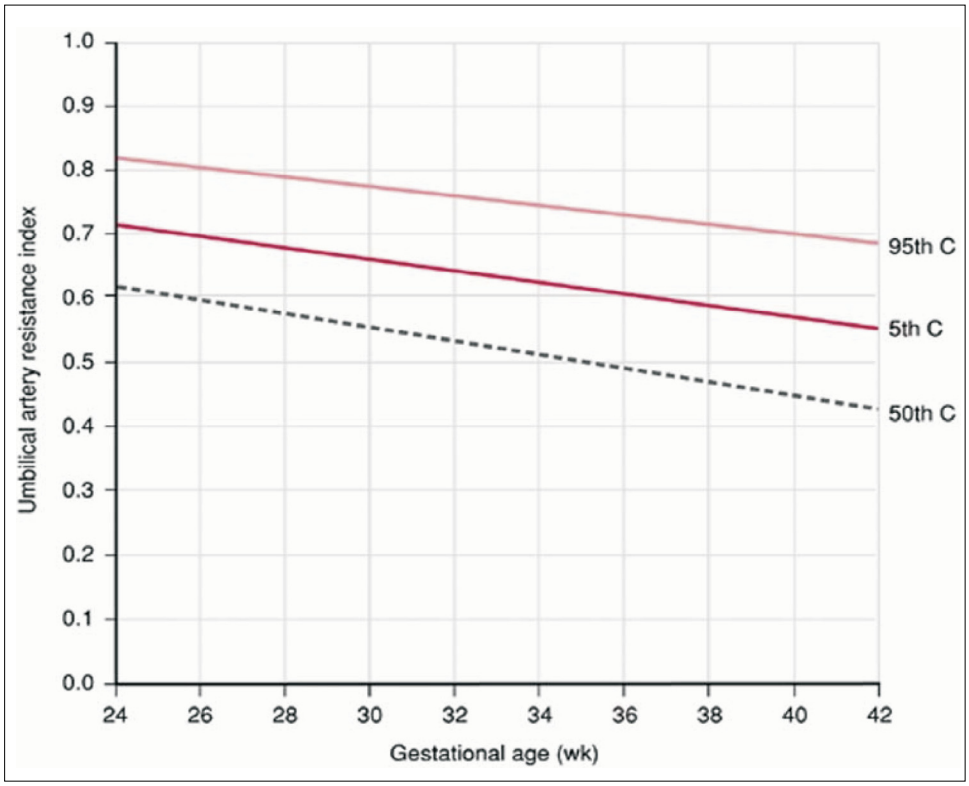
## 7. Other Fetal Artery Doppler Parameters When Doppler Expertise Is Available

### A. Progression of cardiovascular compromise in the fetus with intrauterine growth restriction

AEDF velocity in the umbilical artery is correlated with increasing impediment of flow towards the placenta and decreased number of functioning tertiary villi. This finding is also highly associated with PNM, fetal acidosis, and increased need for NICU admission.[109] It is recognized, however, that this finding may occur days to weeks prior to abnormalities found on other measures of fetal health (NST, BPP, CST) indicating urgent delivery. This is of major importance, especially in the circumstance of IUGR < 32 weeks' gestation, when preterm birth must be weighed against risks of intrauterine asphyxia in choosing timing of delivery.[105,106,109] Other Doppler parameters, particularly assessment of the central venous system, can better predict impending cardiac compromise and the need for delivery (Figure 5).[110–112]

Initially, as fetal hypoxemia develops, redistribution of blood flow occurs such that MCA resistance indices

**Figure 5. Umbilical artery resistance index: 24 to 42 weeks.**




Umbilical artery resistance index (5th , 50th, and 95th percentiles) from cross-sectional study of 1675 pregnancies at 24 to 42 weeks' gestation. Each fetus contributed only one measurement to the study. Signals were recorded from a free-floating loop in the middle of the umbilical cord. Resistance (Pourcelot) index was calculated as (systolic diastolic velocity/systolic velocity). This figure was published in High Risk Pregnancy: Management Options, 3rd edition. James et al. Copyright Elsevier (2006).

fall as umbilical arterial resistance increases, leading to the so-called "brain sparing" effect. Decreased cerebral impedance, like descending aorta impedance also leads to reversal of blood flow in the aortic isthmus. Changes in the cerebral flow parameters, however, do not correlate well with the final stages of asphyxic compromise and therefore are not helpful in choosing timing for delivery. Increased resistance in the umbilical arteries and descending aorta does lead, however, in an increase in right ventricular end-diastolic pressure (after load), leading to decreased right ventricular compliance and increased venous pressure in the right atrium and systemic veins. This can be detected using transtricuspid E/A (early and late diastolic filling) ratios, which increase with decreased ventricular compliance.[110–114]

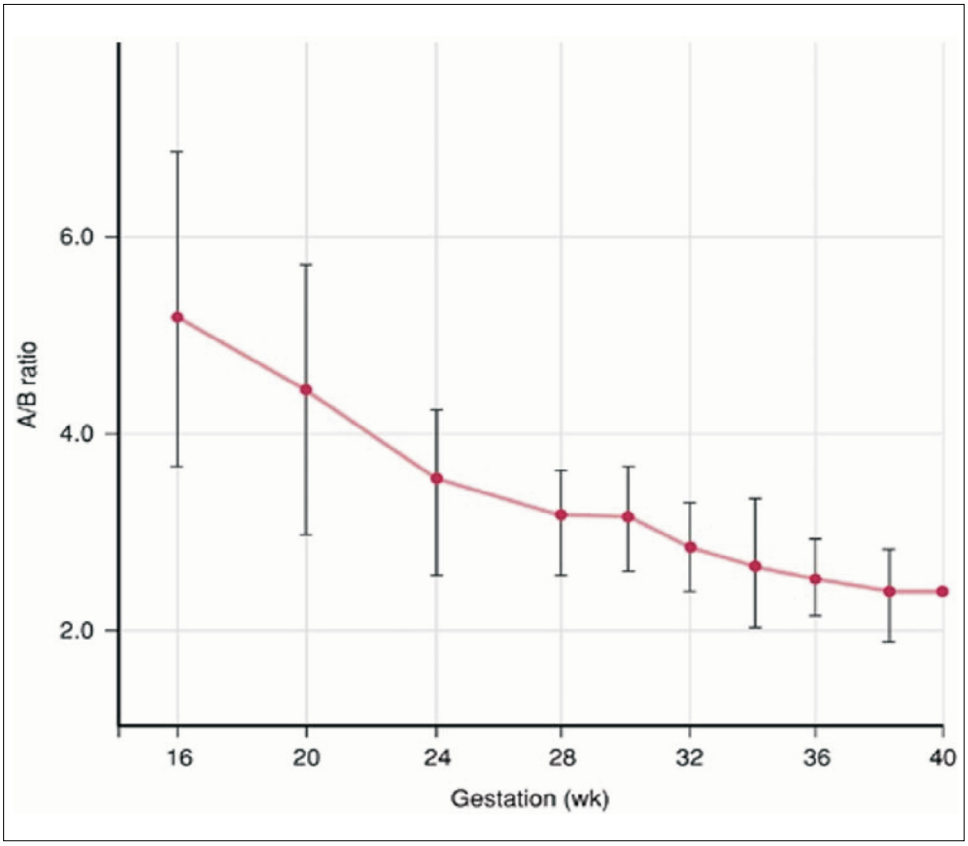
Further deterioration of right ventricular contractility will lead to right ventricular dilatation and tricuspid regurgitation (insufficiency), further exacerbating right atrial filling pressure and resistance to venous filling (Figure 6).

Resistance to venous filling is reflected best by increased pulsatility in the ductus venosus[115–118] during atrial contraction, a finding highly correlated with impending asphyxia and acidosis. Further increases in systemic venous pressures lead to maximum dilatation of the ductus venosus and direct transmission of cardiac impulses to the umbilical vein, causing umbilical venous pulsations. This finding is shown to be highly correlated with severe acidosis and impending fetal demise.

**B. Middle cerebral artery peak systolic velocity as a predictor of fetal anemia**

Many authors conclude that MCA PSV is highly correlated with severe fetal anemia (sensitivity as high as 100%).[119–125] An increase in the percentage of false-positive determinations in the range of 15% to 28% comes with moderate and milder degrees of anemia. In fetuses with non-immune hydrops or when prospectively following a fetus at risk of parvovirus B19-induced fetal anemia, MCA PSV serves as a useful measure of fetal anemia severe enough to require IUT.

**Figure 6. Systolic-to-diastolic ratio (A/B ratio).**




Systolic-to-diastolic ratio (A/B ratio) calculated from umbilical artery flow velocity waveforms (mean ± 2 SDs) obtained in a longitudinal study of 15 normal pregnancies. Study subjects were scanned every 2 weeks, from 24 to 28 weeks' gestation until delivery. Eight of the study subjects had been recuited at 16 weeks and were also scanned every 4 weeks throughtout the second trimester. In all subjects, gestational age was confirmed by ultrasound scanning 16 weeks' gestation. A range-gated pulsed Doppler beam was guided from the ultrasound image to insonate the umbilical artery. This figure was published in High Risk Pregnancy: Management Options, 3rd edition. James et al. Copyright Elsevier (2006).

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