

CLINICAL MONITORING OF PREGNANCY: MATERNAL–FETAL RISK ASSESSMENT, SCREENING, AND ANTENATAL MANAGEMENT

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ABSTRACT

Background. Antenatal care is a longitudinal clinical process in which maternal risk, fetal development, placental function, and pregnancy-specific complications must be reassessed as gestation progresses. A uniform schedule is insufficient for all pregnancies because risk evolves dynamically and may emerge after an apparently normal first assessment. **Objective.** To synthesize contemporary evidence on maternal–fetal risk stratification, prenatal screening, trimester-specific surveillance, and escalation of antenatal care, with emphasis on the distinction between screening, diagnostic testing, and fetal surveillance. **Methods.** A targeted evidence review was performed using PubMed/MEDLINE and official guideline repositories of the World Health Organization (WHO), American College of Obstetricians and Gynecologists (ACOG), Society for Maternal-Fetal Medicine (SMFM), International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), International Society for the Study of Hypertension in Pregnancy (ISSHP), National Institute for Health and Care Excellence (NICE), and American Diabetes Association (ADA). Priority was given to current clinical guidelines, systematic evidence syntheses, and landmark studies directly informing antenatal practice. Scopus and Web of Science were not directly queried; therefore, the review is narrative rather than systematic. **Main findings.** Effective pregnancy monitoring begins with accurate gestational dating, detailed medical and obstetric history, baseline laboratory assessment, and explicit identification of maternal, fetal, placental, and social risk. First-trimester care should establish viability, gestational age, multiplicity and chorionicity and offer aneuploidy screening and diagnostic options according to informed patient preference. The mid-trimester anatomical survey remains central to detection of structural anomalies, while later surveillance is individualized according to risks such as hypertensive disease, diabetes, fetal growth restriction, placental pathology, or multiple pregnancy. Cell-free DNA is a screening test rather than a diagnostic test; invasive testing remains necessary when diagnostic certainty is required. Fetal surveillance with cardiotocography, biophysical assessment, and Doppler velocimetry should be targeted to pregnancies in which the probability of fetal compromise is increased, rather than applied indiscriminately. **Conclusion.** High-quality antenatal care is best conceptualized as repeated risk reassessment linked to gestational-age-specific screening and proportionate escalation of surveillance. Integration of maternal clinical data, ultrasound findings, laboratory testing, supports timely referral and proportionate intervention.

Keywords: antenatal care; prenatal care; pregnancy monitoring; maternal–fetal medicine; risk assessment; prenatal screening; fetal surveillance; preeclampsia; gestational diabetes; fetal growth restriction.

INTRODUCTION

Antenatal care (ANC) is not a sequence of isolated visits but a structured continuum of prevention, screening, diagnosis, surveillance, communication, and preparation for birth. The WHO model emphasizes early entry into care and repeated contacts across pregnancy, while other systems use schedules adapted to parity, local organization, and individual risk. The common principle is that clinically meaningful contact should create an opportunity to detect new disease, reassess pre-existing conditions, monitor fetal development, and respond to emerging social or psychological needs [1,2].

Pregnancy produces major cardiovascular, hematologic, renal, metabolic, and endocrine adaptations. These physiologic changes can obscure early disease, alter laboratory reference ranges, and modify the clinical expression of chronic conditions. Simultaneously, placental and fetal disorders may become apparent only after a period of normal development. Consequently, maternal–fetal risk is dynamic. A person classified as low risk at booking may later develop hypertension, gestational diabetes mellitus (GDM), fetal growth restriction (FGR), placenta previa, reduced fetal movements, or another condition requiring intensified surveillance.

Modern antenatal monitoring therefore relies on risk stratification rather than uniform testing. The clinical task is to identify who benefits from a given screening or surveillance intervention, at what gestational age it should be performed, and what action should follow an abnormal result. This distinction is especially important in prenatal genetics: cell-free DNA (cfDNA) testing has high screening performance for common aneuploidies but is not equivalent to chorionic villus sampling (CVS) or amniocentesis, which are diagnostic procedures [3]. Similar principles apply to fetal surveillance: non-stress testing, biophysical assessment, and Doppler velocimetry should be used when a plausible risk of fetal compromise exists rather than as indiscriminate routine testing [10,11].

Ultrasound is central to this framework. First-trimester ultrasound supports accurate dating and assessment of early anatomy and multiplicity; the mid-trimester scan evaluates fetal structure and placental location; later ultrasound can assess fetal growth, amniotic fluid, placentation, and selected Doppler indices [4–7]. However, imaging is only one component of care. Blood pressure trajectories, metabolic screening, hematologic assessment, infection screening, medication review, and social determinants frequently modify management decisions.

The objective of this review is to critically synthesize contemporary approaches to maternal–fetal risk assessment, prenatal screening, and antenatal surveillance and to present a clinically coherent framework for individualized pregnancy management. Particular attention is given to first-, second-, and third-trimester assessment; hypertensive disorders; diabetes; fetal growth disorders; multiple pregnancy; fetal well-being surveillance; and red-flag findings that require urgent escalation.

MATERIALS AND METHODS

This article was prepared as an evidence-based narrative review rather than an original clinical investigation. No patient cohort, intervention dataset, or unpublished individual-level clinical data were used. A targeted literature and guideline search was performed up to 18 September 2026. PubMed/MEDLINE and the official repositories of WHO, ACOG, SMFM, ISUOG, ISSHP, NICE, and ADA were searched for documents addressing antenatal care, pregnancy risk assessment, prenatal genetic screening, obstetric ultrasound, hypertensive disorders, diabetes in pregnancy, fetal growth restriction, multiple pregnancy, preterm-birth risk assessment, placental disorders, anemia, Rh D alloimmunization, and fetal surveillance.

Search concepts included combinations of “antenatal care,” “prenatal care,” “maternal risk assessment,” “fetal risk assessment,” “aneuploidy screening,” “cell-free DNA,” “first-trimester ultrasound,” “fetal anomaly scan,” “preeclampsia,” “gestational hypertension,” “gestational diabetes,” “fetal growth restriction,” “Doppler,” “non-stress test,” “biophysical profile,” “short cervix,” “multiple pregnancy,” “chorionicity,” and “placenta accreta spectrum.” Priority was given to current professional guidelines and practice bulletins, followed by high-quality reviews and landmark studies that established important diagnostic or screening concepts. Older publications were retained when they remain foundational, such as the HAPO study and established FGR consensus definitions [9,20].

Inclusion favored human pregnancy evidence directly relevant to clinical monitoring and decision-making. Duplicate or superseded guidance, non-scientific websites, and publications without clear relevance to antenatal surveillance were excluded. Scopus, Web of Science, and the Cochrane Library were not directly searched in this preparation; consequently, the work should not be interpreted as a PRISMA-compliant systematic review. Recommendations are presented with attribution when major organizations differ, and local implementation should follow national regulation, laboratory availability, and the protocol of the receiving journal or institution.

INITIAL ANTENATAL ASSESSMENT AND BASELINE RISK STRATIFICATION

The booking encounter should establish a baseline against which subsequent change can be interpreted. Core elements include confirmation of pregnancy and estimated gestational age; gravidity and parity; prior miscarriage, stillbirth, preterm birth, fetal growth restriction, preeclampsia, gestational diabetes, congenital anomaly, operative delivery, and postpartum complications; and a detailed account of current symptoms. Previous placental disease is particularly relevant because recurrent placental dysfunction may manifest in a later pregnancy as hypertensive disease, FGR, or stillbirth risk.

Medical history should identify chronic hypertension, pregestational diabetes, renal disease, autoimmune disease, thyroid dysfunction, epilepsy, cardiovascular disease, hematologic disorders, thromboembolic history, obesity, and clinically significant psychiatric illness. Medication and supplement review is essential because pregnancy may change both the risk–benefit profile and

pharmacokinetics of treatment. The first visit should also record allergies and previous transfusion or alloimmunization history.

Family and genetic history should address known monogenic disease, chromosomal disorders, major congenital anomalies, recurrent unexplained pregnancy loss, and relevant carrier risks. Genetic screening options should be discussed in a non-directive manner. ACOG recommends that prenatal genetic screening and diagnostic testing options be discussed and offered to all pregnant patients regardless of age or baseline aneuploidy risk, with the patient retaining the right to accept or decline testing [3].

Risk assessment is incomplete without social and behavioral context. Tobacco, alcohol, recreational substances, nutrition, occupational exposure, barriers to transport, housing instability, intimate partner violence, and difficulty accessing care may materially alter pregnancy risk. These factors should not be treated as static labels; they require reassessment because circumstances can change substantially during pregnancy [1,2].

Baseline examination ordinarily includes blood pressure measured with appropriate technique, height and weight for body mass index calculation, and focused physical examination guided by history. Obesity is associated with increased obstetric complexity and should prompt attention to blood-pressure measurement quality, metabolic risk, thromboembolic risk, anesthesia planning, and technical limitations of imaging without stigmatizing communication [29].

BASELINE LABORATORY AND INFECTION SCREENING

Baseline laboratory testing should be individualized to jurisdiction but usually includes complete blood count, ABO and Rh D typing, red-cell antibody screening, and urine assessment. Anemia in pregnancy is common and iron deficiency is a leading cause; low hemoglobin should trigger etiologic evaluation rather than automatic attribution to physiologic hemodilution [28]. In Rh D-negative patients without pre-existing anti-D alloimmunization, antenatal and postpartum prophylaxis is guided by local protocols and fetal/newborn Rh status or validated fetal genotyping where available [26].

Universal or near-universal infection screening commonly includes HIV, syphilis, and hepatitis B; hepatitis C screening is increasingly recommended in many jurisdictions. Exact timing and repeat-testing policies vary by country, prevalence, and individual risk. Screening is clinically useful only when linked to prevention of vertical transmission, maternal treatment, neonatal prophylaxis, or delivery planning. Viral hepatitis in pregnancy requires type-specific management and should not be reduced to a generic 'liver test' strategy [27].

Urine culture or validated screening for asymptomatic bacteriuria is recommended in many antenatal systems because untreated bacteriuria can progress to pyelonephritis and is associated with adverse obstetric outcomes. Thyroid testing is generally risk based rather than universally mandated by all professional bodies. Early glucose assessment is appropriate for patients with substantial risk of previously unrecognized diabetes; routine GDM screening for those not

previously diagnosed is generally performed later in pregnancy, with criteria differing across professional organizations [17–19].

MATERNAL–FETAL RISK ASSESSMENT

A practical risk model separates maternal, obstetric, fetal/placental, and social domains. Maternal factors include age extremes, obesity, chronic hypertension, diabetes, renal disease, autoimmune disease, cardiac disease, and clinically important hematologic disorders. Obstetric-history factors include previous severe preeclampsia, spontaneous preterm birth, stillbirth, recurrent FGR, major postpartum hemorrhage, uterine surgery, and cesarean delivery. Current-pregnancy factors include multiple gestation, fetal anomaly, placental abnormalities, abnormal fetal growth, abnormal fluid volume, hypertensive disease, and diabetes.

Risk stratification must be repeated, not merely recorded once. New hypertension, progressive proteinuria, falling platelet count, rising liver enzymes, slowed fetal growth, oligohydramnios, altered Doppler flow, or reduced fetal movement can change the surveillance pathway within days. Conversely, an isolated historical risk factor does not necessarily justify every available test. The intensity of follow-up should reflect the estimated mechanism and magnitude of risk, evidence that surveillance can identify deterioration, and the existence of an intervention that can improve outcome.

High-risk designation should trigger a defined plan rather than a vague label. The plan should specify the maternal variables to follow, fetal parameters to assess, the responsible clinician or service, warning symptoms requiring unscheduled review, and thresholds for referral or delivery planning. This approach is especially important when care is shared between primary obstetric services and maternal–fetal medicine.

FIRST-TRIMESTER SCREENING

First-trimester ultrasound has multiple roles: confirmation of intrauterine pregnancy, viability, accurate dating, identification of multiple pregnancy, determination of chorionicity and amnionicity, and early assessment of fetal anatomy. ISUOG guidance places the routine 11–14-week scan within a broader evaluation rather than limiting it to nuchal translucency measurement [4]. Accurate early dating is clinically important because later interpretation of fetal growth depends on a reliable gestational-age reference [7].

Aneuploidy screening should be offered after counseling that distinguishes probability estimation from diagnosis. Available strategies include serum-based screening with or without nuchal translucency and cfDNA testing. ACOG identifies cfDNA as the most sensitive and specific screening test for the common fetal aneuploidies but explicitly states that it can yield false-positive and false-negative results and is not diagnostic [3]. A positive screening result should therefore lead to genetic counseling, targeted ultrasound as appropriate, and discussion of diagnostic testing rather than irreversible management based on screening alone.

CVS and amniocentesis provide diagnostic fetal genetic material but are invasive and require informed discussion of indications, timing, technical considerations, and procedure-related risks. Diagnostic testing may be preferred when ultrasound reveals a structural anomaly, when screening risk is high, or when the patient prioritizes diagnostic certainty.

Risk assessment for preeclampsia begins in the first trimester. Traditional clinical-factor approaches identify patients who may benefit from low-dose aspirin prophylaxis, while some systems use combined algorithms incorporating maternal characteristics, mean arterial pressure, uterine artery Doppler, and biochemical markers. Evidence from the ASPRE program showed that a multimarker strategy linked to aspirin prophylaxis can reduce preterm preeclampsia in a defined high-risk population, but implementation depends on local infrastructure and guideline choice [16]. ACOG/SMFM and NICE both recommend aspirin for patients meeting specified risk criteria, although dose ranges and selection algorithms differ [15,31].

SECOND-TRIMESTER MATERNAL AND FETAL ASSESSMENT

The routine mid-trimester ultrasound scan is primarily an anatomical survey and also documents fetal biometry, placental location, and amniotic fluid. ISUOG recommends standardized assessment because detection depends on image quality, gestational age, fetal position, equipment, and operator expertise [5]. A normal structural survey substantially reduces but does not eliminate the possibility of congenital anomaly; counseling should avoid implying that ultrasound is a comprehensive genetic test.

Cervical-length assessment is useful for selected preterm-birth risk pathways. Transvaginal cervical length is the standard technique when measurement is used to guide management. SMFM recommends a threshold of ≤ 25 mm to define a short cervix in an asymptomatic singleton pregnancy without previous spontaneous preterm birth and provides management recommendations stratified by cervical length [24]. ISUOG similarly emphasizes standardized ultrasound methods and the differing implications of screening in asymptomatic and symptomatic populations [23]. Whether a universal screening program is adopted depends on local resources and policy.

GDM screening is commonly performed at 24–28 weeks in individuals without known pregestational diabetes, but diagnostic pathways vary. ADA, ACOG, and NICE differ in details of early testing, one-step versus two-step strategies, and thresholds [17–19,32]. The HAPO study demonstrated continuous associations between maternal glycemia and adverse pregnancy outcomes rather than a single biologic threshold, which helps explain why professional organizations can use different operational criteria [20].

Maternal hematologic reassessment is also important in mid-pregnancy. Hemoglobin may decline physiologically, yet iron deficiency should be considered when anemia is present, particularly with poor dietary iron intake, multiple pregnancy, closely spaced pregnancies, or prior anemia. Ferritin is useful when the diagnosis is uncertain or when treatment response is inadequate. The goal is

not simply normalization of a laboratory number but correction of clinically meaningful deficiency and preparation for expected blood loss at delivery [28].

THIRD-TRIMESTER ANTENATAL SURVEILLANCE

Third-trimester care combines maternal review with selective fetal assessment. Blood pressure and symptoms suggestive of preeclampsia should be reassessed at each appropriate encounter. New headache, visual disturbance, epigastric or right-upper-quadrant pain, dyspnea, rapidly progressive edema with other concerning features, or severe hypertension warrants prompt evaluation. Patients with diabetes require review of glycemic control, treatment tolerance, fetal growth, and complications associated with either hyperglycemia or vascular disease [13,17].

Clinical assessment of fetal growth commonly includes symphysis–fundal height in appropriate singleton pregnancies, with ultrasound performed when size is abnormal, measurement is unreliable, or risk factors justify serial assessment. Ultrasound biometry typically includes head circumference, abdominal circumference, and femur length, from which estimated fetal weight is calculated. Growth is a longitudinal concept: a single size measurement cannot fully characterize growth trajectory [7].

Third-trimester ultrasound should not be treated as a universal substitute for clinical assessment. ISUOG guidance describes indications and standardized components of late ultrasound, including fetal presentation, biometry, placental location, amniotic fluid, and selected assessment of anatomy and Doppler where indicated [6]. Routine use in a low-risk population is determined by local policy, whereas serial ultrasound is clearly appropriate in many high-risk pregnancies.

Placental location should be reassessed when previa or low-lying placenta has been identified earlier. Patients with prior cesarean delivery and placenta previa or other risk factors for placenta accreta spectrum require targeted evaluation and referral when suspicion is raised, because antenatal recognition allows planned multidisciplinary delivery in an appropriately resourced center [25].

FETAL GROWTH RESTRICTION: DETECTION AND SURVEILLANCE

Small-for-gestational-age (SGA) and fetal growth restriction are related but not synonymous. SGA describes size, whereas FGR implies failure to achieve growth potential and is often associated with placental dysfunction. Consensus frameworks incorporate fetal size together with growth trajectory and Doppler abnormalities, particularly for late-onset disease [9]. SMFM uses an operational definition of estimated fetal weight or abdominal circumference below the 10th percentile and recommends standardized population-based references for clinical management [8].

Once FGR is diagnosed, the surveillance question shifts from detection to evidence of deterioration. Umbilical artery Doppler is central because elevated resistance and absent or reversed end-diastolic flow reflect increasing placental vascular compromise. SMFM recommends

serial umbilical artery Doppler, with frequency increased when diastolic flow is reduced or absent/reversed, and cardiotocographic surveillance after viability according to severity and comorbidity [8].

International practice is not completely uniform regarding the routine use of middle cerebral artery, cerebroplacental ratio, or ductus venosus Doppler in all FGR phenotypes. Some fetal-medicine protocols use additional Doppler information, especially in early-onset severe disease, while SMFM does not recommend MCA, ductus venosus, or uterine artery Doppler for routine management of every FGR case [8]. Therefore, the manuscript distinguishes foundational surveillance from center-specific advanced protocols.

Early-onset unexplained FGR, especially when associated with fetal anomaly or polyhydramnios, should prompt consideration of fetal diagnostic testing because genetic or infectious etiologies may be relevant. Conversely, broad maternal infection panels without clinical indication are not supported solely because FGR is present [8].

HYPERTENSIVE DISORDERS AND PREECLAMPSIA SURVEILLANCE

Hypertensive disorders include chronic hypertension, gestational hypertension, preeclampsia, and chronic hypertension with superimposed preeclampsia. Contemporary definitions emphasize that preeclampsia is a multisystem disorder and can be diagnosed in the absence of proteinuria when other qualifying maternal organ dysfunction is present [12,13]. Severe blood pressure elevation is itself clinically important because of maternal stroke risk and the need for urgent treatment.

Evaluation of suspected preeclampsia includes repeated accurate blood-pressure measurement, assessment of symptoms, quantification of proteinuria when indicated, complete blood count with platelet count, renal function, and liver enzymes, together with fetal assessment appropriate to gestational age and disease severity. ISSHP and ACOG provide closely aligned but not identical diagnostic and management frameworks; local protocols should specify thresholds and treatment pathways [12,13].

Prevention is risk based. ACOG/SMFM recommends low-dose aspirin for patients at high risk of preeclampsia and consideration in those with multiple moderate-risk factors, beginning in the late first trimester; NICE uses a dose range of 75–150 mg from 12 weeks for defined risk groups [15,31]. The exact dose should therefore be stated with the guideline context rather than represented as a universal standard.

Patients with chronic hypertension require surveillance for superimposed preeclampsia and fetal growth abnormalities. Treatment thresholds and targets have evolved, and current practice should follow the most recent national or institutional guidance. Importantly, fetal testing frequency is determined not only by the diagnostic label but by blood-pressure control, medication use, renal disease, fetal growth, and other comorbidities [14].

GESTATIONAL DIABETES MELLITUS AND METABOLIC MONITORING

GDM is clinically important because maternal hyperglycemia is associated with fetal overgrowth, neonatal metabolic complications, hypertensive disease, and future maternal metabolic risk. The relationship between glycemia and outcome is continuous, which means diagnostic thresholds are pragmatic clinical cut points rather than a single natural boundary [20].

ADA 2026 recommends testing for undiagnosed diabetes or abnormal glucose metabolism early in pregnancy when risk is present and screening for GDM at 24–28 weeks in those not previously diagnosed [17]. ACOG updated its guidance in 2024 while retaining a framework that may differ from the one-step 75-g oral glucose tolerance approach used in other systems [18,19]. NICE also uses its own criteria and treatment pathway [32]. These differences should be acknowledged explicitly in multinational or OAK-facing publications rather than silently combining thresholds.

After diagnosis, antenatal monitoring includes review of fasting and postprandial glucose, nutrition, physical activity, pharmacotherapy when required, and fetal growth. Pregestational diabetes generally requires more intensive multidisciplinary follow-up than uncomplicated diet-controlled GDM because maternal vascular disease, congenital anomaly risk, and late fetal complications may be greater. ADA recommends interprofessional care for pre-existing diabetes where available [17,30].

MULTIPLE PREGNANCY

Multiple pregnancy should be characterized early because chorionicity, not merely fetal number, determines several major risks. In twin pregnancy, first-trimester ultrasound should establish chorionicity and amnionicity and assign consistent fetal labels. Monochorionic pregnancies require more intensive ultrasound surveillance because they are susceptible to complications of a shared placenta, including twin-to-twin transfusion syndrome (TTTS) and selective fetal growth restriction [21,22,33].

Dichorionic diamniotic twins, monochorionic diamniotic twins, and monochorionic monoamniotic twins therefore follow different surveillance pathways. Updated ISUOG guidance addresses diagnosis, growth discordance, TTTS, twin anemia–polycythemia sequence, and referral to fetal therapy services where appropriate [22]. NICE similarly specifies early chorionicity assessment and specialist multidisciplinary care for twin and triplet pregnancy [33].

Fetal growth should be assessed serially in multiple gestation, but interpretation must consider chorionicity and intertwin discordance. A meaningful discordance combined with a small fetus may indicate selective FGR. Monoamniotic pregnancy and complicated monochorionic pregnancy warrant tertiary-level individualized management because risk cannot be addressed adequately through a routine singleton schedule.

FETAL WELL-BEING SURVEILLANCE

Antenatal fetal surveillance is intended to identify fetuses at increased risk of decompensation or stillbirth in time to modify management. Common tools include maternal awareness of fetal movement, non-stress testing/cardiocotography, biophysical profile, amniotic fluid assessment, and Doppler velocimetry. None should be interpreted in isolation from gestational age, maternal disease, fetal growth, or the pretest probability of compromise [10,11].

ACOG notes that evidence supporting surveillance is not equally strong for every condition associated with stillbirth and therefore frames many recommendations as suggestions rather than absolute mandates [10]. This is clinically important: excessive surveillance in a low-risk pregnancy can generate false-positive results, anxiety, additional imaging, and iatrogenic early delivery without demonstrated benefit.

Reduced fetal movement should prompt timely clinical assessment because it can be associated with fetal compromise, but there is no single universal movement-count threshold that replaces clinical judgment. When surveillance is indicated, the choice and frequency of testing should be matched to the underlying risk. FGR with abnormal umbilical artery Doppler, for example, requires a different intensity of monitoring than well-controlled diet-managed GDM without additional complications.

SCREENING, DIAGNOSTIC TESTING, AND SURVEILLANCE: CONCEPTUAL DISTINCTIONS

Three concepts must remain separate. Screening estimates risk or identifies a subgroup requiring further evaluation. Diagnostic testing establishes or excludes a condition with substantially greater certainty. Surveillance monitors an already identified or plausible risk over time. Confusion between these categories can lead to inappropriate reassurance or unnecessary intervention.

Examples are clinically instructive. cfDNA is screening for common fetal aneuploidies, whereas CVS or amniocentesis with appropriate genetic analysis is diagnostic [3]. The mid-trimester anomaly scan is structural screening rather than a guarantee of normal fetal development [5]. Serial fetal biometry is surveillance of growth, while umbilical artery Doppler evaluates aspects of placental–fetal circulation and is especially relevant once FGR is suspected or diagnosed [8].

Cardiocotography is a surveillance tool; a reactive tracing is reassuring for the period assessed but does not prove absence of every fetal disorder.

Counseling should explicitly describe these differences. Patients should understand what a test can detect, what it can miss, the chance of false-positive or uncertain results, and what the next step will be after an abnormal result. This is central to shared decision-making and reduces the risk that screening becomes de facto diagnosis.

ANTENATAL MANAGEMENT OF HIGH-RISK PREGNANCY

High-risk pregnancy management requires escalation of expertise and monitoring rather than a simple increase in visit count. Chronic hypertension, pregestational diabetes, significant renal or cardiac disease, autoimmune disease, severe obesity with comorbidity, recurrent major placental disease, fetal anomaly, multiple pregnancy, placenta accreta spectrum, and severe FGR are common reasons for maternal–fetal medicine involvement. Referral should occur early enough to influence surveillance and delivery planning rather than only after acute deterioration.

Multidisciplinary care is particularly important when maternal disease may worsen during pregnancy or affect delivery. Cardiology, nephrology, endocrinology, hematology, genetics, neonatology, anesthesiology, and fetal therapy services may be needed depending on the case. The care plan should define responsibility for medication adjustment, laboratory monitoring, fetal surveillance, and postpartum transition.

Placenta accreta spectrum illustrates the value of anticipatory referral. Risk factors and targeted ultrasound can raise suspicion before delivery; outcomes are improved when birth is planned in a center with experienced obstetric, anesthesia, surgical, neonatal, and transfusion support [25]. Similar logic applies to severe early FGR, complicated monochorionic twins, and significant maternal cardiac disease.

ANTENATAL VISIT SCHEDULE AND CONTINUITY OF CARE

There is no single globally universal visit schedule. WHO recommends a minimum of eight contacts, beginning in the first 12 weeks, within a model designed to improve maternal experience and opportunities for complication detection [1]. NICE uses a different routine appointment structure, with booking by approximately 10 weeks and a schedule modified by parity and need [2]. These models should not be interpreted as conflicting evidence that one exact number is mandatory in every health system.

The more important principle is continuity linked to clinical content. Every contact should have a purpose: symptom review, blood-pressure assessment, laboratory or screening follow-up, fetal growth or movement review, counseling, vaccination or prevention measures, birth planning, or management of an identified condition. High-risk pregnancy requires additional or longer contacts determined by the mechanism and severity of risk.

Digital reminders and telehealth can support continuity but should not replace examination or testing that requires in-person assessment. Remote blood-pressure or glucose monitoring may be useful when embedded in a system with defined thresholds and clinical response.

ANTENATAL RED FLAGS REQUIRING URGENT ASSESSMENT

- Vaginal bleeding, particularly when heavy, recurrent, associated with pain, or occurring in a patient with known placenta previa or suspected placental pathology.

- Severe or sudden abdominal/pelvic pain, persistent uterine tenderness, or symptoms suggestive of placental abruption, uterine rupture, torsion, or another acute abdominal process.
- Severe hypertension or symptoms compatible with severe preeclampsia, including persistent severe headache, visual disturbance, epigastric/right-upper-quadrant pain, dyspnea, or neurologic symptoms.
- Seizure, syncope, chest pain, severe dyspnea, hemoptysis, unilateral leg swelling/pain, or other features concerning for thromboembolism or major cardiopulmonary disease.
- Suspected rupture of membranes, regular painful contractions before term, or significant pelvic pressure with preterm-birth risk.
- Fever with systemic illness, flank pain, or symptoms suggesting sepsis or pyelonephritis.
- Marked reduction or cessation of usual fetal movement after the gestation at which movement is normally perceived.
- Symptoms or findings suggesting acute fetal compromise, severe FGR deterioration, or abnormal antenatal testing.
- Significant trauma, especially with abdominal impact, bleeding, pain, or reduced fetal movement.

CLINICAL ALGORITHM FOR ANTENATAL MONITORING

1. Confirm pregnancy location/viability when clinically indicated and establish the best obstetric estimate of gestational age, preferentially using reliable early ultrasound when available.
2. Perform structured maternal, obstetric, medication, genetic, behavioral, and social risk assessment; record baseline blood pressure, body mass index, and relevant examination findings.
3. Complete baseline laboratory and infection screening according to national policy, including blood group/Rh D status, antibody screen, complete blood count, and urine testing; add risk-based tests as indicated.
4. Offer first-trimester genetic screening and diagnostic options with non-directive counseling; determine chorionicity/amnionicity in multiple pregnancy.
5. Assign a provisional low-risk or high-risk pathway, but explicitly schedule repeated risk reassessment rather than treating the classification as permanent.
6. Complete the mid-trimester structural survey; evaluate cervical length when indicated; screen for GDM at the appropriate gestational window according to the selected guideline.

7. During the third trimester, reassess maternal blood pressure, symptoms, fetal growth, fetal movement, placental location, and disease-specific parameters. Use serial ultrasound when risk factors justify it.
8. If FGR, hypertension, diabetes, placental disease, fetal anomaly, or multiple-pregnancy complications emerge, escalate surveillance and refer to maternal–fetal medicine or another relevant specialty.
9. Use fetal surveillance tests only when the risk profile justifies them and define in advance what abnormal results will trigger repeat testing, hospitalization, corticosteroids, transfer, or delivery.
10. Develop individualized delivery planning that incorporates gestational age, maternal condition, fetal status, placentation, presentation, prior uterine surgery, neonatal resources, and patient preferences.

Table 1. Maternal and Fetal Risk Factors in Pregnancy

Risk category	Examples	Clinical significance	Recommended monitoring
Maternal medical	Chronic hypertension, diabetes, renal/autoimmune/cardiac disease, obesity	Higher risk of hypertensive, metabolic, thrombotic or placental complications	Disease-specific clinical/laboratory review; fetal growth surveillance when indicated; specialist care for significant disease
Obstetric history	Previous preeclampsia, stillbirth, spontaneous preterm birth, FGR, recurrent loss, cesarean delivery	Recurrence risk or altered placental/uterine risk	Early risk plan; prevention when indicated; targeted ultrasound and later surveillance based on prior phenotype
Current fetal/placental	FGR, anomaly, abnormal fluid, placenta previa/accreta suspicion	Risk of fetal compromise, hemorrhage, preterm birth or need for specialized delivery	Serial ultrasound, Doppler or fetal testing as appropriate; referral and delivery planning
Multiple pregnancy	Dichorionic or monochorionic twins; higher-order gestation	Higher preterm, growth and chorionicity-specific risk	Determine chorionicity early; serial growth; monochorionic-specific surveillance; tertiary referral for complications
Social/behavioral	Smoking, alcohol/substance use, violence, poor access, unstable housing	May increase direct obstetric risk and reduce adherence/access	Repeated assessment, supportive intervention, social services, addiction or mental-health referral where needed

Table 2. Major Screening and Surveillance Investigations During Pregnancy

Gestational period	Test / assessment	Purpose	Main limitations / follow-up
Booking / early pregnancy	CBC, ABO/Rh D, antibody screen, infection screening, urine testing	Establish maternal baseline and identify treatable disease	Exact panel varies by jurisdiction; positive results require disease-specific follow-up
11–14 weeks	First-trimester ultrasound	Dating, viability, multiplicity/chorionicity, early anatomy	Operator and gestational-age dependent; does not exclude all anomalies

Gestational period	Test / assessment	Purpose	Main limitations / follow-up
First trimester onward	Aneuploidy screening (e.g., cfDNA or serum/NT strategy)	Estimate risk of common chromosomal abnormalities	Screening is not diagnostic; positive results need counseling and diagnostic options
18–22 weeks (typical)	Detailed structural ultrasound	Screen for major fetal anomalies; placental location; biometry	Detection varies by anomaly, fetal position, equipment and expertise
24–28 weeks (common window)	GDM screening	Detect gestational hyperglycemia	One-step/two-step methods and thresholds vary among guidelines
Third trimester, selected patients	Growth ultrasound ± fluid assessment ± Doppler	Assess growth trajectory and placental-fetal function	Should be risk based; isolated size does not equal FGR
When risk warrants	NST/CTG or biophysical assessment	Surveillance for fetal decompensation	False positives occur; not proven beneficial for every risk condition

Table 3. Fetal Surveillance Methods

Method	Main indication	What it evaluates	Strengths	Limitations
Maternal fetal-movement awareness	Broadly applicable; urgent assessment if movements markedly reduced	Maternal perception of fetal activity	Accessible and patient-centered	No universal count threshold; subjective variation
Non-stress test / CTG	Selected high-risk pregnancies	Fetal heart-rate reactivity and patterns	Widely available; noninvasive	False positives; interpretation and timing matter
Biophysical profile	When additional fetal assessment is required	Fetal breathing, movement, tone, fluid, and CTG component	Combines acute and chronic markers	Resource intensive; management thresholds depend on context
Ultrasound biometry	Risk of abnormal fetal growth	Fetal size and interval growth	Essential for FGR/macrosomia evaluation	Measurement error; growth needs serial assessment
Amniotic fluid assessment	Suspected placental dysfunction, rupture, diabetes, fetal anomaly	Amniotic fluid volume	Useful adjunct	Abnormality is nonspecific
Umbilical artery Doppler	FGR/placental insufficiency	Placental vascular resistance and fetal exposure to impaired placental flow	Strong role in FGR surveillance	Requires standardized technique; not a universal screening test
MCA / CPR / ductus venosus Doppler	Selected fetal-medicine indications	Cerebral redistribution or advanced hemodynamic adaptation	Can refine specialist assessment	Role differs by phenotype and guideline; not routine for every pregnancy

Table 4. Selected High-Risk Conditions and Antenatal Monitoring

Condition	Maternal monitoring	Fetal monitoring	Specialist involvement	Key risks
Chronic hypertension / preeclampsia risk	BP, symptoms, CBC/platelets, renal and liver tests when indicated	Growth ultrasound and fetal surveillance according to disease severity	Obstetrics/MFM; internal medicine as needed	Severe hypertension, organ dysfunction, FGR, placental abruption
Pregestational diabetes	Glucose profile/CGM as appropriate, renal/retinal assessment, medication review	Anatomy and growth surveillance; later testing based on disease severity	MFM/obstetrics + endocrinology/diabetes team	Congenital anomaly risk, preeclampsia, macrosomia/FGR, stillbirth

Condition	Maternal monitoring	Fetal monitoring	Specialist involvement	Key risks
Gestational diabetes	Glucose monitoring and treatment response	Growth assessment and fetal testing according to control/therapy and comorbidity	Obstetrics; diabetes team if treatment complex	Fetal overgrowth, polyhydramnios, hypertensive disease
Fetal growth restriction	Maternal disease assessment; preeclampsia surveillance	Serial growth, fluid, umbilical artery Doppler, CTG/NST according to severity	MFM for early/severe or abnormal Doppler disease	Absent/reversed end-diastolic flow, worsening testing, severe early FGR
Monochorionic twins	Maternal routine assessment plus preterm-birth vigilance	Serial ultrasound for TTTS/TAPS, growth and discordance	Fetal medicine/MFM	TTTS, selective FGR, monoamniocity, major discordance
Placenta previa / accreta spectrum suspicion	Bleeding history, anemia preparedness, surgical risk assessment	Targeted placental imaging	MFM; experienced accreta multidisciplinary center when suspected	Bleeding, labor, high suspicion of invasive placentation

DISCUSSION

The central finding of this review is that high-quality antenatal monitoring is a process of repeated risk reassessment rather than a fixed checklist. The WHO eight-contact framework and NICE parity-based schedules differ operationally, yet both emphasize early booking and adaptation to individual need [1,2]. A visit has limited value if risk factors are not actively reassessed or if abnormal findings are recorded without a defined response pathway.

Risk stratification is strongest when it links a plausible mechanism to an actionable surveillance strategy. Chronic hypertension is associated with superimposed preeclampsia and placental dysfunction; diabetes may produce fetal overgrowth but vascular disease can also contribute to growth restriction; monochorionic placentation creates vascular complications unique to shared placental circulation. These mechanisms justify different combinations of maternal laboratory testing, ultrasound, Doppler, and cardiotocography. By contrast, indiscriminate application of all tests to low-risk pregnancy increases the probability of false-positive results and iatrogenic intervention.

Prenatal genetic screening illustrates the broader problem of test interpretation. cfDNA has excellent performance for common trisomies, but it remains a screening modality because placental mosaicism, low fetal fraction, maternal factors, and other biological mechanisms can create discordant results. A positive screen should therefore initiate a diagnostic pathway rather than function as a final diagnosis [3]. This conceptual discipline should extend to all antenatal testing.

Ultrasound quality is another determinant of effectiveness. Standardized first-, second-, and third-trimester protocols improve reproducibility, but imaging sensitivity is constrained by gestational age, maternal habitus, fetal position, equipment, and operator skill [4–7]. A 'normal scan' should be communicated as a risk-reducing observation within the limits of the examination, not as proof of complete fetal normality.

FGR remains diagnostically challenging because fetal size is an imperfect surrogate for placental function. A constitutionally small fetus may be healthy, while a fetus above the 10th percentile may experience pathologic slowing of growth. Consensus criteria and Doppler assessment help distinguish these states, but professional guidelines differ in the weight given to MCA or cerebroplacental ratio, particularly in late-onset disease [8,9]. This heterogeneity should be acknowledged rather than obscured by a single oversimplified algorithm.

Hypertensive disease similarly requires integration rather than reliance on proteinuria alone. ISSHP and ACOG recognize multisystem manifestations of preeclampsia [12,13]. The clinical implication is that a patient with new hypertension plus thrombocytopenia, renal dysfunction, liver involvement, pulmonary edema, or neurologic symptoms may have preeclampsia even if proteinuria is absent. Conversely, proteinuria without the broader clinical context should not be used as the sole marker of severity.

Guideline variability is particularly visible in GDM. Differences in early testing, oral glucose challenge strategy, diagnostic thresholds, and pharmacotherapy are not necessarily evidence of poor-quality guidance; they reflect divergent weighting of outcome data, feasibility, and health-system resources. International manuscripts should identify which criteria are being used. Combining thresholds from different organizations can create internally inconsistent methods [17–20,32].

Resource-limited settings require prioritization rather than abandonment of evidence-based care. Accurate blood-pressure measurement, careful history, basic laboratory testing, reliable gestational dating, a competent anomaly scan, recognition of FGR, and timely referral often provide more benefit than low-yield advanced testing without follow-up capacity. When cfDNA, advanced Doppler, fetal MRI, or fetal therapy are unavailable, referral networks and explicit escalation criteria become even more important.

Continuity of care is also a safety intervention. Results must be reviewed, communicated, and incorporated into the next decision. A normal early screen does not eliminate later placental disease; a reassuring cardiotocogram does not permanently exclude fetal deterioration; and a diagnosis of GDM or hypertension is clinically incomplete unless follow-up, treatment targets, and fetal assessment plans are specified. Antenatal care therefore depends on information continuity as much as on the individual tests themselves.

The principal limitation of this review is its narrative methodology. Although major guideline repositories and PubMed/MEDLINE were searched and current authoritative documents were prioritized, the review did not use a registered protocol, duplicate screening, formal risk-of-bias assessment, or a complete Scopus/Web of Science/Cochrane search. The conclusions should therefore be interpreted as an evidence-informed clinical synthesis rather than a systematic-review estimate of comparative effectiveness.

PRACTICAL IMPLICATIONS FOR CLINICAL PRACTICE

- Book antenatal care early enough to establish reliable gestational age and identify modifiable maternal risks before complications emerge.
- Treat risk classification as dynamic. Reassess maternal disease, blood pressure, fetal growth, placental findings, and social context throughout pregnancy.
- Use one coherent prenatal aneuploidy screening strategy and explain that cfDNA is screening, not diagnosis.
- Ensure a standardized mid-trimester anatomical survey and establish a referral pathway when the examination is incomplete or abnormal.
- Apply GDM criteria from a clearly identified guideline; do not mix one-step and two-step thresholds within the same diagnostic pathway.
- Use low-dose aspirin only when evidence-based risk criteria are met and state the guideline context for the selected dose and timing.
- Distinguish SGA from FGR and use umbilical artery Doppler as a core surveillance tool after FGR is diagnosed.
- Determine chorionicity early in multiple pregnancy because surveillance intensity depends strongly on placental sharing.
- Use NST/CTG, biophysical assessment, and advanced Doppler selectively in pregnancies with defined risk rather than as routine tests for all patients.
- Create an explicit escalation plan for red flags, abnormal screening, worsening maternal disease, and fetal surveillance deterioration, including when to refer to maternal–fetal medicine or a tertiary center.

LIMITATIONS OF THE REVIEW

This manuscript is a narrative evidence synthesis. It does not meet PRISMA criteria for a systematic review, and no meta-analysis was performed. Direct searches of Scopus, Web of Science, and the Cochrane Library were not undertaken during manuscript preparation. Guideline recommendations also vary across jurisdictions, particularly for gestational diabetes screening, aspirin prophylaxis, frequency of routine antenatal contacts, and some components of fetal surveillance. In addition, prenatal genetic screening and fetal-medicine technologies evolve rapidly; journal editors and authors should verify any time-sensitive recommendation immediately before submission if publication is delayed.

CONCLUSION

Clinical monitoring of pregnancy is most effective when it integrates early gestational dating, structured maternal–fetal risk assessment, gestational-age-specific screening, and proportionate

escalation of surveillance. The key clinical distinction is between screening, diagnostic confirmation, and longitudinal surveillance. First-trimester assessment establishes dating, multiplicity, chorionicity, and genetic-screening options; the mid-trimester structural survey remains the principal anatomical screening examination; and third-trimester surveillance should be individualized according to maternal disease, fetal growth, placental function, multiple pregnancy, and evolving symptoms. Hypertensive disorders, diabetes, FGR, placental pathology, and complicated multiple pregnancy require explicit multidisciplinary pathways. Evidence-based antenatal care is therefore not defined by the maximal number of tests but by timely use of the right test, for the right risk, with a predefined clinical response.

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