The Review Of
DIABETIC
STUDIES OPEN ACCESS

Integrated Diagnostic Pathways In Maternal Care: Coordinated Roles Of Radiology, Laboratory Testing, Nursing Assessment, And Midwifery Care

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Abstract
Maternal healthcare has undergone a substantial transformation from fragmented, discipline-specific practices toward integrated, multidisciplinary systems designed to improve early detection of complications and optimize outcomes for mothers and infants. Despite advances in obstetric medicine, maternal morbidity and mortality remain significant global concerns, with many adverse events attributable to delayed recognition of clinical deterioration, inadequate diagnostic evaluation, or poor coordination among healthcare professionals. Integrated diagnostic pathways—structured frameworks that combine radiological imaging, laboratory investigations, continuous nursing surveillance, and midwifery assessment—have emerged as essential mechanisms for delivering timely, evidence-based care across antenatal, intrapartum, and postpartum periods.
Radiological modalities provide crucial anatomical and functional information regarding fetal development, placental integrity, and maternal pathology. Laboratory testing offers biochemical, hematological, immunological, and microbiological data necessary for diagnosing conditions such as hypertensive disorders of pregnancy, gestational diabetes, infection, anemia, and coagulopathy. Nurses contribute continuous monitoring and early warning systems capable of detecting subtle physiological deterioration, while midwives deliver holistic, woman-centered care emphasizing physiological childbirth while maintaining vigilance for complications. Effective maternal care depends on seamless integration of these disciplines through standardized protocols, communication pathways, and digital health technologies. This narrative review synthesizes current evidence on coordinated diagnostic roles within maternal care, examines applications across the continuum of pregnancy, identifies barriers to implementation, and explores emerging innovations including point-of-care testing, telemedicine, artificial intelligence, and precision obstetrics. Integrated diagnostic pathways represent a cornerstone of modern maternal healthcare and are essential for reducing preventable morbidity and mortality worldwide.

Keywords: maternal health; obstetrics; diagnostic pathways; radiology; laboratory medicine; nursing; midwifery; multidisciplinary care.

Introduction

Maternal health remains one of the most sensitive indicators of healthcare system effectiveness, reflecting not only clinical quality but also accessibility, equity, and coordination of care. According to the World Health Organization, approximately 287,000 women died globally from pregnancy-related causes in 2020,

representing a maternal mortality ratio of 223 deaths per 100,000 live births (1). Although most deaths occur in low-resource settings, high-income countries have experienced rising rates of severe maternal morbidity, highlighting persistent gaps in early detection and management of obstetric complications (2).

Many maternal deaths are preventable and frequently associated with delays in recognizing complications, inadequate diagnostic evaluation, or fragmented healthcare delivery systems. The widely cited "three delays" model identifies delays in seeking care, reaching care, and receiving appropriate care as major contributors to maternal mortality (3). Within healthcare facilities, the third delay often results from insufficient monitoring, failure to interpret diagnostic findings accurately, or lack of coordination among healthcare professionals.

Pregnancy produces profound physiological changes that affect nearly every organ system, complicating clinical assessment. Cardiovascular adaptations include increased plasma volume, cardiac output, and heart rate, along with decreased systemic vascular resistance (4). Respiratory changes result in increased tidal volume and mild respiratory alkalosis, while renal adaptations lead to increased glomerular filtration rate and altered electrolyte balance (5). Hematologic changes create a hypercoagulable state that protects against hemorrhage but increases the risk of thromboembolism (6). These physiological shifts may mask early signs of pathology, making it difficult to distinguish normal pregnancy symptoms from life-threatening conditions without comprehensive evaluation.

Historically, obstetric care operated within hierarchical models dominated by physician decision-making. Contemporary maternal healthcare increasingly emphasizes interprofessional collaboration, recognizing that safe outcomes depend on coordinated contributions from multiple disciplines (7). Radiologists provide imaging essential for diagnosing structural abnormalities and guiding interventions. Laboratory specialists generate biochemical and microbiological data necessary for identifying metabolic, hematologic, and infectious conditions. Nurses perform continuous surveillance and implement early warning systems, while midwives provide holistic care that integrates physical, psychological, and social aspects of maternal health.

Integrated diagnostic pathways synthesize these diverse inputs into coherent clinical decision-making processes. Such pathways emphasize standardized assessment protocols, multidisciplinary communication, and clearly defined escalation procedures. They are particularly important because maternal deterioration can occur rapidly; conditions such as postpartum hemorrhage, eclampsia, sepsis, or amniotic fluid embolism may progress from mild symptoms to life-threatening emergencies within hours (8).

Advances in digital health technologies have further facilitated integration. Electronic medical records enable real-time sharing of clinical data, while telemedicine expands access to specialist consultations in remote areas (9). Point-of-care testing provides rapid laboratory results at the bedside, reducing delays in diagnosis and treatment.

This review examines the coordinated roles of radiology, laboratory testing, nursing assessment, and midwifery care within integrated maternal diagnostic pathways, exploring applications across antenatal, intrapartum, and postpartum periods as well as barriers and future directions.

Physiological Adaptations of Pregnancy and Diagnostic Complexity

Pregnancy induces extensive physiological changes designed to support fetal development but which simultaneously complicate diagnostic interpretation. Plasma volume expansion of up to 50% leads to dilutional anemia, lowering hemoglobin concentration despite increased red cell mass (4). Cardiac output increases by approximately 30–50%, driven by both increased stroke volume and heart rate, while systemic vascular resistance decreases due to hormonal influences such as progesterone-mediated vasodilation (4). These changes may obscure early signs of hemorrhage or cardiovascular compromise.

Respiratory adaptations include increased minute ventilation and decreased functional residual capacity due to diaphragmatic elevation (5). Pregnant individuals commonly experience dyspnea, making it difficult to differentiate physiological breathlessness from pathological conditions such as pulmonary embolism or cardiomyopathy without additional diagnostic evaluation.

Renal physiology also changes substantially. Increased renal plasma flow and glomerular filtration rate result in lower baseline serum creatinine and urea levels (5). Consequently, values considered normal outside pregnancy may indicate renal impairment in pregnant patients. Endocrine changes promote insulin

resistance, predisposing to gestational diabetes mellitus (10). Hemostatic systems shift toward hypercoagulability, increasing levels of clotting factors and reducing fibrinolytic activity, thereby elevating thromboembolic risk (6).

These physiological transformations affect interpretation of laboratory tests and vital signs. Mild leukocytosis is common, particularly during labor, potentially masking infection. Elevated D-dimer levels reduce specificity for diagnosing venous thromboembolism. Blood pressure typically decreases during mid-pregnancy before rising near term, making early hypertensive disorders difficult to detect without serial measurements (11). Integrated diagnostic pathways therefore emphasize longitudinal monitoring and multidisciplinary interpretation rather than reliance on single data points.

Radiological Imaging in Maternal Diagnostic Pathways

Radiological imaging is fundamental to modern obstetric practice. Ultrasonography remains the primary modality due to its safety, availability, and ability to provide real-time assessment of fetal development and maternal anatomy. First-trimester ultrasound confirms intrauterine pregnancy, determines gestational age, and detects ectopic pregnancy or multiple gestations (12). Second-trimester anomaly scans evaluate fetal anatomy, while third-trimester assessments monitor growth, amniotic fluid volume, and placental position. Doppler ultrasound plays a crucial role in assessing uteroplacental and fetoplacental circulation. Abnormal Doppler findings are associated with placental insufficiency and increased risk of adverse perinatal outcomes, guiding decisions regarding surveillance and timing of delivery (12). Point-of-care ultrasound has expanded diagnostic capabilities in emergency settings, allowing rapid bedside evaluation of maternal cardiac function, pulmonary status, and intra-abdominal bleeding (13).

Magnetic resonance imaging provides high-resolution visualization of soft tissues without ionizing radiation and is particularly useful for evaluating placenta accreta spectrum, fetal central nervous system anomalies, and maternal neurological conditions (14). Computed tomography, although involving radiation exposure, may be necessary for diagnosing life-threatening conditions such as pulmonary embolism or intracranial hemorrhage. Modern protocols minimize fetal exposure, and maternal stabilization takes priority when risks are substantial (15).

Interventional radiology techniques have become increasingly important in obstetric care. Uterine artery embolization is an effective treatment for postpartum hemorrhage when medical and surgical measures fail, preserving fertility in many cases (16). Image-guided procedures also facilitate management of pelvic abscesses and vascular anomalies.

Laboratory Medicine in Maternal Care

Laboratory diagnostics provide essential biochemical and hematological data for identifying maternal disorders. Routine antenatal screening includes evaluation of hemoglobin levels, blood group and Rh status, infectious diseases, and metabolic conditions (17). Serial testing enables detection of anemia, thrombocytopenia, or coagulation abnormalities that may influence obstetric management.

Hypertensive disorders of pregnancy illustrate the importance of laboratory integration. Diagnosis of pre-eclampsia requires evidence of hypertension combined with organ dysfunction such as proteinuria, renal impairment, liver enzyme elevation, or thrombocytopenia (11). Biomarkers such as placental growth factor and soluble fms-like tyrosine kinase-1 improve early detection and risk stratification (18).

Gestational diabetes is identified through glucose tolerance testing, enabling interventions that reduce risks of macrosomia, birth trauma, and neonatal complications (10). Laboratory testing is also critical in obstetric emergencies, including rapid crossmatching for transfusion in hemorrhage and measurement of lactate levels in sepsis (19). Point-of-care testing technologies allow rapid bedside analysis, facilitating timely interventions.

Nursing Surveillance and Early Warning Systems

Nurses play a central role in integrated diagnostic pathways through continuous monitoring and early detection of clinical deterioration. Obstetric early warning systems combine vital signs and clinical observations to identify patients at risk of severe morbidity, triggering escalation protocols when thresholds

are exceeded (20). Continuous nursing presence allows recognition of subtle changes that may precede catastrophic events such as hemorrhage or sepsis.
Nursing responsibilities also include medication administration, fluid management, postoperative care, and patient education. Effective communication with the multidisciplinary team is essential for coordinated decision-making.

Midwifery Care and Continuity Models
Midwives provide comprehensive, woman-centered care across pregnancy, childbirth, and postpartum periods. Midwife-led continuity models have been associated with reduced intervention rates, lower preterm birth risk, and high patient satisfaction without compromising safety in low-risk pregnancies (21). Continuous presence during labor enables early detection of complications and timely referral to specialist care when necessary.
Midwives also play crucial roles in antenatal education, breastfeeding support, and community follow-up, contributing to long-term maternal and neonatal health.

Integration Across Antenatal, Intrapartum, and Postpartum Care
Integrated diagnostic pathways extend across the entire continuum of maternal care. Antenatal care focuses on screening and prevention, intrapartum care requires real-time coordination among multidisciplinary teams, and postpartum care addresses complications that may arise after discharge, including hemorrhage, infection, thromboembolism, and mental health disorders (22).

Barriers and Future Directions
Implementation challenges include resource limitations, workforce shortages, fragmented information systems, and sociocultural barriers to healthcare utilization (1,23). Emerging technologies such as artificial intelligence, telemedicine, and wearable monitoring devices offer promising solutions for enhancing diagnostic integration and improving maternal outcomes (24–26).

Conclusion
Integrated diagnostic pathways represent a transformative approach to maternal healthcare, enabling early detection of complications, timely interventions, and improved outcomes for mothers and infants. Coordinated collaboration among radiology, laboratory medicine, nursing, and midwifery disciplines is essential for delivering safe, high-quality care across the continuum of pregnancy. Continued investment in multidisciplinary training, technological innovation, and health system strengthening will be crucial for achieving global maternal health goals.

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