

Patient Pathway Analysis: A Study on the Utilization of Laboratory and Radiological Tests in Routine Midwifery Intervention

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Abstract

Background: Patient Pathway Analysis (PPA) is an increasingly utilized health systems approach that evaluates patient movement across healthcare services and identifies diagnostic and treatment gaps. In maternal and midwifery care, laboratory and radiological investigations constitute essential components of routine intervention, supporting early diagnosis, risk stratification, and maternal–fetal safety. However, inefficiencies in diagnostic utilization, delayed referrals, and variability in practice remain global concerns. Objective: This literature review aims to analyze the patient pathway in routine midwifery care with a focus on the utilization patterns, clinical relevance, timing, accessibility, and health system implications of laboratory and radiological tests. Methods: A structured literature review was conducted using peer-reviewed articles, WHO guidelines, and maternal health policy reports. The review synthesizes evidence on antenatal, intrapartum, and postpartum diagnostic pathways, emphasizing interdisciplinary collaboration among midwives, laboratory professionals, radiologists, and healthcare administrators. Results: Evidence indicates that timely laboratory testing (hemoglobin, blood grouping, infectious screening, glucose tolerance testing) and obstetric ultrasound significantly reduce maternal and neonatal morbidity. However, disparities in access, over-utilization in high-income settings, and under-utilization in low-resource environments remain prevalent. Patient pathway bottlenecks commonly occur at referral, test turnaround time, and result interpretation stages. Conclusion: Optimizing diagnostic utilization within midwifery-led care requires integrated pathway mapping, standardized protocols, digital health integration, and interprofessional coordination. Patient Pathway Analysis offers a systems-level framework for improving maternal health outcomes.

Keywords: Patient Pathway Analysis, Midwifery, Laboratory Testing, Radiology, Antenatal Care, Diagnostic Utilization, Maternal Health Systems.

Introduction

Maternal health remains a central global health priority, embedded within Sustainable Development Goal 3, which seeks to reduce the global maternal mortality ratio to fewer than 70 deaths per 100,000 live births. Despite significant advances over recent decades, preventable maternal mortality persists, particularly in low- and middle-income countries. The World Health Organization reported that approximately 287,000

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women died during pregnancy and childbirth in 2020, with most deaths occurring in resource-limited settings (World Health Organization [WHO], 2023). These deaths are often attributed to preventable conditions such as hemorrhage, hypertensive disorders, infection, and obstructed labor—conditions that can be mitigated through timely diagnostic assessment and appropriate referral.

Midwifery-led models of care have demonstrated substantial benefits in improving maternal satisfaction, continuity of care, and cost-effectiveness without compromising safety (Sandall et al., 2016). Routine midwifery interventions rely extensively on laboratory investigations and radiological imaging to identify maternal and fetal risks. Hematological screening detects anemia; serological testing identifies infectious diseases; glucose tolerance testing diagnoses gestational diabetes; and obstetric ultrasonography evaluates fetal development and placental positioning. However, the effectiveness of these diagnostic services depends not only on their availability but also on how efficiently they are integrated into the patient pathway.

Patient Pathway Analysis (PPA) provides a structured approach to understanding patient movement through healthcare systems, highlighting diagnostic and therapeutic gaps. Originally applied in infectious disease programs such as tuberculosis control, PPA has gained recognition as a strategic health systems tool capable of identifying fragmentation in service delivery (Hanson et al., 2017). Within maternal health, PPA offers an opportunity to examine how pregnant women interact with midwives, laboratories, radiology units, referral hospitals, and community health systems.

This review critically examines the utilization of laboratory and radiological tests within routine midwifery interventions through the lens of Patient Pathway Analysis. It explores how diagnostics are integrated across antenatal, intrapartum, and postpartum stages; identifies systemic barriers; and evaluates interdisciplinary collaboration among midwives, laboratory professionals, radiologists, and health administrators

Conceptual Framework of Patient Pathway Analysis in Maternal Care

Patient Pathway Analysis is grounded in health systems theory, emphasizing the sequential interactions between patients and service providers from initial contact to outcome resolution. In maternal healthcare, the pathway typically begins with pregnancy recognition and progresses through antenatal visits, diagnostic testing, referral when necessary, delivery, and postpartum follow-up.

The maternal diagnostic pathway is not linear but iterative. Women may move between primary midwifery clinics, secondary hospitals, laboratory facilities, and imaging centers. Delays may occur at several junctures, including test ordering, specimen transportation, result interpretation, and referral approval. These delays correspond to the “three delays” model described in maternal mortality literature: delay in seeking care, delay in reaching care, and delay in receiving adequate care (Thaddeus & Maine, 1994).

Applying PPA to midwifery interventions allows researchers to map where laboratory and radiological services intersect with clinical decision-making. For example, a pregnant woman presenting for her first antenatal visit undergoes hemoglobin testing. If anemia is detected, iron therapy is initiated. If severe anemia is identified, referral to a higher-level facility may be required. Each step involves coordination across healthcare actors and administrative processes. Bottlenecks in laboratory turnaround time or result reporting may delay intervention and increase risk. Digital health systems, including electronic medical records and laboratory information systems, have been shown to improve pathway efficiency by reducing transcription errors and enabling rapid result access (WHO, 2016). However, digital fragmentation between facilities remains common, especially in rural contexts.



Figure 1. Conceptual Patient Pathway Model in Midwifery Diagnostic Care

Laboratory Testing in Routine Midwifery Intervention

Laboratory diagnostics constitute the cornerstone of preventive maternal healthcare. WHO antenatal guidelines recommend a standardized panel of investigations at defined gestational intervals (WHO, 2016). These investigations serve preventive, diagnostic, and prognostic purposes.

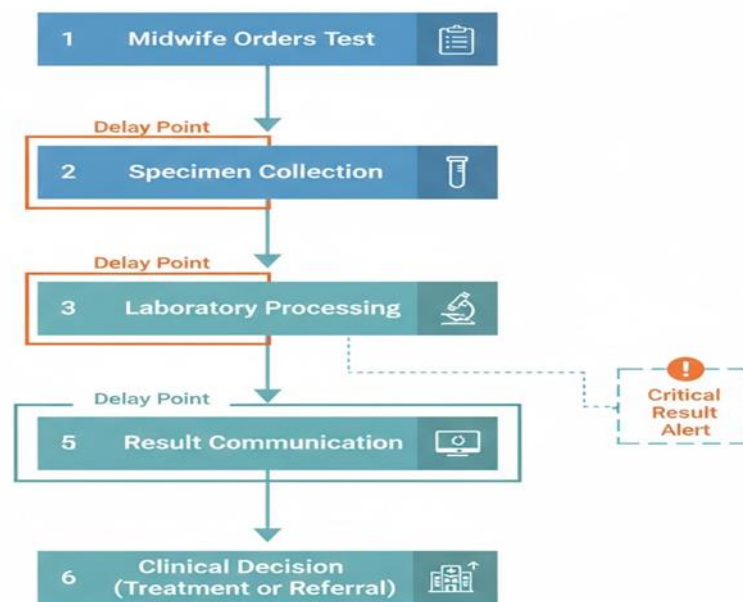


Figure 2. Laboratory Workflow in Midwifery Care

Hematological Assessment

Anemia in pregnancy affects approximately 40% of women globally and is associated with increased risks of preterm birth, low birth weight, and maternal mortality (Stevens et al., 2013). Hemoglobin testing during the first antenatal visit enables early detection and intervention. From a pathway perspective, anemia screening requires specimen collection, laboratory processing, result reporting, and follow-up counseling.

In decentralized settings, delays in hemoglobin analysis may result from transportation barriers or reagent shortages.

Blood Grouping and Rh Typing

ABO and Rh typing are essential for preventing hemolytic disease of the fetus and newborn. Identification of Rh-negative mothers allows for prophylactic anti-D immunoglobulin administration. Inadequate laboratory capacity to perform blood grouping or stock anti-D immunoglobulin represents a critical pathway failure point.

Infectious Disease Screening

Routine screening for HIV, hepatitis B, and syphilis significantly reduces vertical transmission. Rapid diagnostic tests have transformed pathway efficiency by enabling same-day results, thereby minimizing loss to follow-up (Drain et al., 2014). However, confirmatory testing and linkage to treatment remain areas of vulnerability in fragmented systems.

Glucose Tolerance Testing

Gestational diabetes mellitus (GDM) affects between 5% and 15% of pregnancies depending on population characteristics (McIntyre et al., 2019). Oral glucose tolerance testing requires standardized timing and patient preparation. Delays or patient non-compliance may disrupt accurate diagnosis. In resource-limited settings, selective rather than universal screening is often implemented, potentially missing asymptomatic cases.

Urinalysis and Proteinuria Screening

Urinalysis plays a critical role in detecting urinary tract infections and proteinuria associated with preeclampsia. Dipstick testing provides rapid results but may lack sensitivity compared to laboratory-based analysis. Inconsistent supply of reagents represents a recurring pathway obstacle.

The integration of these laboratory services into routine midwifery care demonstrates variability across health systems. In high-income countries, laboratories are often integrated within primary care networks, ensuring rapid turnaround times. In contrast, rural clinics in low-resource settings may depend on centralized laboratories, introducing delays that compromise timely management.

Table 1. Routine Laboratory Tests Across the Midwifery Care Continuum

Stage of Care	Laboratory Test	Clinical Purpose	Impact on Patient Pathway	Potential Bottleneck
First Antenatal Visit	Hemoglobin (CBC)	Detect anemia	Early iron therapy or referral	Delayed turnaround time
First Antenatal Visit	Blood group & Rh typing	Prevent hemolytic disease	Anti-D prophylaxis planning	Reagent stockout
First Antenatal Visit	HIV screening	Prevent vertical transmission	Immediate ART referral	Loss to follow-up
First Antenatal Visit	Syphilis (RPR/VDRL)	Prevent congenital infection	Same-day treatment if rapid test	Confirmatory test delay
24–28 Weeks	Oral Glucose Tolerance Test	Diagnose GDM	Dietary/insulin intervention	Patient non-compliance

Third Trimester	Group B Streptococcus	Neonatal infection prevention	Intrapartum antibiotic prophylaxis	Lab accessibility
Any Stage	Urinalysis	Detect UTI, proteinuria	Early preeclampsia detection	Dipstick supply shortage

Radiological Imaging in Midwifery Care

Radiological assessment in pregnancy is dominated by obstetric ultrasonography, which is considered safe when applied appropriately. Ultrasound does not use ionizing radiation and has become a standard component of antenatal care in many settings (Salvesen, 2009).

First-trimester ultrasound confirms intrauterine pregnancy, estimates gestational age, and detects multiple gestations. Accurate dating reduces misclassification of preterm and post-term births, thereby influencing induction decisions. Second-trimester anomaly scanning identifies structural malformations, allowing for early referral and counseling. Third-trimester imaging assesses fetal growth, amniotic fluid volume, and placental location.

In certain high-risk cases, Doppler ultrasound evaluates placental blood flow. Magnetic resonance imaging (MRI) may be used for complex fetal anomalies but remains limited due to cost and availability. Ionizing radiation modalities such as computed tomography are avoided unless maternal life-threatening conditions necessitate imaging (American College of Obstetricians and Gynecologists, 2017).

From a pathway perspective, ultrasound accessibility varies significantly. In high-income countries, routine scans are often integrated into antenatal schedules. In contrast, rural and low-income contexts may lack equipment or trained personnel. Task-shifting models that train midwives in basic obstetric ultrasonography have demonstrated promising results in improving access (Swanson et al., 2014).

Table 2. Radiological Utilization in Routine Midwifery Intervention

Trimester	Imaging Type	Indication	Clinical Influence	Outcome	Pathway Delay Risk
First	Dating Ultrasound	Confirm gestation	Accurate EDD		Equipment shortage
Second	Anomaly Scan	Detect malformations	Early referral		Appointment backlog
Third	Growth Scan	Monitor IUGR	Timely planning	induction	Rural access limitations
High-risk	Doppler Ultrasound	Placental insufficiency	Emergency referral		Specialist availability
Complicated cases	MRI	Fetal anomalies	Multidisciplinary planning		High cost

Integration of Laboratory and Radiological Services in the Patient Pathway

The maternal diagnostic pathway is characterized by interdependent interactions between midwives, laboratory professionals, radiologists, and administrative staff. Efficient integration depends on communication, standardized protocols, and information sharing.

Turnaround time is a critical performance indicator. Delayed laboratory results may postpone treatment for anemia or infections. Similarly, delayed ultrasound appointments may defer diagnosis of fetal growth restriction. Studies indicate that same-day testing and result communication significantly improve adherence to recommended interventions (Hanson et al., 2017).

Health administration plays a pivotal role in ensuring resource allocation, equipment maintenance, workforce training, and supply chain stability. Laboratory stockouts and malfunctioning ultrasound machines represent administrative failures that disrupt patient pathways.

Interdisciplinary collaboration enhances diagnostic accuracy. Midwives rely on laboratory technologists for precise testing and on radiologists for imaging interpretation. In some contexts, telemedicine facilitates remote consultation, mitigating workforce shortages.

Table 3. Diagnostic Integration Barriers Identified in Patient Pathway Analysis

Barrier Type	Description	Effect on Midwifery Care	Health System Level
Structural	Limited lab infrastructure	Delayed diagnosis	Primary care
Workforce	Shortage of trained sonographers	Missed imaging	Secondary care
Administrative	Referral approval delays	Postponed management	Policy level
Financial	Out-of-pocket costs	Reduced compliance	Patient level
Digital	Lack of EMR integration	Lost test results	System-wide

Health Systems Barriers and Facilitators

Health systems barriers to optimal diagnostic utilization are multifaceted. Infrastructure deficits, workforce shortages, supply chain disruptions, financial barriers, and sociocultural factors all contribute to pathway inefficiencies.

In low-resource settings, limited laboratory capacity often necessitates centralized testing, prolonging turnaround time. Transportation barriers may prevent timely specimen delivery. Financial constraints, including out-of-pocket payments, may discourage women from completing recommended tests.

Conversely, high-income countries face challenges of overutilization. Excessive imaging without clinical indication increases healthcare costs and may contribute to anxiety or unnecessary interventions (Brownlee et al., 2017). Diagnostic stewardship, defined as the rational use of tests based on evidence-based guidelines, has emerged as a strategy to balance underuse and overuse.

Digital health innovations offer promising solutions. Electronic referral systems, laboratory information management systems, and mobile health reminders improve pathway continuity. However, digital inequity and lack of interoperability remain obstacles.

Public Health and Policy Implications

Maternal diagnostics must be contextualized within broader public health strategies. Universal health coverage frameworks emphasize equitable access to essential diagnostic services. WHO recommends at least eight antenatal contacts, each representing an opportunity for integrated diagnostic assessment (WHO, 2016).

Policy reforms should prioritize strengthening laboratory networks, expanding ultrasound training programs, and integrating diagnostic indicators into maternal health monitoring systems. Cost-effectiveness analyses indicate that early detection of anemia and gestational diabetes reduces long-term healthcare expenditure by preventing complications.

Community engagement also influences pathway success. Health education initiatives encourage early antenatal registration and adherence to testing schedules. Sociocultural beliefs may influence acceptance of ultrasound imaging or blood testing; therefore, culturally sensitive counseling is essential.

Discussion

This review demonstrates that laboratory and radiological tests are integral components of routine midwifery intervention. Patient Pathway Analysis reveals both strengths and vulnerabilities within maternal diagnostic systems. While evidence supports the effectiveness of routine screening in reducing maternal morbidity, disparities in access and quality persist.

The integration of diagnostics within midwifery-led models enhances early risk detection and referral efficiency. However, the effectiveness of these models depends on robust health systems infrastructure. Interdisciplinary collaboration and administrative coordination are critical determinants of pathway performance.

Future research should apply quantitative PPA methodologies to maternal care, mapping real-world data on turnaround times, referral delays, and outcome correlations. Economic evaluations of point-of-care diagnostics in midwifery settings are also warranted.

Interprofessional Collaboration (IPC) in Saudi Diagnostic Pathways

Effective maternal care relies on a "multidisciplinary care" model where midwives, family physicians, radiologists, and laboratory technicians collaborate seamlessly. Saudi Vision 2030 emphasizes that midwives, when fully integrated into interdisciplinary teams, can deliver about 90% of essential maternal interventions.

The "Diagnostic Relay"

The midwifery pathway functions as a "relay race" where patient information and biological samples are passed between specialized professionals:

- Midwives serve as primary advocates and coordinators, ensuring requisitions are clear and patients are properly prepared for diagnostic procedures.
- Laboratory Technicians process biological samples to provide the data that forms the basis of many diagnoses.
- Radiologists and Technologists provide critical anatomical and functional data through imaging, enhancing the ability to monitor pathologies at early stages.

Barriers to Effective IPC

In Saudi hospitals, collaboration is sometimes hindered by role ambiguity, communication challenges, and cultural hierarchies. Fragmented communication systems and high workloads further contribute to diagnostic delays.

Economic Analysis of Midwifery Diagnostics in KSA

The Saudi healthcare system is moving toward a **value-based care** model, where the cost-effectiveness of diagnostics is a primary consideration.

Conclusion

Patient Pathway Analysis offers a valuable framework for evaluating diagnostic utilization within routine midwifery intervention. Laboratory and radiological services significantly influence maternal and neonatal outcomes, yet their impact is contingent upon efficient integration within health systems. Strengthening diagnostic capacity, promoting interdisciplinary collaboration, and implementing evidence-based policies are essential for optimizing maternal health pathways. As global health systems strive toward universal

coverage and reduced maternal mortality, diagnostic integration within midwifery care must remain a strategic priority.

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