Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202412779

Medication Use during Pregnancy and Lactation: Integrating Pharmacovigilance, Maternal Nursing, Laboratory Monitoring, Imaging, and Dental Care

Zahiyah Muqbil Al-Hanini Al-Khaibari(1), Turki Hamood Alotaibi(2), Abdullah Aloush Alotaibi(3), Ahmed Nuwaifea Q Aljohani(4), Zurayfah Muhanna Arnun(5), Mohammed Abdulghani Almaliki(6), Yasser Hassan Salhabi7(7), Maha Aziz Alenzi(8), Hajah Mohamad Azybi(9), Sarah Falah Alenezi10(10), Marwah Saad Jamaan Alharbi(11)

(1)King Khalid Hospital and Prince Sultan Medical Services Center, Al-Kharj, Ministry of Health, Riyadh Health Cluster, Saudi Arabia
(2)Compliance Department, Riyadh Branch, Ministry of Health, Saudi Arabia
(3)Ruwaidah General Hospital, Ministry of Health, Health Cluster, Saudi Arabia
(4)Quality Management, Primary Care, Ministry of Health, Saudi Arabia
(5)Tayma General hospita, Saudi Arabia
(6)Maternity and Children's Hospital, Al-Kharj, Ministry of Health, Saudi Arabia
(7)Sabya General Hospital - Jazan Health Cluster, Sabya, Jazan, Saudi Arabia
(8)Rumah General Hospital, Second Health Cluster, Saudi Arabia
(9)Samtah General Hospital, Ministry of Health, Saudi Arabia
(10)Al-Sa'ada Health Center, Ministry of Health, Saudi Arabia
(11)Prince Mohammed bin Abdulaziz Hospital, Riyadh, Ministry of Health, Saudi Arabia

Abstract

Medication use during pregnancy and lactation represents a complex clinical challenge requiring integration across multiple disciplines. Despite more than 200 million annual pregnancies globally, the majority of women receive medications with limited safety data, as pregnant and breastfeeding populations have historically been excluded from clinical trials. This narrative review synthesizes contemporary evidence (2016–2024) on medication safety during pregnancy and lactation, integrating perspectives from pharmacovigilance, maternal nursing, laboratory monitoring, diagnostic imaging, and dental care. Pharmacovigilance systems, including pregnancy exposure registries and the FDA Adverse Event Reporting System, provide essential post-marketing surveillance despite persistent regulatory fragmentation. Maternal nurses and midwives serve as frontline counselors, yet knowledge gaps and communication barriers limit optimal medication counseling. Therapeutic drug monitoring has demonstrated particular value for antiepileptic drugs and other agents with narrow therapeutic indices, where pregnancy-induced pharmacokinetic changes necessitate dose adjustment. Diagnostic imaging and dental care, often unnecessarily avoided during pregnancy, are safe when evidence-based guidelines are followed, with ultrasonography and MRI preferred, and lidocaine and amoxicillin representing low-risk dental medications. This review proposes an integrated, multidisciplinary framework emphasizing preconception counseling, risk-benefit assessment, interprofessional collaboration, and robust post-marketing surveillance to optimize maternal and fetal outcomes.

Keywords: pregnancy medication safety, pharmacovigilance, lactation pharmacology, therapeutic drug monitoring, maternal nursing.

Introduction

The use of medications during pregnancy and lactation is a near-universal phenomenon. Globally, more than 200 million women become pregnant each year, and the majority receive at least one medication during pregnancy, whether for chronic conditions, acute infections, or pregnancy-related symptoms such as nausea and pain (Mansour et al., 2024; Vignato et al., 2023). Despite this ubiquity, the evidence base for medication safety in these populations remains remarkably inadequate. Pregnant and breastfeeding women have historically been excluded from clinical trials due to ethical concerns regarding fetal exposure, leaving clinicians to rely on animal studies, uncontrolled observational data, and post-marketing surveillance — all of which carry inherent limitations (Alexe et al., 2024). Consequently, approximately 70–80% of medications lack sufficient pregnancy safety data to inform clinical decision-making, creating a therapeutic quandary for both healthcare providers and patients (Thorpe et al., 2023).

This evidence gap has profound clinical implications. Untreated maternal conditions — including epilepsy, psychiatric disorders, diabetes, hypertension, and infections — pose substantial risks to both mother and fetus, often exceeding the risks associated with appropriate medication use (Dathe & Schaefer, 2018). A central tenet of perinatal

*Corresponding author mmkzo00018@gmail.com (Zahiyah Muqbil Al-Hanini Al-Khaibari).
Receive Date: 22 December 2024, Revise Date: 30 December 2024, Accept Date: 31 December 2024

pharmacology is that the potential benefit of a medication must be weighed against its known and unknown risks, a principle that necessitates nuanced, individualized clinical judgment rather than categorical avoidance of pharmacotherapy (AbuShweimeh et al., 2023). The consequences of therapeutic nihilism are well documented: inadequately controlled maternal disease is associated with miscarriage, preterm birth, congenital anomalies, and long-term neurodevelopmental impairment in offspring (Daw et al., 2023).

Addressing medication safety during pregnancy and lactation requires an integrated, multidisciplinary approach that extends beyond the prescribing clinician. Pharmacovigilance systems provide the surveillance infrastructure to detect safety signals after market approval (World Health Organization, 2022). Maternal nurses and midwives serve as the frontline interface between healthcare systems and pregnant women, translating complex pharmacological information into actionable guidance (Cha et al., 2021). Laboratory monitoring, particularly therapeutic drug monitoring, allows for dose optimization in the context of pregnancy-induced pharmacokinetic alterations (Arfman et al., 2020). Diagnostic imaging and dental care — domains often neglected in discussions of perinatal medication safety — are essential components of comprehensive maternal care, each with distinct safety considerations and evidence-based guidelines (ACOG, 2017; Nadanovsky et al., 2024). This review synthesizes contemporary evidence across these interconnected domains, proposing an integrated framework for optimizing medication safety during pregnancy and lactation.

Pharmacovigilance in Pregnancy and Lactation

Regulatory Frameworks and Evolution

Pharmacovigilance — the science and activities relating to the detection, assessment, understanding, and prevention of adverse effects or any other drug-related problem — is particularly critical in the perinatal context, where the consequences of medication exposure may not manifest for months or years (Kappel et al., 2023). The regulatory landscape for medication safety in pregnancy has undergone significant transformation over the past decade. Until the 2010s, the U.S. Food and Drug Administration (FDA) classified drugs into five pregnancy categories (A, B, C, D, and X), a system that was widely criticized for oversimplifying complex risk-benefit assessments and creating false dichotomies between "safe" and "unsafe" medications (Brucker & King, 2017). In December 2014, the FDA implemented the Pregnancy and Lactation Labeling (Drugs) Final Rule (PLLR), which replaced the categorical system with narrative subsections addressing pregnancy, lactation, and females and males of reproductive potential (Brucker & King, 2017). Each subsection includes a risk summary, clinical considerations, and supporting data, providing a more nuanced framework for clinical decision-making. However, the PLLR does not apply to over-the-counter medications, and compliance across drug labels has been inconsistent (Dathe & Schaefer, 2018).

Pregnancy Exposure Registries and Post-Marketing Surveillance

Pregnancy exposure registries (PERs) represent a cornerstone of maternal pharmacovigilance. These observational studies systematically collect health information on pregnant women exposed to specific medical products, tracking both maternal and neonatal outcomes (AbuShweimeh et al., 2023). A recent landscape analysis identified 45 data collection systems in low- and middle-income countries (LMICs), with 36 currently in operation, categorized into six structural types based on their approach and scope (Berrueta et al., 2021). However, significant investment gaps remain, particularly in LMICs where the burden of maternal and neonatal mortality is highest and where new vaccine and drug introductions require robust safety monitoring infrastructure (World Health Organization [WHO], 2024).

In high-income settings, the FDA Adverse Event Reporting System (FAERS) serves as a critical pharmacovigilance tool. A 2024 comparative analysis of FAERS and the Drugs and Lactation Database (LactMed®) identified 2,628 adverse drug events related to lactation exposure, with 68.4% occurring in infants under two months of age, 5.5% classified as life-threatening, and 3.6% resulting in death (Tezel Yalçın et al., 2024). Notably, 84.7% of reported cases were categorized as serious, with nervous system drugs accounting for 50.9% of implicated medications (Tezel Yalçın et al., 2024). This analysis demonstrated that FAERS is highly sensitive for detecting potential adverse events, while LactMed® provides more specific, evidence-based guidance — highlighting the complementary roles of spontaneous reporting systems and curated databases.

Harmonization Challenges and the Call to Action

Despite these advances, substantial regulatory fragmentation persists. A 2024 "call to action" published in the *British Journal of Clinical Pharmacology* highlighted the ambiguities and lack of harmonization in global regulations governing post-marketing pregnancy and breastfeeding safety studies (Alexe et al., 2024). The authors, representing multiple pharmaceutical companies, noted that inconsistent requirements across regulatory jurisdictions impede the efficient conduct of safety studies and delay the generation of actionable evidence (Roque Pereira et al., 2022). Key areas of divergence include the definition of pregnancy outcomes, requirements for long-term infant follow-up, and standards for data collection and reporting. This fragmentation creates a paradox: while the need for pregnancy-specific safety data is universally acknowledged, the regulatory environment often

disincentivizes the very studies that would generate such data (Kappel et al., 2023).

The implications extend beyond regulatory compliance to clinical practice. A study examining online information discrepancies regarding medication safety during pregnancy and lactation found that inconsistencies across sources can result in suboptimal treatment for pregnant and lactating women, unnecessary weaning from breastfeeding, and potential fetal or infant harm (Tezel Yalçın et al., 2024). These findings underscore the need for a coordinated international approach to maternal pharmacovigilance that harmonizes definitions, standards, and reporting requirements while respecting regional regulatory frameworks (Berrueta et al., 2021). Figure 1 depicts the sequential process from pre-market assessment through post-marketing surveillance, including spontaneous reporting (FAERS), pregnancy exposure registries, signal detection, and regulatory action, culminating in updated clinical guidance and label changes.

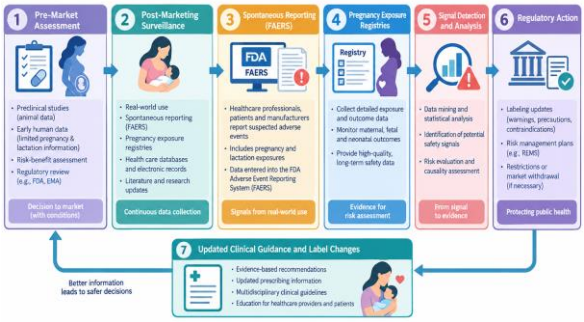

Figure 1. Pharmacovigilance Pathway for Medication Safety in Pregnancy and Lactation

Note. Adapted from concepts in Alexe et al. (2024), Berrueta et al. (2021), and Tezel Yalçın et al. (2024).

Maternal Nursing and Medication Counseling

The Frontline Role of Nurses and Midwives

Maternal nurses and midwives occupy a unique position in the medication safety landscape. They are often the first point of contact for pregnant women, conducting initial assessments, providing education, and administering medications in both outpatient and inpatient settings (Giles et al., 2024). The nursing role encompasses medication history-taking, patient education about teratogenic risks, monitoring for adverse effects, and coordination with prescribing clinicians (Giles et al., 2024). A comprehensive medication history — including prescribed drugs, over-the-counter medications, vitamins, minerals, and dietary supplements — provides the foundation for screening potential teratogens and identifying opportunities for intervention (Balkam, 2022). The first trimester represents the period of greatest fetal vulnerability to teratogenic exposure, making early and thorough medication assessment essential (Charron et al., 2020).

Counseling by midwives on medication intake during pregnancy, labor, lactation, and the postpartum period is of particular importance given women's concerns about fetal safety and the potential for unnecessary medication avoidance (Cha et al., 2021). Research has demonstrated that midwives are well-positioned to support medication adherence, as exemplified by their role in promoting low-dose aspirin for preeclampsia prevention (Vinogradov et al., 2023). However, the effectiveness of nursing-led medication counseling depends on nurses' knowledge, confidence, and access to reliable information resources (Ricci, 2020).

Knowledge Gaps and Educational Needs

Despite their critical role, nurses and midwives often report insufficient training in perinatal pharmacology. A study examining midwives' counseling practices identified barriers including limited knowledge of medication safety databases, difficulty interpreting risk-benefit information, and concerns about liability (Surtimanah et al., 2019). The complexity of risk communication is compounded by the historical context in which many medications were assigned pregnancy categories without robust supporting data, creating a legacy of uncertainty that persists despite the PLLR transition (Blattner et al., 2016).

Educational interventions have shown promise in addressing these gaps. Comprehensive nursing textbooks and continuing education programs increasingly incorporate medication safety content specific to maternal-newborn care, including medication alert boxes, safety alerts, and nursing considerations for drugs used in maternity settings (Giles et al., 2024). Simulation-based training and interprofessional education initiatives offer additional avenues for building competency in perinatal medication counseling (Giles et al., 2024). However, systematic integration of pharmacovigilance principles into nursing curricula remains incomplete, and many practicing nurses lack familiarity with key resources such as LactMed® and MotherToBaby (Tezel Yalçın et al., 2024).

Interprofessional Collaboration

Optimal medication safety during pregnancy and lactation requires seamless interprofessional collaboration. Obstetric care providers frequently work alongside endocrinologists, psychiatrists, neurologists, and other specialists to manage chronic conditions during pregnancy (Dathe & Schaefer, 2018). Pharmacists contribute essential expertise in medication history-taking, reconciliation, and review, with particular value in evaluating teratogenic risks and recommending therapeutic alternatives (Adrover et al., (2016). A study of pharmacist-led interventions for pregnant women referred due to first-trimester medication concerns found that all patients were advised to continue their pregnancies after comprehensive assessment determined that the medications were not teratogenic (van de Vusse et al.,

2022). This finding highlights the potential for pharmacist involvement to prevent unnecessary pregnancy terminations and reduce maternal anxiety.

Effective interprofessional collaboration, however, requires structured communication pathways and shared decision-making frameworks. The nurse's role as care coordinator positions them to facilitate information exchange among specialists, ensuring that medication decisions consider the full clinical picture (Giles et al., 2024). This coordination function is particularly important for women with pre-existing medical conditions who may be receiving care from multiple providers who are not aware of the pregnancy (Balkam, 2022).

Laboratory Monitoring and Therapeutic Drug Monitoring

Pharmacokinetic Changes in Pregnancy

Pregnancy induces profound physiological changes that alter drug pharmacokinetics across absorption, distribution, metabolism, and excretion. Plasma volume increases by 40–50%, total body water expands, and body fat composition changes, collectively increasing the volume of distribution for many drugs (Arfman et al., 2020). Hepatic enzyme activity is altered, with some cytochrome P450 isoforms induced and others inhibited (Stojanova et al., 2021). Renal blood flow and glomerular filtration rate increase by up to 50%, accelerating elimination of renally cleared drugs (Stojanova et al., 2021). These changes can result in subtherapeutic drug concentrations when standard dosing regimens are maintained, or conversely, supratherapeutic levels for drugs primarily cleared by pathways that are inhibited (Arfman et al., 2020).

The clinical consequences of these pharmacokinetic alterations are most pronounced for drugs with narrow therapeutic indices, where small changes in plasma concentration can mean the difference between therapeutic efficacy and toxicity. Antiepileptic drugs (AEDs) exemplify this challenge. A comprehensive review of AED pharmacokinetics during pregnancy found that clearance increases and concentrations decrease for lamotrigine, levetiracetam, and oxcarbazepine, potentially leading to seizure breakthrough and fetal exposure to seizures (Arfman et al., 2020). Monitoring of levetiracetam, licarbazepine, lamotrigine, and topiramate is recommended during and after pregnancy, with trough concentrations obtained twice before pregnancy to establish individualized reference values (Arfman et al., 2020). Without such monitoring, clinicians risk either undertreating maternal disease or overexposing the fetus to medication.

Therapeutic Drug Monitoring in Clinical Practice

Therapeutic drug monitoring (TDM) — the measurement of drug concentrations in biological fluids to optimize dosing — has established value in pregnancy for selected drug classes (Arfman et al., 2020). Beyond AEDs, TDM is recommended for lithium, used in bipolar disorder, where pregnancy-related changes in renal clearance can lead to subtherapeutic levels and mood destabilization (Arfman et al., 2020). Monitoring of antiretroviral drugs in HIV-infected pregnant women has also been investigated, with evidence supporting dose adjustments for certain agents based on pregnancy-specific pharmacokinetic data (Stojanova et al., 2021). The role of TDM for antibiotics during pregnancy remains less well-defined, though physiological changes may reduce concentrations of beta-lactams and other agents, potentially compromising treatment efficacy (Stojanova et al., 2021).

The practical implementation of TDM in pregnancy faces several barriers. Scheduling of blood sampling at appropriate intervals (typically trough levels before the next dose) requires coordination between obstetrics, laboratory medicine, and pharmacy services (Arfman et al., 2020). Turnaround times for results may delay necessary dose adjustments, particularly in settings without on-site laboratory capabilities. Furthermore, trimester-specific reference ranges are not established for most drugs, and interpretation of concentrations requires clinical context including gestational age, co-medications, and individual patient factors (Stojanova et al., 2021).

Comprehensive Laboratory Assessment

Laboratory monitoring during pregnancy extends beyond drug concentration measurement to include organ function assessment, which is particularly important when using medications with potential hepatotoxicity or nephrotoxicity (Table 1). A study of clinical pharmacist involvement in monitoring hepatic function in pregnant women receiving methyldopa for hypertension found that initial elevations in liver enzymes stabilized on subsequent testing, suggesting relative safety when appropriate monitoring is in place (Opinc & Kalinka, 2021). This finding underscores the importance of baseline and serial laboratory testing for pregnant women on medications known to affect hepatic or renal function.

The interpretation of routine prenatal laboratory tests can also be affected by medication exposure. A retrospective cohort study found that antiseizure medications significantly alter second-trimester maternal serum biochemical markers used in prenatal screening for fetal aneuploidy and neural tube defects (Besimoglu et al., 2022). Clinicians interpreting these screening results must consider maternal medication exposure to prevent misclassification of fetal risk and avoid unnecessary invasive procedures such as amniocentesis. This example illustrates the broader principle that laboratory monitoring in pregnancy requires integration of pharmacokinetic, pharmacodynamic, and clinical information within a multidisciplinary framework (Arfman et al., 2020).

Table 1. Integrated Considerations for Medication Safety During Pregnancy and Lactation

Domain	Key Considerations	Clinical Recommendations
Pharmacovigilance	Regulatory harmonization; pregnancy exposure registries; spontaneous reporting systems	Utilize FAERS, LactMed®; contribute to registries; advocate for international harmonization
Maternal Nursing	Medication history-taking; patient education; interprofessional coordination	Obtain comprehensive medication history; provide non-directive counseling; facilitate specialist communication
Laboratory Monitoring	Pharmacokinetic changes; narrow therapeutic index drugs; organ function assessment	Establish individualized reference values; monitor AEDs, lithium; interpret prenatal screening with medication context
Imaging	Radiation dose; contrast agents; trimester-specific risks	Prefer ultrasound/MRI; limit gadolinium; discontinue breastfeeding only when indicated
Dental Care	Oral-systemic health; timing of procedures; medication safety	Schedule elective care in second trimester; use lidocaine, amoxicillin; avoid NSAIDs in first/third trimesters

Note. AEDs = antiepileptic drugs; MRI = magnetic resonance imaging; NSAIDs = nonsteroidal anti-inflammatory drugs. Adapted from ACOG (2017), Nadanovsky et al. (2024), Arfman et al. (2020), and Tezel Yalçın et al. (2024).

Diagnostic Imaging During Pregnancy and Lactation

Radiation Safety and Dose Considerations

Diagnostic imaging is an essential component of medical care that should not be withheld from pregnant women when clinically indicated. The American College of Obstetricians and Gynecologists (ACOG, 2017) emphasizes that ultrasonography and magnetic resonance imaging (MRI) are not associated with risk and represent the imaging techniques of choice for pregnant patients. For modalities involving ionizing radiation, including radiography, computed tomography (CT), and nuclear medicine, the radiation dose to the fetus is typically well below the threshold associated with fetal harm (Jain, 2019). The critical threshold for teratogenic effects is generally considered to be 100 milligray (mGy); diagnostic imaging studies rarely approach this level, with abdominal and pelvic CT delivering an estimated fetal dose of 10–50 mGy (ACOG, 2017).

The timing of exposure influences the nature of potential effects. During the pre-implantation period (0–2 weeks post-conception), radiation exposure may result in embryonic death or may have no effect, following an all-or-none principle (Jain, 2019). Organogenesis (2–10 weeks) represents the period of greatest sensitivity to teratogenic effects, with malformations possible at doses exceeding 200 mGy (ACOG, 2017). Later in pregnancy, the primary concern shifts to carcinogenesis rather than structural anomalies, with the risk of childhood cancer induction estimated to be very low for most diagnostic procedures (Kim & Boyd, 2022). These dose-response relationships inform the clinical approach: imaging should be performed when medically necessary, using the lowest radiation dose that achieves diagnostic quality (Ding et al., 2023).

Specific Imaging Modalities

Ultrasonography is the preferred first-line imaging modality in pregnancy, offering real-time evaluation without ionizing radiation (Lie et al., 2022). MRI is similarly safe throughout pregnancy and provides superior soft tissue contrast for evaluating maternal conditions such as appendicitis, deep vein thrombosis, and neurological emergencies (Lie et al., 2022). The use of gadolinium-based contrast agents (GBCAs) during pregnancy requires more careful consideration. While no harm has been definitively attributed to MRI with GBCA administration during pregnancy, gadolinium crosses the placenta and may theoretically dissociate into a neurotoxic non-chelated form (Jabehdar Maralani et al., 2022). Current recommendations advise limiting gadolinium use to situations where it significantly improves diagnostic performance and is expected to alter maternal or fetal management (ACOG, 2017).

For CT imaging, modern dose-reduction techniques and protocol optimization can minimize fetal exposure while maintaining diagnostic accuracy. CT pulmonary angiography, commonly performed to evaluate suspected pulmonary embolism in pregnancy, can be executed with fetal doses well below the 100 mGy threshold (dos Santos et al., 2020). Imaging of anatomical regions remote from the gravid uterus — such as the head, neck, thorax, and extremities — delivers negligible fetal doses, often less than 1 mGy (Ding et al., 2023). The decision to perform CT during pregnancy should be based on clinical necessity and the expectation that the results will meaningfully inform management (Gupta et al., 2016).

Breastfeeding Considerations

Lactating women undergoing diagnostic imaging with contrast agents face unique considerations (Table 2). For iodinated contrast media

used in CT, current evidence indicates that excretion into breast milk is minimal and that breastfeeding can continue without interruption (dos Santos et al., 2020). For gadolinium-based contrast agents, ACOG (2017) recommends that breastfeeding should not be interrupted following administration. This represents a shift from earlier practice, when temporary cessation of breastfeeding for 24 hours was sometimes recommended. Women should be informed about the small exposure to the infant and supported in making informed decisions about breastfeeding continuation (De Souza et al., 2024).

Table 2. Safety Profiles of Selected Medications Commonly Used in Pregnancy

Medication	Pregnancy Safety	Lactation Safety	Key Considerations
Amoxicillin	Safe (Category B)	Compatible	First-line for dental/UTI infections
Lidocaine	Safe (Category B)	Compatible	Standard dental anesthetic
Lamotrigine	Requires monitoring	Compatible	TDM recommended; dose adjustment in pregnancy
Lithium	Risk of cardiac anomalies	Monitor infant	TDM essential; avoid abrupt discontinuation
Paracetamol	First-line analgesic	Compatible	Preferred over NSAIDs
Ibuprofen	Avoid 1st/3rd trimester	Compatible	FDA warning for 2nd half of pregnancy
Gadolinium contrast	Limit to essential use	Continue breastfeeding	Theoretical risk of dissociation
Iodinated contrast	Safe when indicated	Continue breastfeeding	Minimal breast milk excretion

Note. TDM = therapeutic drug monitoring; UTI = urinary tract infection; NSAIDs = nonsteroidal anti-inflammatory drugs. Adapted from Nadanovsky et al. (2024), ACOG (2017), Arfman et al. (2020), and Bensaod (2024).

Dental Care During Pregnancy and Lactation

The Oral-Systemic Health Connection

Dental care during pregnancy is often unnecessarily deferred due to misconceptions about safety, yet untreated oral disease poses significant risks to both mother and fetus. Periodontal infections, pulp-involved caries, and third molar pericoronitis are common oral conditions in pregnancy, with periodontitis and acute pulpitis linked to adverse perinatal outcomes including preterm birth and low birth weight (Kamalabadi et al., 2023). The physiological changes of pregnancy — including increased estrogen and progesterone levels, altered immune response, and changes in oral flora — exacerbate susceptibility to gingivitis and periodontal disease (Barbosa et al., 2023). Nausea and vomiting during pregnancy can lead to enamel erosion (perimolysis), while increased acidity in the oral cavity promotes cariogenic processes (Anderson & Silk, 2022).

The second trimester represents the optimal window for elective dental procedures, as organogenesis is complete and the risk of preterm labor associated with third-trimester interventions is avoided (Rozylo-Kalinowska, 2020). Emergency dental care should be provided at any gestational age when clinically indicated. Comprehensive preconception oral examinations and standardized prenatal oral hygiene are key preventive strategies that can reduce the need for urgent interventions during pregnancy (Anderson & Silk, 2022).

Medication Safety in Dental Practice

Medication selection for dental procedures in pregnant women should prioritize low-risk agents. Lidocaine, the most commonly used local anesthetic in dentistry, has extensive safety data in pregnancy with no evidence of teratogenicity at doses used in dental practice (Rozylo-Kalinowska, 2020). Lidocaine with epinephrine is considered acceptable, as the epinephrine concentration used in dental anesthesia is unlikely to cause clinically significant vasoconstriction of uteroplacental vessels (Naseem et al., 2016). For patients requiring antibiotic therapy, amoxicillin, amoxicillin-clavulanate, and cephalexin represent first-line choices, as penicillins and cephalosporins have well-established safety profiles in pregnancy (Favero et al., 2021). Clindamycin is an acceptable alternative for penicillin-allergic patients (Naseem et al., 2016).

Analgesic selection requires particular attention. Acetaminophen (paracetamol) is the analgesic of choice for mild to moderate dental pain throughout pregnancy (Hwang et al., 2018). Nonsteroidal anti-inflammatory drugs (NSAIDs) should be avoided in the first and third trimesters due to associations with miscarriage and premature closure of the ductus arteriosus, respectively (Bensaod, 2024). Codeine-containing analgesics should be used with caution due to potential neonatal respiratory depression and the risk of dependence (Favero et al., 2021). The FDA issued a safety communication in 2024 requiring label changes for NSAIDs regarding use in the second half of pregnancy, reflecting accumulating evidence of fetal renal and cardiovascular effects (Siegel & Sammaritano, 2024).

Dental Radiography Safety

Dental radiography is safe during pregnancy when appropriate precautions are observed. The radiation dose from dental X-rays is extremely low,

with bitewing radiographs exposing the fetus to approximately 5–20 microsieverts — up to 30,000 times lower than the threshold for harm (Hwang et al., 2018). The American Dental Association (Nadanovsky et al., 2024) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) have updated their recommendations to state that patients do not need to wear a protective apron or thyroid collar during dental X-rays, as modern equipment and techniques limit scatter radiation to negligible levels. Lead shielding remains available for patients who prefer it, but its routine use is no longer considered necessary (Nadanovsky et al., 2024).

Integration and Synthesis: A Multidisciplinary Framework

The domains discussed in this review — pharmacovigilance, maternal nursing, laboratory monitoring, imaging, and dental care — are often addressed in isolation, yet optimal medication safety during pregnancy and lactation demands their integration. Table 1 summarizes the key considerations across these domains, while Figure 2 presents a conceptual model for integrated maternal medication safety.

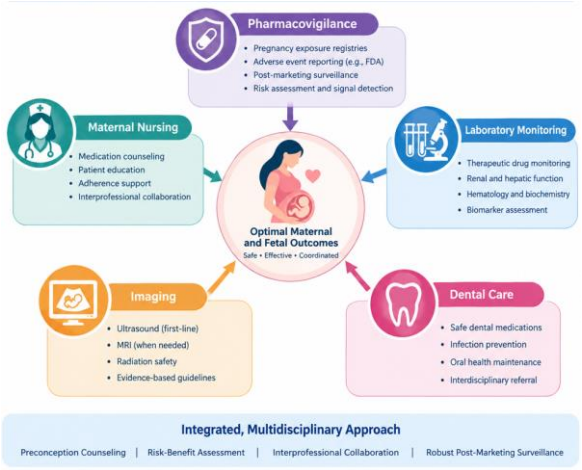

Figure 2. Conceptual Model for Integrated Maternal Medication Safety

Note. Adapted from ACOG (2017), Nadanovsky et al. (2024), Alexe et al. (2024), Arfman et al. (2020), and Giles et al. (2024).

Future Directions and Recommendations

Several priorities emerge for advancing medication safety in pregnancy and lactation. First, the harmonization of international pharmacovigilance regulations is urgently needed to facilitate efficient generation of pregnancy-specific safety data. The "call to action" issued by pharmaceutical industry representatives in 2024 provides a roadmap for reducing regulatory fragmentation (Alexe et al., 2024). Second, the integration of pharmacovigilance training into nursing and midwifery curricula must be strengthened, equipping frontline providers with the knowledge and resources to counsel patients effectively (Surtimanah et al., 2019). Third, expanded use of therapeutic drug monitoring for narrow therapeutic index drugs should be supported by the development of trimester-specific reference ranges and point-of-care testing capabilities (Arfman et al., 2020). Fourth, evidence-based guidelines for imaging and dental care during pregnancy must be disseminated more widely to counter persistent misconceptions about safety that lead to unnecessary avoidance of essential care (ACOG, 2017; Nadanovsky et al., 2024). Finally, research efforts should prioritize the inclusion of pregnant and lactating women in clinical trials when scientifically and ethically appropriate, moving beyond the default exclusion that has historically characterized drug development (Berrueta et al., 2021).

Conclusion

Medication use during pregnancy and lactation requires a paradigm shift from risk avoidance to risk-benefit optimization through multidisciplinary integration. Pharmacovigilance systems provide the surveillance infrastructure to detect safety signals, but regulatory harmonization and expanded pregnancy exposure registries are needed to generate actionable evidence (Alexe et al., 2024; Berrueta et al., 2021). Maternal nurses and midwives, as frontline providers, require enhanced training and resources to fulfill their potential as medication safety counselors. Laboratory monitoring, particularly therapeutic drug monitoring for antiepileptic drugs and other narrow therapeutic index agents, offers a personalized approach to dose optimization in the context of pregnancy-induced pharmacokinetic changes. Diagnostic imaging and dental care, often unnecessarily deferred, are safe and essential components of comprehensive maternal care when evidence-based guidelines are followed. By integrating these domains within a collaborative, patient-centered framework, healthcare systems can better protect the health of both mothers and their children during this critical period.

References

1. AbuShweimeh, R., Knudson, S., Chaabane, S., Pal, S. N., Skidmore, B., Stergachis, A., & Bhat, N. (2023). Pregnancy exposure registries for drugs and vaccines in low-income and middle-income countries: scoping review protocol. *BMJ open*, *13*(5), e070543.
2. Adrover, R., Siri, C., Cocozzella, D., Quarin, C., Romé, J., & Azi, H. (2016). Hepatotoxicity from Alpha-Methyldopa During Pregnancy: Two Case Reports. *Journal of Clinical Gastroenterology and Treatment*, *2*(3), 1-3.
3. Alexe A, Eisele O, Fernandes MF, Garg A, Kovacs B, Wurst K, Balramsingh-Harry L, Abramova N, Zheteyeva Y, Lewis D. Call to action: harmonization of pharmacovigilance regulations for post-marketing pregnancy and breastfeeding safety studies. British Journal of Clinical Pharmacology. 2024 Mar;90(3):715-21.

4. American College of Obstetricians and Gynecologists. (2017). Committee Opinion No. 723: guidelines for diagnostic imaging during pregnancy and lactation. *Obstetrics & Gynecology*, *130*(4), e210-e216.
5. Anderson, R., & Silk, H. (2022). Oral Health Intervention Before Pregnancy: A Preconception Approach. *Journal of the California Dental Association*, *50*(4), 217-222.
6. Arfman, I. J., Wammes-van der Heijden, E. A., Ter Horst, P. G., Lambrechts, D. A., Wegner, I., & Touw, D. J. (2020). Therapeutic Drug Monitoring of Antiepileptic Drugs in Women with Epilepsy Before, During, and After Pregnancy: IJ Arfman et al. *Clinical pharmacokinetics*, *59*(4), 427-445.
7. Balkam, J. J. (2022). Galactagogues and lactation: Considerations for counseling breastfeeding mothers. *MCN: The American Journal of Maternal/Child Nursing*, *47*(3), 130-137.
8. Barbosa, M. C. F., da Rocha, N. B., de Souza Gomes Rodrigues, H., de Oliveira, D. S. B., Fernandes, L. A., & de Lima, D. C. (2023). Maternal knowledge of oral health during pregnancy and childbirth. *Maternal and Child Health Journal*, *27*(9), 1607-1615.
9. Bensaod, L. (2024). Evaluation of Practice and Awareness of the Safety Profile of Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) among Dental Practitioners: A Cross-Sectional Study.
10. Berrueta, M., Ciapponi, A., Bardach, A., Cairoli, F. R., Castellano, F. J., Xiong, X., ... & Buekens, P. (2021). Maternal and neonatal data collection systems in low-and middle-income countries for maternal vaccines active safety surveillance systems: A scoping review. *BMC pregnancy and childbirth*, *21*(1), 217.
11. Besimoglu, B., Öcal, F. D., Sinaci, S., Atalay, A., Tanaçan, A., & Şahin, D. (2022). Effect of antiepileptic drugs on serum biochemical marker levels of first and second trimester screening tests. *Journal of Obstetrics and Gynaecology Research*, *48*(7), 1607-1612.
12. Blattner, C. M., Danesh, M., Safaee, M., & Murase, J. E. (2016). Understanding the new FDA pregnancy and lactation labeling rules. *International Journal of Women's Dermatology*, *2*(1), 5.
13. Brucker, M. C., & King, T. L. (2017). The 2015 US Food and Drug Administration pregnancy and lactation labeling rule. *Journal of midwifery & women's health*, *62*(3), 308-316.
14. Cha, E., Smart, M. J., Braxter, B. J., & Faulkner, M. S. (2021). Preconception care to reduce the risks of overweight and obesity in women of reproductive age: an integrative review. *International journal of environmental research and public health*, *18*(9), 4582.
15. Charron, E., Mayo, R. M., Heavner-Sullivan, S. F., Eichelberger, K. Y., Dickes, L., Truong, K. D., & Rennert, L. (2020). "It'sa very nuanced discussion with every woman": Health care providers' communication practices during contraceptive counseling for patients with substance use disorders. *Contraception*, *102*(5), 349-355.
16. Dathe, K., & Schaefer, C. (2018). Drug safety in pregnancy: the German Embryotox institute. *European journal of clinical pharmacology*, *74*(2), 171-179.
17. Daw, J. R., Underhill, K., Liu, C., & Allen, H. L. (2023). The health and social needs of medicaid beneficiaries in the postpartum year: Evidence from a multistate survey: Study examines extension of Medicaid benefits one year postpartum. *Health Affairs*, *42*(11), 1575-1585.
18. De Souza, J., Viswanath, V. K., Echterhoff, J. M., Chamberlain, K., & Wang, E. J. (2024). Augmenting telepostpartum care with vision-based detection of breastfeeding-related conditions: algorithm development and validation. *JMIR AI*, *3*(1), e54798.
19. Ding, A., Joshi, J., & Tiwana, E. (2023). Patient safety in radiology and medical imaging. In *Patient Safety: A Case-based Innovative Playbook for Safer Care* (pp. 261-277). Cham: Springer International Publishing.
20. dos Santos, F. M., Senra, C., & Maciel, C. (2020, January). Contrast Agents Administration in Pregnancy and Lactation: Safety Issues and Practical Points in Everyday Practice. European Congress of Radiology-ECR 2020.
21. Favero, V., Bacci, C., Volpato, A., Bandiera, M., Favero, L., & Zanette, G. (2021). Pregnancy and dentistry: A literature review on risk management during dental surgical procedures. *Dentistry journal*, *9*(4), 46.
22. Giles, A., Prusinski, R., & Wallace, L. (2024). *Maternal-newborn nursing*. OpenStax.
23. Gupta, R., Bajaj, S. K., Kumar, N., Chandra, R., Misra, R. N., Malik, A., & Thukral, B. B. (2016). Magnetic resonance imaging-a troubleshooter in obstetric emergencies: a pictorial review. *Indian Journal of Radiology and Imaging*, *26*(01), 44-51.
24. Hwang, S. Y., Choi, E. S., Kim, Y. S., Gim, B. E., Ha, M., & Kim, H. Y. (2018). Health effects from exposure to dental diagnostic X-ray. *Environmental health and toxicology*, *33*(4), e2018017.

25. Jabehdar Maralani, P., Kapadia, A., Liu, G., Moretti, F., Ghandehari, H., Clarke, S. E., ... & Schieda, N. (2022). Canadian Association of Radiologists recommendations for the safe use of MRI during pregnancy. *Canadian Association of Radiologists Journal*, *73*(1), 56-67.
26. Jain, C. (2019). ACOG Committee Opinion No. 723: guidelines for diagnostic imaging during pregnancy and lactation. *Obstetrics & Gynecology*, *133*(1), 186.
27. Kamalabadi, Y. M., Campbell, M. K., Zitoun, N. M., & Jessani, A. (2023). Unfavourable beliefs about oral health and safety of dental care during pregnancy: a systematic review. *BMC oral health*, *23*(1), 762.
28. Kim, E., & Boyd, B. (2022). Diagnostic imaging of pregnant women and fetuses: literature review. *Bioengineering*, *9*(6), 236.
29. Lie, G., Eleti, S., Chan, D., Roshen, M., Cross, S., & Qureshi, M. (2022). Imaging the acute abdomen in pregnancy: a radiological decision-making tool and the role of MRI. *Clinical Radiology*, *77*(9), 639-649.
30. Mansour, O., Russo, R. G., Straub, L., Bateman, B. T., Gray, K. J., Huybrechts, K. F., & Hernández-Díaz, S. (2024). Prescription medication use during pregnancy in the United States from 2011 to 2020: trends and safety evidence. *American journal of obstetrics and gynecology*, *231*(2), 250-e1.
31. Nadanovsky, P., Pires dos Santos, A. P., & Nunan, D. (2024). Too Much Dental Radiography—Reply. *JAMA internal medicine*, *184*(12), 1481-1481.
32. Naseem, M., Khurshid, Z., Khan, H. A., Niazi, F., Zohaib, S., & Zafar, M. S. (2016). Oral health challenges in pregnant women: Recommendations for dental care professionals. *The Saudi Journal for Dental Research*, *7*(2), 138-146.
33. Opinc, M., & Kalinka, J. (2021). Drug-induced liver injury in early pregnancy associated with methyldopa administration during antihypertensive therapy. *Journal of Obstetrics and Gynecological Investigations*, *4*(1), 1-4.
34. Ricci, S. (2020). *Essentials of maternity, newborn, and women's health*. Lippincott Williams & Wilkins.
35. Roque Pereira, L., Durán, C. E., Layton, D., Poulentzas, G., Lalagkas, P. N., Kontogiorgis, C., & Sturkenboom, M. (2022). A Landscape Analysis of Post-Marketing Studies Registered in the EU PAS Register and ClinicalTrials. gov Focusing on Pregnancy Outcomes or Breastfeeding Effects: A Contribution from the ConcePTION Project: LR Pereira et al. *Drug safety*, *45*(4), 333-344.
36. Rozylo-Kalinowska, I. (2020). Safety Precautions for Dental Patient and Dental Staff Using X-Rays. In *Imaging Techniques in Dental Radiology: Acquisition, Anatomic Analysis and Interpretation of Radiographic Images* (pp. 177-188). Cham: Springer International Publishing.
37. Siegel, C. H., & Sammaritano, L. R. (2024). Safety of medications used to treat autoimmune rheumatic diseases during pregnancy and lactation. *JCR: Journal of Clinical Rheumatology*, *30*(7S), S25-S33.
38. Stojanova, J., Arancibia, M., Ghimire, S., & Sandaradura, I. (2022). Understanding the pharmacokinetics of antibiotics in pregnancy: is there a role for therapeutic drug monitoring? A narrative review. *Therapeutic Drug Monitoring*, *44*(1), 50-64.
39. Surtimanah, T., Noviyanti, E., & Meliyanti, M. (2019). Differences of family support and iron tablets consumed post pregnant women classes and midwives counseling. *IJPHRD*, *10*(3), 999-1006.
40. Tezel Yalçın, H., Yalçın, N., Ceulemans, M., & Allegaert, K. (2024). Drug safety during breastfeeding: A comparative analysis of FDA adverse event reports and LactMed®. *Pharmaceuticals, 17*(12), 1654.
41. Thorpe, P. G., Gilboa, S. M., Hernandez-Diaz, S., Lind, J., Cragan, J. D., Briggs, G., ... & National Birth Defects Prevention Study. (2013). Medications in the first trimester of pregnancy: most common exposures and critical gaps in understanding fetal risk. *Pharmacoepidemiology and drug safety*, *22*(9), 1013-1018.
42. van de Vusse, D., Mian, P., Schoenmakers, S., Flint, R. B., Visser, W., Allegaert, K., & Versmissen, J. (2022). Pharmacokinetics of the most commonly used antihypertensive drugs throughout pregnancy methyldopa, labetalol, and nifedipine: a systematic review. *European journal of clinical pharmacology*, *78*(11), 1763-1776.
43. Vignato, J., Mehner, B., Negrete, A., & Segre, L. S. (2023). Over-the-counter pain medication use during pregnancy. *MCN: The American Journal of Maternal/Child Nursing*, *48*(4), 209-214.
44. Vinogradov, R., Smith, V., Hiu, S., McParlin, C., Farnworth, A., & Araújo-Soares, V. (2023). Let's talk aspirin: A survey of barriers and facilitators faced by midwives when engaging in conversations about aspirin with women at risk of pre-eclampsia. *Midwifery*, *127*, 103860.

45. World Health Organization. (2022). *WHO Pharmaceuticals Newsletter: No. 2, 2022*. World Health Organization.

World Health Organization. (2024). *Landscape analysis of pregnancy exposure registries in low-and middle-income countries*. World Health Organization.