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Teratogenic Medications: An Updated Review For Pharmaceutical Workers

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Abstract:

Background: The impact of teratogenic drugs on fetal development remains a critical concern for pharmaceutical workers and healthcare professionals. These drugs, including neurological, antimicrobial, and hormonal medications, can cause structural, functional, or growth anomalies during pregnancy, particularly in the first trimester, a crucial phase of organogenesis.

Aim: This review highlights updated knowledge on teratogenic medications, focusing on their mechanisms, risks, and outcomes, to aid healthcare professionals in safeguarding maternal and fetal health.

Methods: The study synthesizes findings from recent literature on various classes of teratogenic drugs, their pharmacological actions, and their specific effects on fetal development. Regulatory frameworks like the U.S. Food and Drug Administration's Pregnancy and Lactation Labeling Rule (PLLR) are also discussed.

Results: Neurological medications such as antiepileptics (e.g., valproate and carbamazepine) exhibit high teratogenic potential, leading to neural tube defects, craniofacial malformations, and growth delays. Antimicrobial agents, including tetracyclines and fluoroquinolones, have been associated with skeletal growth suppression and renal toxicity. Hormonal drugs like diethylstilbestrol have caused genital anomalies and adenocarcinomas, while excessive vitamin A intake leads to neural tube and cardiovascular malformations. Regulatory categories of drug safety emphasize the importance of balancing maternal benefits against fetal risks.

Conclusion: Teratogenic drugs pose significant risks, necessitating careful risk-benefit assessments and multidisciplinary management during pregnancy. Education on safer alternatives and adherence to regulatory guidelines are vital to minimize fetal harm while addressing maternal health needs.

Keywords: Teratogenic drugs, pregnancy, fetal anomalies, neurological medications, antimicrobial drugs, hormonal drugs, pharmaceutical workers.

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Introduction:

Over recent decades, the medical community has developed a deeper understanding of the potential detrimental effects of certain drugs on fetal development, particularly when administered during pregnancy. A notable example is thalidomide, initially marketed as a safe over-the-counter remedy for morning sickness, which resulted in severe outcomes for the fetus, including miscarriages and congenital deformities [1]. In 2015, the US Food and Drug Administration (FDA) advanced its drug safety framework by replacing the traditional "A, B, C, D, X" pregnancy labeling system with the Pregnancy and Lactation Labeling Rule (PLLR) [2]. The severity of fetal defects depends on the gestational age at exposure, with the first trimester, a critical phase of organogenesis, being especially vulnerable to major malformations [3]. An in-depth understanding of teratogenic drugs' mechanisms, risks, and outcomes is essential for healthcare professionals to safeguard maternal and fetal health.

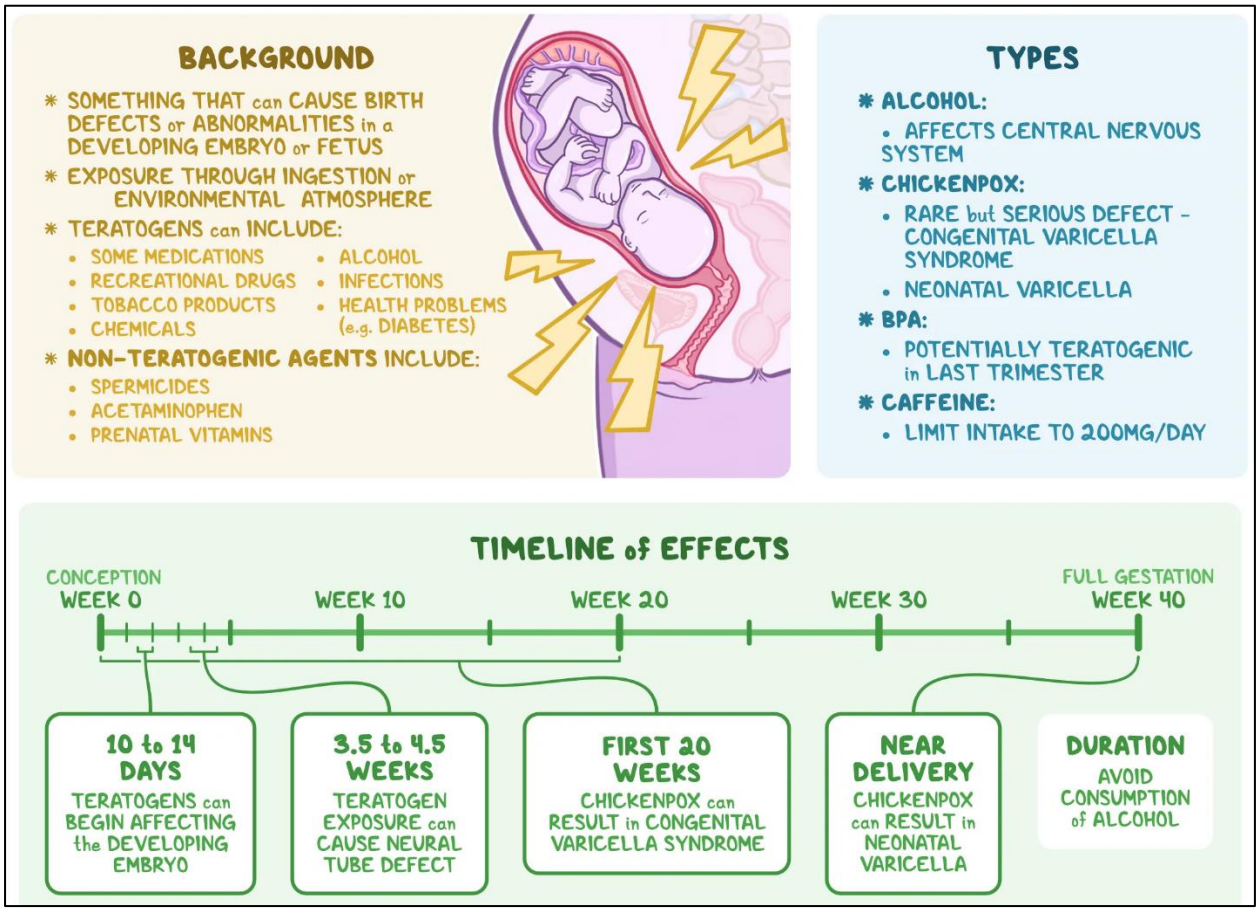

Figure 1: Teratogenicity.

Issues of Concern: Neurological Medications

Neurological medications rank among the most teratogenic drug categories. Antiepileptic drugs (AEDs), widely prescribed for managing seizures, neuropathic pain, migraines, and psychiatric conditions, exhibit significant teratogenic risks. At lower doses, AEDs may impair cognitive development, while higher doses are linked to structural abnormalities [4]. Phenobarbital, for instance, induces CYP450 2B and 3A gene activity, genetics that cause DNA base transversions. Clinically, this translates to inhibited growth, delayed motor development, and increased fetal mortality [5][6]. Similarly, valproate poses substantial teratogenic risks, leading to cardiac defects, neural tube anomalies such as spina bifida, and developmental delays. It has been associated with fetal valproate syndrome, characterized by distinct facial dysmorphisms, limb defects, cleft palate, and urinary tract abnormalities [7][8][9]. These outcomes are mediated by folate inhibition, histone deacetylase disruption, and reactive oxygen species accumulation [10][11]. Carbamazepine, used for epilepsy and bipolar disorder during pregnancy, metabolizes into carbamazepine-

10,11-epoxide, which damages DNA and is associated with craniofacial anomalies, reduced IQ, and growth delays [9][12]. Lamotrigine, although deemed one of the safer mood stabilizers for pregnancy, presents a heightened risk for fetal facial malformations, particularly cleft defects [13][14]. Phenytoin exposure in utero elevates the risk of fetal phenytoin syndrome (FHS), characterized by growth deficiencies, intellectual impairments, and facial abnormalities such as a short nose with anteverted nostrils. This teratogenicity arises from free radicals generated through prostaglandin H synthase bioactivation, leading to oxidative DNA damage [15][16]. Topiramate, another AED used for epilepsy and migraines, has been associated with hypospadias and oral clefts in infants, particularly when administered in high doses during pregnancy [17][18].

Issues of Concern: Antimicrobial Medications

Antimicrobial drugs, extensively prescribed during pregnancy and lactation, warrant careful attention due to pharmacokinetic changes in pregnant women and potential fetal harm. Chloramphenicol, which inhibits bacterial protein synthesis by binding to the 50S ribosomal subunit, can cause dose-dependent bone marrow suppression and gray baby syndrome, particularly in premature infants with underdeveloped renal and hepatic metabolism [19][20]. Tetracyclines, known to bind to the 30S ribosomal subunit, are contraindicated in pregnancy due to risks of liver necrosis, skeletal growth suppression, and dental defects. Their capacity to cross the placenta and form calcium complexes can result in bone discoloration and hypoplastic tooth enamel [23][24]. Fluoroquinolones, acting on bacterial DNA gyrase and topoisomerase IV enzymes, are linked to renal, cardiac, and central nervous system toxicity. Studies have demonstrated dose-dependent cartilage damage and limb development impairment in embryonic tissues [21][22]. Streptomycin, an aminoglycoside, is associated with irreversible congenital deafness and should be avoided, particularly in the first trimester. Other aminoglycosides, such as gentamicin, tobramycin, and amikacin, may be cautiously administered when the benefits outweigh the risks. Sulfamethoxazole/trimethoprim poses risks of fetal malformations in early pregnancy and kernicterus in late gestation, while nitrofurantoin, although generally safe, has been linked to hemolytic anemia in glucose-6-phosphate dehydrogenase-deficient mothers [21]. Rifampin, safe at recommended doses, can cause fetal malformations and newborn bleeding at higher dosages [21]. Azole antifungals, particularly fluconazole at doses exceeding 400 mg/day, have been linked to craniofacial anomalies resembling Antley-Bixler syndrome, highlighting the need for caution with antifungal prescriptions during pregnancy [25].

Issues of Concern: Anticoagulants

Coumarin derivatives, such as warfarin, are widely recognized for their teratogenic effects during pregnancy. These compounds function as vitamin K antagonists, disrupting the γ-carboxylation of glutamyl residues, a critical process for normal skeletal development. This impairment often leads to significant fetal anomalies, including skeletal malformations, nasal hypoplasia, and central nervous system abnormalities. The most severe manifestation, known as fetal warfarin syndrome (FWS), is particularly likely to occur when exposure happens between gestational weeks 6 and 9 [26][27]. During this period, the fetus is highly susceptible to teratogenic insults, making careful management of anticoagulation therapy essential for pregnant individuals. Alternative anticoagulants with a safer profile, such as low molecular weight heparins, are often recommended to mitigate these risks. Monitoring maternal coagulation parameters, alongside a tailored therapeutic approach, is critical to minimize fetal harm while maintaining maternal health. This underscores the importance of a multidisciplinary team in managing high-risk pregnancies.

Issues of Concern: Antithyroid Medications

Antithyroid drugs, including propylthiouracil (PTU) and methimazole (MMI), are pivotal in managing hyperthyroidism during pregnancy but present significant teratogenic risks. These medications inhibit thyroperoxidase, reducing thyroid hormone synthesis. However, they have been associated with fetal complications such as aplasia cutis and structural anomalies like choanal or esophageal atresia, though evidence regarding these effects remains contentious [28][29]. Clinical guidelines recommend PTU during the first trimester due to its relatively lower risk profile compared to MMI, which is preferred later in pregnancy. Despite these precautions, thyroid dysfunction in pregnancy requires a delicate balance

between controlling maternal hyperthyroidism and minimizing fetal risks. Frequent monitoring of thyroid hormone levels is essential to adjust dosages appropriately. Ongoing research aims to refine therapeutic strategies to ensure both maternal and fetal safety while addressing the complex interplay of thyroid dysfunction and teratogenesis.

Issues of Concern: Vitamin A

Vitamin A, essential for embryonic development, becomes teratogenic when consumed in excessive amounts through diet or supplements. Retinoic acid, a metabolite of vitamin A, plays a vital role in embryogenesis but may cause severe malformations if dysregulated. High doses of vitamin A during pregnancy have been linked to neural tube defects, cardiovascular anomalies, and craniofacial malformations. These effects are attributed to the interaction of retinoids with cranial neural crest cells and specific cellular groups within the central nervous system, leading to developmental disruptions [30][31]. Pregnant individuals are advised to limit vitamin A intake, adhering to recommended daily allowances to avoid teratogenic thresholds. Awareness campaigns and prenatal counseling emphasize the risks associated with over-the-counter supplements containing high doses of vitamin A or retinoids. The development of safer alternatives, such as non-teratogenic vitamin A analogs, is ongoing. These measures underscore the need for vigilant prenatal care and education regarding the teratogenic risks of excessive vitamin A consumption.

Issues of Concern: Hormonal Medications

Hormonal medications during pregnancy, particularly diethylstilbestrol (DES) and androgenic steroids, have demonstrated significant teratogenic potential. DES, a synthetic estrogen once prescribed to prevent miscarriages, is now linked to adverse outcomes, including vaginal and cervical adenocarcinomas and genital tract anomalies in offspring exposed in utero [32][33]. Its ability to cross the placenta and metabolize into reactive intermediates amplifies its teratogenic effects. Similarly, androgenic steroids administered during the first trimester can lead to masculinization of female fetuses, presenting as clitoromegaly or labial fusion [34]. These findings have prompted regulatory agencies to restrict the use of such medications during pregnancy. In contemporary practice, hormonal therapies are employed with caution, ensuring their necessity outweighs potential risks. Genetic counseling and detailed fetal monitoring are integral to managing pregnancies where hormonal interventions are unavoidable. Enhanced understanding of hormonal teratogenic mechanisms has also driven advancements in developing safer therapeutic options for at-risk pregnancies.

Fetal Development and Teratogenic Drugs:

Teratogenic drugs are classified based on their potential to cause harm to a developing fetus. Regulatory authorities, including the U.S. Food and Drug Administration (FDA), have established categories to guide healthcare professionals in assessing the risks associated with drug use during pregnancy. These categories provide a framework for determining the degree of teratogenic risk:

- **Category A:** Drugs in this category have been studied in pregnant women and have demonstrated no risk to the fetus in the first trimester or later stages of development. These medications are considered safe when used appropriately.
- **Category B:** Animal studies have shown no evidence of harm to the fetus, but well-controlled studies in pregnant women are lacking. Alternatively, some animal studies may indicate adverse effects, but human studies have not confirmed these risks.
- **Category C:** Drugs in this category lack adequate human studies, and animal studies have revealed potential adverse effects. These medications should only be used if the benefits to the mother outweigh potential risks to the fetus.
- **Category D:** Evidence from human studies or post-market surveillance indicates a risk to the fetus. However, these drugs may be considered if the benefits of treatment for life-threatening conditions outweigh the risks.

- **Category X:** Medications in this category are contraindicated during pregnancy due to significant evidence of fetal abnormalities or adverse outcomes. The risks associated with these drugs far outweigh any potential benefits. By understanding these classifications, healthcare providers can make informed decisions regarding the use of medications during pregnancy, balancing maternal health needs with fetal safety.

Common Drug-Induced Fetal Anomalies:

Teratogenic drugs are known to cause a variety of fetal anomalies, depending on the type of medication, the timing of exposure during pregnancy, and the dose administered. These anomalies often result from interference with normal developmental processes, leading to structural, functional, or growth abnormalities.

- **Central Nervous System (CNS) Defects:** Drugs such as antiepileptics, including valproate and carbamazepine, are associated with neural tube defects, including spina bifida. Valproate, in particular, disrupts folate metabolism, a critical factor in neural tube development, resulting in incomplete closure of the spinal column.
- **Cardiovascular Anomalies:** Lithium, used to treat bipolar disorder, has been linked to congenital heart defects, particularly Ebstein's anomaly. This condition involves the malformation of the tricuspid valve, impairing cardiac function.
- **Craniofacial Malformations:** Isotretinoin, a retinoid used for severe acne, is a potent teratogen known to cause craniofacial deformities such as cleft palate and micrognathia. Its mechanism involves disruption of cranial neural crest cell migration and differentiation.
- **Limb Defects:** Thalidomide, historically prescribed as a sedative, is infamous for causing phocomelia, a condition characterized by shortened or absent limbs. This occurs due to impaired angiogenesis during limb bud development.
- **Skeletal Abnormalities:** Warfarin, an anticoagulant, impairs vitamin K-dependent γ-carboxylation of proteins essential for bone development. This can lead to nasal hypoplasia and stippled epiphyses, hallmark features of fetal warfarin syndrome.
- **Endocrine Disruptions:** Diethylstilbestrol (DES), a synthetic estrogen, is associated with vaginal adenocarcinoma and reproductive tract malformations in female offspring. Its teratogenic effects are linked to altered hormonal signaling pathways.
- **Gastrointestinal Malformations:** Methimazole, an antithyroid drug, is implicated in choanal and esophageal atresia, conditions that obstruct normal airway and digestive tract development.
- **Miscellaneous Anomalies:** Nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen can cause premature closure of the ductus arteriosus, leading to pulmonary hypertension in the neonate. The severity of these anomalies underscores the necessity for healthcare providers to exercise caution when prescribing medications to pregnant women. By understanding the teratogenic potential of specific drugs, clinicians can implement preventive strategies, prioritize alternative treatments, and counsel patients effectively to reduce fetal risks.

Role of Pharmacists in Dealing with Pregnancy and Teratogenic Drugs:

Pharmacists play a pivotal role in ensuring the safe and effective use of medications during pregnancy, particularly in the context of teratogenic drugs. Their unique expertise in pharmacology and patient counseling equips them to mitigate the risks associated with teratogens while prioritizing both maternal and fetal health. This responsibility encompasses various aspects, including medication management, patient education, risk assessment, and interprofessional collaboration.

Medication Management and Risk Mitigation

Pharmacists are at the forefront of managing medications for pregnant women, particularly in cases where teratogenic drugs are involved. Their responsibilities include conducting thorough reviews of patients' medication histories to identify and mitigate potential risks. Pharmacists ensure that medications prescribed during pregnancy align with established safety guidelines and regulatory classifications, such as the FDA's pregnancy categories. They also assess the appropriateness of drug therapy, considering the

balance between maternal health needs and fetal safety. When necessary, pharmacists recommend alternative therapies with lower teratogenic risks or suggest dose adjustments to minimize fetal exposure while maintaining therapeutic efficacy for the mother.

Patient Education and Counseling

Patient education is a cornerstone of pharmacists' role in dealing with teratogenic drugs. Pregnant women may lack awareness of the potential risks associated with specific medications. Pharmacists are instrumental in providing clear, evidence-based information about the teratogenic potential of drugs, including possible fetal anomalies and developmental effects. They counsel patients on the importance of adhering to prescribed regimens, avoiding over-the-counter medications without professional guidance, and understanding the consequences of noncompliance. This guidance empowers pregnant women to make informed decisions regarding their medication use, thereby reducing the likelihood of inadvertent exposure to teratogens.

Risk Assessment and Preconception Planning

Pharmacists play a critical role in risk assessment, particularly for women of childbearing age who are planning pregnancy or are at risk of unplanned pregnancies. By reviewing medication profiles and medical histories, pharmacists can identify teratogenic risks and engage in preconception counseling. For women on teratogenic drugs, pharmacists may collaborate with physicians to implement pregnancy prevention programs, such as prescribing contraceptives or initiating patient education on effective birth control methods. These strategies are essential for minimizing unintended teratogenic exposure during the critical early stages of fetal development.

Monitoring and Pharmacovigilance

Pharmacists actively participate in monitoring and reporting adverse drug reactions associated with teratogenic drugs. This pharmacovigilance role involves tracking maternal and fetal outcomes in cases where teratogenic medications are used. By maintaining meticulous records and contributing to post-market surveillance data, pharmacists help refine safety profiles for medications and support evidence-based decision-making in clinical practice. Monitoring efforts also enable early identification of potential teratogenic effects, facilitating timely interventions and adjustments to treatment protocols.

Interprofessional Collaboration

Effective management of teratogenic drugs during pregnancy requires collaboration among healthcare professionals, and pharmacists are integral members of this interprofessional team. They work alongside physicians, nurses, and other specialists to develop individualized care plans for pregnant patients. Pharmacists contribute their expertise in drug interactions, pharmacokinetics, and teratogenicity to inform prescribing decisions and optimize patient outcomes. Additionally, pharmacists play a key role in educating other healthcare providers about the safe use of medications in pregnancy, fostering a unified approach to minimizing teratogenic risks.

Ethical Considerations and Patient Autonomy

Pharmacists are bound by ethical responsibilities to prioritize patient safety and autonomy. When dealing with teratogenic drugs, they must navigate complex scenarios involving potential risks to the fetus while respecting the mother's right to make informed choices about her treatment. Pharmacists ensure that patients are fully informed of the benefits, risks, and alternatives to their prescribed medications, enabling them to weigh their options and make decisions aligned with their values and circumstances. This ethical approach fosters trust between pharmacists and patients and reinforces the importance of patient-centered care.

Role in Emergency Situations

In cases where a pregnant woman inadvertently takes a teratogenic drug or experiences complications related to medication use, pharmacists provide critical support. They assess the severity of

potential fetal harm and collaborate with the healthcare team to determine appropriate interventions. Pharmacists may recommend diagnostic tests, such as ultrasounds or amniocentesis, to evaluate fetal development and guide clinical decision-making. Their expertise in managing drug-related emergencies ensures timely and effective responses, reducing the likelihood of adverse outcomes.

Research and Continuing Education

Pharmacists contribute to advancing knowledge in the field of teratology through research and participation in continuing education programs. By staying abreast of emerging data on teratogenic drugs, pharmacists ensure that their practice reflects the latest scientific evidence. They may also engage in clinical studies investigating the safety and efficacy of medications during pregnancy, furthering the understanding of teratogenic risks and informing future guidelines.

Policy Development and Advocacy

Pharmacists play a role in shaping policies and advocating for regulations that promote safe medication use during pregnancy. They may collaborate with healthcare organizations, regulatory agencies, and advocacy groups to develop guidelines for prescribing teratogenic drugs and implementing risk management programs. Through their advocacy efforts, pharmacists help raise awareness of teratogenic risks and emphasize the importance of preventive measures at both individual and systemic levels. In conclusion, pharmacists serve as essential healthcare providers in managing the complexities of teratogenic drug use during pregnancy. Their multifaceted role encompasses medication management, patient education, risk assessment, interprofessional collaboration, and advocacy. By leveraging their expertise and commitment to patient safety, pharmacists play a critical role in safeguarding maternal and fetal health while addressing the unique challenges posed by teratogenic drugs.

Clinical Significance

The importance of addressing teratogenic drugs in clinical practice cannot be overstated, as their potential to cause significant harm to a developing fetus represents a critical concern in healthcare. Medical professionals are tasked with the responsibility of understanding the profound implications these substances have on pregnancy outcomes. Exposure to teratogenic agents during gestation is associated with a spectrum of adverse effects, including congenital anomalies, developmental delays, pregnancy loss, and enduring health complications for the child. This necessitates a rigorous approach to prescribing, underscored by informed decision-making on the part of both healthcare providers and expectant mothers. Comprehensive knowledge of teratogenic mechanisms, along with emerging research findings, is fundamental to designing effective prevention strategies. Such strategies aim to mitigate risks and enhance the safety of maternal and fetal health, ensuring the highest standards of care for pregnant individuals.

Interprofessional Team Interventions

The ethical and judicious management of teratogenic drugs relies on a cohesive interprofessional healthcare team equipped with specialized expertise and a commitment to patient-centered care. By fostering collaboration among clinicians, nurses, pharmacists, and other healthcare professionals, the risks associated with teratogenic drug use can be minimized while optimizing maternal and fetal outcomes. Healthcare providers must maintain a high level of proficiency and understanding of teratogenic drugs. Prior to prescribing, obtaining a comprehensive medication history is essential to avoid clinically significant drug interactions. Physicians and advanced practice providers should have an in-depth comprehension of potential risks and pharmacological interactions. Pharmacists play a pivotal role in medication reconciliation, addressing questions, and supporting team decision-making. Additionally, nurses and allied health professionals must demonstrate competence in drug administration, ongoing monitoring, and patient education to safeguard both mother and child. A robust strategy for managing teratogenic drug use is indispensable. The interprofessional team should collaborate to establish standardized protocols encompassing prescribing, monitoring, and patient education. These protocols should emphasize risk assessment and foster a culture of patient safety. Engaging the pregnant patient in discussions about the potential risks of medication therapy is critical. The principles of informed consent and patient autonomy

should guide these interactions, with the shared goal of prioritizing the health of both the mother and the fetus. Transparent and empathetic communication ensures that patients are empowered to make well-informed decisions about their treatment, reinforcing trust and partnership in the care process.

Conclusion:

Teratogenic medications continue to present challenges for healthcare professionals tasked with ensuring both maternal and fetal well-being. Understanding the mechanisms, risks, and outcomes associated with these drugs is essential for minimizing adverse effects. Neurological medications, including antiepileptics such as valproate and carbamazepine, exemplify the dangers posed by teratogens, with outcomes ranging from neural tube defects to developmental delays. These risks underscore the need for individualized risk assessments and alternative therapies when managing conditions like epilepsy and bipolar disorder in pregnant patients. Antimicrobial agents, widely prescribed during pregnancy, also require cautious use. Drugs like tetracyclines and fluoroquinolones, though effective, are linked to skeletal and renal anomalies, emphasizing the necessity of prescribing safer alternatives whenever possible. Hormonal medications and excessive vitamin A intake further highlight the complex interplay between maternal health needs and fetal safety. Historical cases, such as diethylstilbestrol, have demonstrated the long-term consequences of teratogenic exposure, influencing modern regulatory frameworks and prescribing practices. Regulatory systems, such as the U.S. FDA's Pregnancy and Lactation Labeling Rule, play a pivotal role in guiding healthcare professionals by categorizing drugs based on their teratogenic potential. These frameworks enable informed decision-making, balancing the benefits of treatment against the risks of fetal harm. Moreover, the classification of teratogens into categories (A through X) offers a structured approach to evaluate and mitigate risks. To ensure optimal care, interdisciplinary collaboration among obstetricians, pharmacists, and other healthcare providers is crucial. Ongoing education for pharmaceutical workers and healthcare professionals can enhance awareness of teratogenic risks and foster the adoption of safer therapeutic options. Personalized counseling for pregnant patients and meticulous monitoring of drug use are vital components of prenatal care. Future research should focus on refining therapeutic strategies and developing non-teratogenic alternatives to address maternal health needs without compromising fetal development. In conclusion, the management of teratogenic medications demands a nuanced understanding of their pharmacological actions, coupled with adherence to regulatory guidelines. By prioritizing maternal and fetal safety, healthcare professionals can contribute to reducing the burden of drug-induced fetal anomalies while advancing maternal healthcare outcomes.

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الملخص:

الخلفية :يمثل تأثير الأدوية المسببة لتشوه الاجنة على نمو الجنين مصدر قلق بالغ للعاملين في مجال الصيدلة والرعاية الصحية. يمكن لهذه الأدوية، بما في ذلك الأدوية العصبية والمضادات الميكروبية والهرمونية، أن تسبب تشوهات هيكلية أو وظيفية أو في النمو خلال فترة الحمل، خاصة في الثلث الأول، الذي يُعد مرحلة حاسمة لتكوين الأعضاء.

الهدف :تسلط هذه المراجعة الضوء على المعرفة المحدثة حول الأدوية المسببة لتشوه الاجنة، مع التركيز على آلياتها ومخاطرها وتأثيراتها، لمساعدة المتخصصين في الرعاية الصحية في حماية صحة الأم والجنين.

المنهجية :يجمع البحث نتائج الأدبيات الحديثة حول الفئات المختلفة من الأدوية المسببة لتشوه الاجنة، وآليات عملها الدوائية، وتأثيراتها المحددة على نمو الجنين. كما يناقش الإطار التنظيمي مثل قاعدة تصنيف الحمل والرضاعة الخاصة بإدارة الغذاء والدواء الأمريكية.(PLLR)

النتائج :أظهرت الأدوية العصبية مثل مضادات الصرع (مثل الفالبروات والكاربامازبين) قدرة تشوه عالية، مما يؤدي إلى عيوب الأنبوب العصبي وتشوهات الوجه والجماجم وتأخر النمو. وارتبطت العوامل المضادة للميكروبات، مثل التتراسيكلين والفلوروكينولونات، بتثبيط نمو الهيكل العظمي وسمية الكلى. تسببت الأدوية الهرمونية مثل الداي إيثيل ستيلبيسترول في تشوهات تناسلية وأورام غدية، بينما أدى الإفراط في تناول فيتامين (أ) إلى تشوهات في الأنبوب العصبي والأوعية الدموية القلبية. تؤكد الفئات التنظيمية لسلامة الأدوية أهمية تحقيق التوازن بين فوائد الأم ومخاطر الجنين.

الخلاصة :تشكل الأدوية المسببة لتشوه الاجنة مخاطر كبيرة، مما يستلزم تقييمات دقيقة للمخاطر والفوائد وإدارة متعددة التخصصات أثناء الحمل. يعد التعليم بشأن البدائل الأكثر أمانًا والالتزام بالإرشادات التنظيمية أمرًا ضروريًا لتقليل الضرر على الجنين مع تلبية احتياجات صحة الأم.

الكلمات المفتاحية :الأدوية المسببة لتشوه الاجنة، الحمل، تشوهات الجنين، الأدوية العصبية، الأدوية المضادة للميكروبات، الأدوية الهرمونية، العاملون في الصيدلة.