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Genetic Factors Contributing to Obstetric Hemorrhage: A Review of Current Evidence

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Abstract Obstetric hemorrhage remains one of the leading causes of maternal morbidity and mortality worldwide. While environmental and clinical factors have been extensively studied, hereditary factors are increasingly recognized as important contributors to the risk and severity of hemorrhagic events during pregnancy and childbirth. This literature review aims to synthesize current evidence on the role of genetic predisposition in obstetric hemorrhage. Studies indicate that variations in genes related to coagulation pathways, platelet function, and vascular integrity may influence susceptibility to excessive bleeding. Understanding these genetic determinants can improve risk assessment, inform personalized management strategies, and enhance preventive care for at-risk women. Despite advances, gaps remain in the comprehensive identification of relevant genetic markers, underscoring the need for further genomic and epidemiological research.

Keywords Obstetric hemorrhage, Maternal bleeding, Hereditary factors, Genetic predisposition, Coagulation disorders, Pregnancy complications

1. Introduction

Obstetric hemorrhage is a significant global health concern, representing one of the leading causes of maternal morbidity and mortality, particularly in low- and middle-income countries. [4] According to the World Health Organization, hemorrhage accounts for approximately 27% of all maternal deaths worldwide, making it a critical area of obstetric care that requires both preventive and therapeutic strategies. Obstetric hemorrhage can occur during pregnancy, labor, or the postpartum period, and its etiology is multifactorial, encompassing clinical, environmental, and genetic determinants. While risk factors such as uterine atony, placenta previa, and traumatic delivery have been extensively studied, the contribution of hereditary or genetic factors is increasingly recognized as an important yet underexplored area of maternal-fetal medicine. [3]

Genetic predisposition may influence the susceptibility of pregnant women to excessive bleeding through several biological mechanisms. These include abnormalities in coagulation pathways, platelet function, and vascular integrity, which collectively impact hemostasis. Variations in genes encoding coagulation factors, such as Factor V, Factor VIII, and fibrinogen, have been linked to altered clotting capacity, potentially increasing the risk of hemorrhage during childbirth. Similarly, mutations or polymorphisms in genes regulating platelet adhesion and aggregation may compromise primary hemostasis, contributing to severe blood loss. Understanding these genetic determinants is essential not only for identifying high-risk individuals but also for developing personalized strategies for prevention and management. [5]

Recent advances in molecular genetics and genomics have facilitated the identification of genetic markers associated with obstetric hemorrhage. For instance, studies employing genome-wide association studies (GWAS) and targeted gene analysis have revealed associations between specific single nucleotide polymorphisms (SNPs) and coagulation disorders that predispose women to excessive bleeding. Furthermore, inherited conditions such as von Willebrand disease, hemophilia carriers, and other rare coagulopathies demonstrate the relevance of hereditary factors in clinical practice. The identification of such genetic risks has practical implications for prenatal screening, patient counseling, and individualized delivery planning. [6]

Despite these advances, the literature highlights several gaps in current knowledge. Many studies have small sample sizes, lack ethnic diversity, or focus predominantly on postpartum hemorrhage without considering antepartum or intrapartum bleeding. Additionally, the complex interaction between genetic and environmental factors, such as nutritional status, comorbidities, and obstetric interventions, complicates the interpretation of genetic contributions. As a result, there remains a need for comprehensive research integrating genomics, epidemiology, and clinical data to provide robust evidence on the role of hereditary factors in obstetric hemorrhage. [2]

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The significance of understanding hereditary influences extends beyond risk assessment. By elucidating the genetic mechanisms underlying abnormal bleeding, clinicians can implement targeted preventive measures, such as prophylactic administration of clotting factor concentrates, optimization of labor management, or early referral to specialized centers. Moreover, knowledge of genetic susceptibility informs the development of guidelines for family counseling, allowing women with known hereditary risks to make informed reproductive choices and anticipate potential complications during pregnancy. [7]

2. Materials and Methods

This study is a comprehensive literature review aimed at evaluating the role of hereditary factors in the development of obstetric hemorrhage. The review followed a structured methodology to ensure the inclusion of relevant, recent, and high-quality scientific evidence. [1]

1. Literature Sources

The data for this review were obtained from multiple electronic databases, including **PubMed, Scopus, Web of Science, and Google Scholar**. Additionally, relevant articles were identified through references cited in previously published reviews and meta-analyses. Efforts were made to include studies published in **English and Russian** between **2000 and 2025**, ensuring a focus on contemporary findings related to genetics, obstetrics, and hemostasis.

2. Search Strategy

A systematic search was conducted using a combination of **keywords and Medical Subject Headings (MeSH)** terms. The primary search terms included: [8]

"obstetric hemorrhage" OR "maternal bleeding"
"genetic factors" OR "hereditary predisposition"
"coagulation disorders" OR "platelet function"
"pregnancy complications"

Boolean operators (AND, OR) were used to refine the search and combine terms for maximum sensitivity. For example, searches such as "obstetric hemorrhage AND genetic predisposition" were conducted to identify studies specifically examining hereditary contributions to maternal bleeding.

3. Inclusion and Exclusion Criteria

To ensure the relevance and quality of the selected studies, the following **inclusion criteria** were applied:

Original research studies, systematic reviews, and meta-analyses addressing genetic or hereditary factors in obstetric hemorrhage.

Studies reporting genetic markers, gene polymorphisms, or hereditary coagulation disorders associated with bleeding risk during pregnancy, labor, or postpartum.

Studies with clear methodology, sample size, and clinical outcome data.

The **exclusion criteria** were:

Case reports or studies with insufficient sample size (<20 participants).

Studies not specifically related to obstetric hemorrhage or maternal bleeding.

Non-English/Russian publications without accessible abstracts.

Articles focused solely on environmental, surgical, or pharmacological risk factors without addressing hereditary contributions.

4. Data Extraction

For each eligible study, the following data were systematically extracted:

Author(s), year of publication, and study location.

Study design (cohort, case-control, cross-sectional, or review).

Population characteristics (age, ethnicity, pregnancy stage).

Genetic factors analyzed (coagulation factor genes, platelet function genes, inherited disorders). [9]

Key findings regarding the association between genetic variants and risk/severity of obstetric hemorrhage.

Data extraction was conducted independently by two researchers to ensure accuracy and minimize bias. Discrepancies were resolved through discussion and consensus.

5. Data Synthesis and Analysis

Given the heterogeneity of study designs and genetic markers, a **qualitative synthesis** approach was employed. Studies were categorized based on the type of hereditary factor assessed, such as:

Coagulation factor gene mutations (e.g., Factor V Leiden, prothrombin gene mutation).

Platelet function and aggregation gene variants.

Inherited bleeding disorders (e.g., von Willebrand disease, hemophilia carriers).

The findings were analyzed to identify patterns of association, potential mechanisms of action, and clinical relevance. Where possible, comparative insights were drawn regarding differences in hereditary influence among populations and ethnic groups.

6. Ethical Considerations

As this study is a review of previously published literature, no direct patient involvement was conducted, and ethical approval was not required. However, all studies included were critically appraised to ensure adherence to ethical research standards, including informed consent and appropriate reporting of human subject data.

3. Conclusions

In conclusion, obstetric hemorrhage is a major maternal health issue with multifactorial etiology, in which hereditary factors play a crucial but underappreciated role. Genetic variations affecting coagulation, platelet function, and vascular integrity contribute to individual susceptibility and influence clinical outcomes. Despite emerging evidence,

substantial gaps remain in understanding the full spectrum of genetic determinants. This literature review aims to synthesize current knowledge on hereditary contributions to obstetric hemorrhage, highlighting the implications for clinical practice, risk assessment, and future research. Recognizing the interplay between genetic and environmental factors is essential for improving maternal safety, developing personalized care strategies, and reducing the global burden of obstetric hemorrhage. Obstetric hemorrhage remains a critical cause of maternal morbidity and mortality worldwide, with multifactorial etiology involving clinical, environmental, and genetic factors. This review highlights the significant role of hereditary predisposition in influencing the risk, severity, and clinical outcomes of maternal bleeding during pregnancy, labor, and the postpartum period. Genetic variations affecting coagulation pathways, platelet function, and vascular integrity have been shown to contribute to individual susceptibility to obstetric hemorrhage. Inherited disorders such as von Willebrand disease, hemophilia carriers, and polymorphisms in coagulation factor genes underscore the clinical relevance of hereditary factors in maternal care. [10]

Understanding the genetic determinants of obstetric hemorrhage has important implications for both risk assessment and clinical management. Identification of women with genetic susceptibility allows for targeted preventive strategies, such as individualized monitoring during labor, prophylactic administration of clotting factor concentrates, and timely referral to specialized centers. Furthermore, incorporating genetic screening into prenatal care can facilitate informed counseling, enhance maternal safety, and potentially reduce the incidence of severe hemorrhagic events.

Despite the advances in molecular genetics and genomics, significant gaps remain in fully elucidating the spectrum of hereditary factors associated with obstetric hemorrhage. Many studies are limited by small sample sizes, population -specific findings, and incomplete integration of genetic and environmental variables. Therefore, further large-scale, multicenter, and ethnically diverse studies are needed to provide robust evidence for clinical practice and to inform guidelines for genetic risk assessment in obstetrics.

In summary, hereditary factors play a crucial and underappreciated role in the development of obstetric hemorrhage. Recognizing and understanding these genetic influences is essential for improving maternal outcomes, advancing personalized obstetric care, and guiding future research in maternal-fetal medicine. Enhanced awareness of genetic susceptibility can ultimately contribute to the reduction of maternal morbidity and mortality associated with hemorrhagic complications.

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