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Review Article

Preconception counseling in women with pre-existing diabetes mellitus: evidence-based strategies to improve pregnancy outcomes

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ABSTRACT

Pregnancy complicated by pre-existing diabetes mellitus is associated with increased maternal and fetal morbidity. Hyperglycemia during the periconceptional period significantly increases the risk of congenital malformations, spontaneous abortions, and adverse perinatal outcomes. Preconception counseling plays a vital role in optimizing metabolic control and minimizing complications before pregnancy occurs. The aim of this review is to summarize current evidence and highlight practical clinical strategies for optimizing pregnancy outcomes in women with pre-existing diabetes. A literature search was conducted using PubMed and Google Scholar for articles published between 2000 and 2024 using keywords "preconception care," "diabetes," and "pregnancy outcomes". Relevant literature was identified from international clinical guidelines and peer-reviewed publications using standard database searches. Optimal preconception care includes achieving strict glycemic control, screening for diabetic complications, reviewing medications, initiating folic acid supplementation, optimizing body weight, and ensuring effective contraception until glycemic targets are achieved. Multidisciplinary care involving obstetricians, endocrinologists, dieticians, and ophthalmologists is essential for comprehensive management. Evidence suggests that structured preconception programs significantly reduce congenital malformations, perinatal mortality, and maternal complications in diabetic pregnancies. Despite this, many pregnancies in women with diabetes remain unplanned, emphasizing the need for improved counseling and awareness. Early identification and management of reproductive-age women with diabetes should be incorporated into routine clinical care. Implementation of standardized preconception counseling protocols can substantially improve maternal and fetal outcomes.

Keywords: Preconception counseling, Pregestational diabetes, Glycemic control, Pregnancy outcomes, Maternal complications, Fetal complications

INTRODUCTION

Pre-existing diabetes mellitus (DM) remains one of the most important medical conditions affecting pregnancy outcomes worldwide.[1,2] The prevalence of both type 1 and type 2 diabetes among women of reproductive age has increased significantly, contributing to a growing burden of high-risk pregnancies. Unlike gestational DM, hyperglycemia in pre-existing diabetes affects embryogenesis during the critical period of organogenesis (3-8 weeks of gestation), leading to an increased risk of congenital malformations and adverse perinatal outcomes.

Poor glycemic control in the periconceptional period is strongly associated with spontaneous abortions, congenital anomalies, and maternal complications. Despite clear guideline recommendations, many pregnancies in women with diabetes remain unplanned, limiting opportunities for risk optimization. Preconception counseling has emerged as a key intervention to improve maternal and fetal

outcomes by optimizing metabolic status and addressing modifiable risk factors prior to conception.

This review aims to summarize current evidence and highlight practical clinical strategies for improving pregnancy outcomes in women with pre-existing diabetes.

According to the American diabetes association (ADA) and the National Institute for Health and Care Excellence (NICE), preconception care is the most effective intervention to reduce adverse outcomes in diabetic pregnancies.[3,4]

LITERATURE REVIEW

A narrative review of literature was conducted using PubMed, Google Scholar, and guideline sources for studies published from 2000 to 2024. Search terms included "preconception care," "diabetes," "pregnancy outcomes," and "pregestational diabetes." Relevant English-language articles, guidelines, systematic reviews, and original studies were included based on clinical relevance.

PATHOPHYSIOLOGY OF HYPERGLYCEMIA-INDUCED TERATOGENESIS

Maternal hyperglycemia contributes to teratogenesis through multiple mechanisms, including oxidative stress, altered gene expression, apoptosis in embryonic tissues, and impaired neural crest migration. These pathological processes interfere with normal embryonic development and organogenesis, thereby increasing the risk of congenital anomalies.[5,6]

The risk of congenital malformations increases proportionally with elevated HbA1c at conception.[7-9]

MATERNAL AND FETAL RISKS IN PRE-EXISTING DIABETES

Maternal risks

Women with pre-existing diabetes face several maternal complications during pregnancy. These include progression of diabetic retinopathy, worsening nephropathy, development of preeclampsia, episodes of severe hypoglycemia, and diabetic ketoacidosis. The presence of chronic diabetic complications before conception further increases maternal morbidity and may adversely affect pregnancy outcomes.

Fetal and neonatal risks

Fetal and neonatal complications are also significantly increased in diabetic pregnancies. These include spontaneous abortion, congenital malformations such as cardiac defects, neural tube defects, and caudal regression syndrome, and macrosomia, polyhydramnios, intrauterine fetal demise, and neonatal hypoglycemia. Pregestational diabetes is associated with increased maternal complications and adverse neonatal outcomes.[10-12]

ROLE OF PRECONCEPTION COUNSELING

Preconception counseling aims to optimize maternal health before conception and reduce the risks associated with diabetic pregnancy. The primary objectives include achieving optimal glycemic control, reducing teratogenic risk, screening for and stabilizing end-organ damage, modifying medications that may be harmful during pregnancy, and providing contraceptive guidance until pregnancy can be safely attempted.

Glycemic optimization before conception

Achieving optimal glycemic control before conception is the cornerstone of preconception care in women with diabetes. Both the ADA and NICE recommend a target HbA1c level below 6.5% (48 mmol/mol), provided this can be achieved without causing significant hypoglycemia.[3,4]

Women should be advised to avoid conception if HbA1c exceeds 10%, as the risk of congenital anomalies rises substantially at higher glycemic levels. Tight glycemic control before conception has been shown to reduce the incidence of congenital malformations, spontaneous abortion, and adverse perinatal outcomes.

Table 1: Relationship between maternal HbA1c at Conception and Risk of Congenital Malformations

HbA1c level at conception	Estimated risk of congenital malformations
≤6.5%	~2-3% (near baseline population risk)
7-8%	~5%
8-9%	~8-10%
>10%	20-25%

Folic acid supplementation

Women with pre-existing diabetes should receive high-dose folic acid supplementation at a dose of 5 mg daily, beginning at least three months before conception and continuing through the first trimester. Adequate folic acid supplementation significantly reduces the risk of neural tube defects and is strongly recommended by major international guidelines.[4] NICE recommends continuation until 12 weeks of gestation, while the ADA similarly supports high-dose folic acid supplementation in women planning pregnancy.

SCREENING FOR DIABETIC COMPLICATIONS

Retinopathy

Pregnancy may accelerate proliferative retinopathy.[13] Preconception fundoscopic examination is recommended.

Nephropathy

Assessment of renal function is essential in women planning pregnancy. Evaluation should include serum creatinine measurement, urine albumin-to-creatinine ratio assessment, and blood pressure monitoring. Diabetic nephropathy is associated with increased risks of fetal growth restriction, preeclampsia, preterm birth, and worsening maternal renal function during pregnancy.[10] Identification and optimization of renal disease before conception are therefore crucial.

Cardiovascular assessment

Cardiovascular evaluation should be considered, particularly in women with long-standing type 1 diabetes and those with type 2 diabetes who have additional cardiovascular risk factors. Assessment may include blood pressure evaluation, electrocardiography, and further investigations when clinically indicated. Identification of cardiovascular disease before conception allows appropriate counseling and risk stratification.

MEDICATION REVIEW AND DRUG SAFETY

Teratogenic medications must be discontinued prior to conception.

Table 2: Drug safety in preconception period.

Drug class	Recommendation before conception
ACE inhibitors	Discontinue
ARBs	Discontinue
Statins	Discontinue
Metformin	May be continued (case-based decision)
Insulin	Preferred therapy
SGLT2 inhibitors	Discontinue
GLP-1 receptor agonists	Discontinue

Insulin remains the gold standard therapy for glycemic control during pregnancy.[3,4,14]

Weight optimization and lifestyle

Weight optimization and lifestyle modification are fundamental components of preconception care in women with pre-existing diabetes. Women should be encouraged to achieve a healthy body mass index, preferably below 25 kg/m² where feasible, before conception. Medical nutrition therapy tailored to individual needs can help improve glycemic control and reduce insulin resistance. Regular moderate physical activity further enhances insulin sensitivity and contributes to better metabolic health. Smoking cessation and avoidance of alcohol should be strongly emphasized as part of preconception counseling. Obesity is associated with increased risks of preeclampsia, cesarean delivery, fetal macrosomia, and other adverse pregnancy outcomes; therefore, achieving optimal weight before conception can significantly improve maternal and fetal health.[15]

Thyroid screening

Type 1 DM is associated with autoimmune thyroid disease. TSH testing is recommended preconceptionally.

Contraception until optimal control

Women with diabetes should be advised to use effective contraception until optimal glycemic control has been achieved, diabetic complications have been appropriately evaluated and stabilized, and potentially teratogenic medications have been discontinued or replaced with safer alternatives.

Multidisciplinary care

Successful preconception care requires a multidisciplinary approach involving obstetricians, endocrinologists, ophthalmologists, dieticians, and diabetes educators.

IMPACT OF STRUCTURED PRECONCEPTION PROGRAMS

Multiple studies have demonstrated the effectiveness of structured preconception care programs in improving outcomes among women with pre-existing diabetes. These programs are associated with improved glycemic control before conception, reduced rates of congenital anomalies, lower perinatal mortality, and decreased incidence of maternal complications such as preeclampsia.[16-18]

WHO emphasizes integration of preconception care into routine diabetes management for reproductive-age women.[19]

Table 3: Key components of preconception evaluation in women with pre-existing diabetes.

Assessment component	Recommended evaluation	Purpose
Glycemic control	HbA1c measurement	Ensure HbA1c <6.5% before conception
Blood glucose monitoring	SMBG or CGM	Achieve stable glycemic control
Retinal examination	Dilated fundus exam	Detect and treat diabetic retinopathy
Renal assessment	Serum creatinine, urine albumin	Evaluate diabetic nephropathy
Cardiovascular assessment	BP measurement, ECG if indicated	Identify cardiovascular risk
Medication review	Stop ACE inhibitors, ARBs, statins	Avoid teratogenic drugs

Continued.

Assessment component	Recommended evaluation	Purpose
Thyroid function test	TSH levels	Detect autoimmune thyroid disease
Folic acid supplementation	5 mg/day	Prevent neural tube defects
Weight and BMI assessment	BMI calculation	Address obesity and insulin resistance
Contraceptive counseling	Reliable contraception until control achieved	Prevent unplanned high-risk pregnancy

Table 4: Insulin regimen adjustments in preconception and early pregnancy.

Insulin strategy	Description	Clinical considerations
Basal-bolus regimen	Long-acting basal insulin + rapid-acting mealtime insulin	Most commonly recommended regimen
Multiple daily injections	3-4 injections per day	Allows flexible glycemic control
Continuous subcutaneous insulin infusion (insulin pump)	Continuous basal insulin delivery with bolus dosing	Useful in women with type 1 diabetes
Rapid-acting insulin analogues	Insulin lispro, insulin aspart	Better postprandial glucose control
Long-acting insulin analogues	Insulin detemir or glargine	Used for basal coverage
Dose adjustments	Frequent dose titration based on SMBG	Insulin requirement may vary before pregnancy

Table 5: Maternal and fetal complications associated with pre-existing diabetes in pregnancy.

Maternal complications	Fetal/neonatal complications
Preeclampsia	Congenital malformations
Worsening diabetic retinopathy	Macrosomia
Diabetic nephropathy progression	Polyhydramnios
Diabetic ketoacidosis	Intrauterine fetal demise
Hypoglycemia episodes	Neonatal hypoglycemia
Increased cesarean section rate	Respiratory distress syndrome
Infections	Birth trauma

CLINICAL STRATEGIES FOR IMPROVING PREGNANCY OUTCOMES

Achieving optimal glycemic control before conception

Optimal glycemic control prior to conception is the most important determinant of pregnancy outcome in women with pre-existing diabetes. Poor glycemic control during early embryogenesis increases risk of congenital malformations and spontaneous abortions. Women planning pregnancy should aim for an HbA1c level below 6.5% without significant hypoglycemia. Regular self-monitoring of blood glucose and appropriate adjustment of insulin therapy help maintain stable glycemic levels. Several studies have demonstrated that achieving near-normal HbA1c levels before conception significantly reduces incidence of congenital anomalies, spontaneous abortion, and adverse perinatal outcomes. Structured preconception care programs emphasizing glycemic optimization have consistently shown improved pregnancy outcomes in women with pre-existing diabetes.[16-18]

Early screening and management of DM complications

Women with long-standing diabetes should undergo evaluation for chronic complications before conception. Screening for diabetic retinopathy, nephropathy, and cardiovascular disease is essential because pregnancy may worsen these conditions. Dilated fundus examination and renal function assessment should be performed as part of routine evaluation. Preconception assessment of diabetic retinopathy, nephropathy, and cardiovascular disease facilitates timely intervention and reduces maternal morbidity during pregnancy. Women with advanced diabetic complications require individualized counseling and multidisciplinary management before conception.[13,20]

Medication adjustment and insulin optimization

Several medications commonly used in diabetic patients may have teratogenic effects and should be discontinued before conception. Drugs such as ACE inhibitors, angiotensin receptor blockers, and statins are contraindicated in pregnancy. Insulin therapy remains the preferred treatment for achieving tight glycemic control in women planning pregnancy. Rapid-acting insulin analogues provide better postprandial glucose control and may improve glycemic stability. Current guidelines recommend discontinuation of potentially teratogenic medications before conception and emphasize insulin as the preferred therapy for achieving tight glycemic control during pregnancy. Appropriate medication review before

conception contributes substantially to safer maternal and fetal outcomes.[3,4,14]

Nutritional counseling and lifestyle modification

Lifestyle modification plays an important role in improving pregnancy outcomes among women with diabetes. Medical nutrition therapy guided by a dietician helps maintain optimal glycemic levels and appropriate weight. Regular moderate physical activity improves insulin sensitivity and metabolic control. Lifestyle interventions aimed at weight reduction, healthy dietary practices, and regular physical activity improve insulin sensitivity and glycemic control. These measures reduce the risk of pregnancy complications associated with obesity and diabetes.[15]

Multidisciplinary antenatal care

Pregnancy in women with pre-existing diabetes requires coordinated multidisciplinary management. Care should involve obstetricians, endocrinologists, dieticians, and diabetes educators. Early antenatal registration and regular follow-up visits allow close monitoring of maternal and fetal health. Patient education regarding glucose monitoring and insulin administration is essential. Evidence suggests that coordinated multidisciplinary care involving obstetricians, endocrinologists, diabetes educators, ophthalmologists, and dieticians improves metabolic control and reduces adverse maternal and neonatal outcomes.[16-18]

DISCUSSION

Despite strong evidence supporting preconception counseling, many pregnancies among women with diabetes remain unplanned, limiting opportunities for optimization before conception. Studies have identified lack of awareness, inadequate counseling, socioeconomic barriers, and limited access to specialized preconception services as major challenges to implementation.[20]

Clinical strategies for improving pregnancy outcomes should therefore focus on routine integration of preconception counseling into diabetes care. Healthcare providers should regularly discuss reproductive intentions with women of childbearing age, provide individualized risk assessment, encourage effective contraception until glycemic targets are achieved, and promote folic acid supplementation before conception. Structured preconception programs have been associated with improved glycemic control at conception, lower rates of congenital malformations, and reduced perinatal mortality.[16-18]

Greater involvement of primary care physicians, endocrinologists, and obstetricians is necessary to ensure timely referral and continuity of care. Expanding access to preconception services and increasing patient awareness may substantially improve maternal and fetal outcomes, particularly in low- and middle-income countries.

FUTURE DIRECTIONS AND RESEARCH GAPS

Despite significant advances in the management of diabetes in pregnancy, several gaps remain in optimizing preconception care for women with pre-existing DM. One major challenge is the limited awareness and utilization of structured preconception counseling services among women of reproductive age with diabetes. Future research should focus on strategies to improve patient education, accessibility of counseling programs, and early identification of women planning pregnancy.

Another important area is the integration of digital health technologies such as continuous glucose monitoring systems and telemedicine platforms in preconception care. These technologies have the potential to improve glycemic monitoring, enhance patient engagement, and facilitate remote management, particularly in resource-limited settings. Emerging technologies such as continuous glucose monitoring and telemedicine may improve glycemic control and pregnancy outcomes.[21,22]

Further studies are also required to evaluate the long-term maternal and offspring outcomes associated with different preconception management strategies. Large multicenter prospective studies could provide stronger evidence on optimal glycemic targets, medication safety, and lifestyle interventions before conception.

In addition, more research is needed to understand the psychosocial barriers that prevent women with diabetes from seeking preconception counseling. Addressing these barriers through targeted educational programs and community-based interventions may improve the uptake of preventive care.

Strengthening multidisciplinary collaboration and developing standardized clinical guidelines for preconception management of diabetes remain essential priorities. Future efforts should aim to integrate endocrinology, obstetric, and primary care services to ensure comprehensive care for women planning pregnancy.

CONCLUSION

Preconception counseling significantly improves pregnancy outcomes in women with pre-existing diabetes. Achieving optimal glycemic control before conception is the most critical modifiable factor in preventing congenital malformations. Structured, guideline-based multidisciplinary care should be universally implemented. Implementation of practical preconception clinical strategies including glycemic optimization, complication screening, medication review, lifestyle modification and coordinated multidisciplinary management can substantially improve maternal and fetal outcomes.

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