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INNOVATIVE MONITORING TECHNOLOGIES FOR PRIMIGRAVID WOMEN IN MODERN OBSTETRICS

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Abstract: This literature review discusses innovative monitoring technologies for primigravid women, including telemedicine platforms, remote blood pressure monitoring, mobile cardiotocography, wireless sensor systems and Doppler assessment of uteroplacental and fetal blood flow. Modern digital solutions allow earlier detection of hypertensive disorders, placental dysfunction, fetal growth restriction and other obstetric complications, while also improving patient routing and the rational use of medical resources. The review highlights the clinical value of home telemonitoring in intermediate- and high-risk pregnancies, the role of mobile applications and artificial intelligence in decision support, and the importance of ethical, organizational and economic conditions for implementation. The integration of digital technologies into antenatal care should be based on standardized protocols, data protection, patient education and interdisciplinary cooperation.

Keywords: first pregnancy, primigravida, telemedicine, remote monitoring, blood pressure, mobile CTG, Doppler ultrasound, digital obstetrics.

Introduction

Primigravid women require increased attention in modern obstetrics because they more frequently develop hypertensive disorders, placental dysfunction, fetal growth restriction, abnormalities of labor and adverse perinatal outcomes. Traditional antenatal care is usually based on scheduled visits and episodic assessment of maternal and fetal status. Although this model remains fundamental, it may not always provide sufficiently early detection of rapidly progressing complications.

The digitalization of health care, the development of telemedicine platforms, mobile applications, wearable sensors and data analysis algorithms open new opportunities for continuous observation of pregnant women. Innovative monitoring technologies make it possible to combine routine clinical assessment with remote control of blood pressure, symptoms, fetal heart rate, glucose levels, body weight and other indicators. This is particularly important for women living in remote areas and for patients with intermediate or high obstetric risk.

The aim of this review is to analyze literature data on the use of innovative monitoring technologies in primigravid women and to evaluate their significance for early detection of complications, optimization of antenatal care and improvement of maternal and perinatal outcomes.

Telemedicine in obstetrics: main directions

Telemedicine technologies occupy an increasingly important place in obstetrics and gynecology. Publications of recent years demonstrate a steady growth of interest in remote consultations, hybrid antenatal visits, mobile health applications, electronic diaries, telemonitoring systems and remote

interpretation of diagnostic data. Telemedicine does not replace clinical examination, ultrasound, laboratory diagnostics or emergency care, but it can effectively complement them and improve continuity of observation.

Historically, the first projects in teleobstetrics were associated with remote consultations between district hospitals and specialized centers. Currently, this field includes video consultations, digital referral pathways, remote analysis of cardiotocograms, home monitoring of blood pressure and symptoms, monitoring of glycemia in gestational diabetes and postpartum telefollow-up. Such tools are especially useful in high-risk pregnancies, where delays in decision-making may lead to severe maternal or fetal complications.

The most promising model is a hybrid approach in which telemedicine supplements face-to-face visits. This system preserves the clinical value of direct examination while reducing unnecessary travel, improving access to specialists and enabling rapid correction of management tactics. For primigravid women, who may not recognize early warning symptoms, telemedicine can also play an educational role and improve adherence to medical recommendations.

Remote blood pressure monitoring and prevention of preeclampsia

Hypertensive disorders of pregnancy remain a leading cause of maternal and perinatal morbidity. For primigravid women this problem is especially significant because nulliparity is considered an epidemiological risk factor for preeclampsia. Remote blood pressure monitoring allows pregnant women to measure blood pressure at home and transmit the results to a clinician or digital platform for assessment.

The literature emphasizes that this model improves the frequency and quality of observation, helps distinguish true hypertension from the white-coat phenomenon, allows earlier detection of a persistent increase in blood pressure and supports timely referral for additional examination. In women at high risk of preeclampsia, daily or regular home measurements may reveal dangerous trends earlier than standard scheduled visits.

Remote blood pressure control should be implemented within clear clinical protocols. These protocols must define threshold values, the frequency of measurements, rules for repeated measurements, criteria for urgent contact with medical staff and indications for hospitalization. Without standardized procedures, telemonitoring may increase anxiety and workload without improving outcomes.

For primigravid women, remote monitoring may be combined with symptom questionnaires, assessment of edema, headache, visual disturbances, epigastric pain, fetal movements and urine protein testing when indicated. In this way, telemonitoring becomes not only a technical tool but also a component of risk-oriented antenatal care.

Mobile cardiotocography and wireless sensor systems

Cardiotocography is a widely used method for assessing fetal functional status. Evidence-based data indicate that routine admission CTG in low-risk labor does not always improve perinatal outcomes. However, in high-risk pregnancies and in situations requiring dynamic fetal surveillance, CTG remains an important diagnostic method.

Mobile CTG devices and wireless sensor systems create new opportunities for monitoring pregnant women at risk. Modern mobile devices can record fetal heart rate and uterine activity outside a hospital setting, transmit the data to a remote center and allow analysis by trained specialists. This

approach is especially relevant for women living far from perinatal centers, for patients with reduced fetal movements, placental dysfunction, fetal growth restriction or a history of adverse perinatal outcomes.

Studies comparing mobile CTG with conventional on-site nonstress testing have shown a high level of diagnostic concordance. When the procedure is performed by trained staff or after adequate patient instruction, remote fetal monitoring can reduce the need for repeated hospital visits while maintaining clinical safety. Nevertheless, mobile CTG should be used selectively and according to indications, because excessive monitoring may lead to overdiagnosis and unnecessary interventions.

Wireless sensor systems expand the possibilities of maternal monitoring. They may include sensors for body temperature, heart rate, physical activity, uterine activity and other parameters. The integration of such systems with electronic medical records can support dynamic observation, but it requires reliable communication channels, technical support and clear responsibility for data interpretation.

Home telemonitoring of complicated pregnancies

Home telemonitoring is of special importance in complicated pregnancy. Retrospective and qualitative studies describe programs that include monitoring of maternal temperature, blood pressure, fetal movements, uterine contractions, symptoms, glycemia and CTG results. In intermediate- and high-risk pregnancies, such programs may reduce the number of hospital visits, improve patient satisfaction and allow earlier intervention when warning signs appear.

This model is particularly relevant for premature rupture of membranes, fetal growth restriction, preeclampsia, gestational diabetes and adverse obstetric history. For primigravid women, home telemonitoring may reduce uncertainty and increase participation in their own care. At the same time, it must be accompanied by clear instructions explaining which symptoms require immediate medical attention.

Implementation of home telemonitoring requires staff training, patient education, measurement protocols, technical support and documentation procedures. The clinician should receive information in a structured form; otherwise, a large amount of unfiltered data may overload the health care team. Therefore, the success of telemonitoring depends not only on devices but also on the organization of the care pathway.

Doppler ultrasound as a component of innovative monitoring

Doppler assessment of uteroplacental and fetal blood flow remains one of the most informative tools for predicting complications in high-risk pregnancy. Uterine artery Doppler in the first and second trimesters is used to assess the probability of placentation disorders, preeclampsia and fetal growth restriction. Abnormal resistance indices reflect impaired trophoblast invasion and insufficient remodeling of spiral arteries.

Umbilical artery assessment reflects the state of placental perfusion, while the middle cerebral artery and cerebroplacental ratio help identify fetal adaptation to hypoxia. In pregnancies complicated by placental insufficiency, Doppler ultrasound provides important information for choosing the frequency of monitoring, timing of hospitalization and delivery planning.

The most promising direction is the combination of Doppler ultrasound with clinical-anamnestic scales, first-trimester biomarkers and remote blood pressure monitoring. Such an integrated approach allows clinicians to move from isolated measurements to a comprehensive prediction of adverse

outcomes. For primigravid women, this is especially important because serious complications may develop without a previous obstetric history.

Artificial intelligence and digital decision support

Modern digital platforms are gradually moving from simple data transmission to analytical support for clinical decision-making. Machine learning algorithms can identify hidden patterns in large datasets that include demographic characteristics, blood pressure trends, laboratory indicators, ultrasound parameters, Doppler indices and symptoms reported by the patient.

In obstetric practice, such solutions must be used with caution. An algorithm cannot replace the clinical thinking of a physician; it should serve as a decision support tool that improves risk stratification and helps identify patients who need closer observation. Transparency, validation on local populations and regular audit of algorithmic performance are mandatory conditions for safe use.

For primigravid women, artificial intelligence may be particularly useful in the comprehensive assessment of the risk of preeclampsia, fetal growth restriction, preterm birth and operative delivery. Integration of AI tools into electronic medical records and telemedicine platforms may improve routing and enable timely involvement of specialized centers.

Organizational, ethical and economic aspects of implementation

Despite its obvious potential, the implementation of telemedicine in obstetrics is associated with several limitations. These include insufficient digital infrastructure, unstable internet connection, low digital literacy among some patients, lack of standardized protocols and possible increase in workload for medical personnel. If these factors are not addressed, telemedicine may deepen inequalities rather than reduce them.

Special attention should be paid to personal data protection, informed consent, documentation of remote consultations and the legal status of telemedical recommendations. Pregnant women must understand the possibilities and limitations of remote care, including situations in which an urgent face-to-face examination is required. Data transmission and storage should comply with confidentiality and security requirements.

Economic effectiveness is an important argument in favor of telemonitoring. Studies of home telemedical CTG and remote observation have demonstrated the possibility of reducing transportation costs, unnecessary outpatient visits and repeated hospital admissions. However, cost-effectiveness depends on the target population, device price, staff workload, reimbursement mechanisms and integration with existing perinatal care systems.

For the successful implementation of digital obstetrics, pilot projects, staff training, patient-centered interfaces and multidisciplinary teams are necessary. National adaptation is essential because technological solutions must correspond to local clinical pathways, language, infrastructure and regulatory conditions.

Conclusion

The analysis of the literature shows that innovative monitoring technologies have considerable potential to improve the observation of primigravid women. The most clinically significant tools include telemedicine platforms, remote blood pressure monitoring, mobile CTG, home telemonitoring, Doppler ultrasound and digital decision support systems.

These technologies make it possible to move from an episodic model of antenatal observation to a proactive risk-oriented system based on early detection of adverse trends, rapid communication and individualized routing. For primigravid women, this approach is particularly valuable because complications may appear for the first time and progress rapidly.

Effective implementation requires standardized protocols, education of patients and medical personnel, technical support, data protection, cost-effectiveness assessment and integration into the existing system of perinatal care. Innovative monitoring should be considered not as a replacement for the physician, but as a scientifically grounded tool for improving the quality, safety and accessibility of obstetric care.

References

1. Levanov V.M., Perevezentsev E.A., Kalitkina O.A. Application of telemedicine technologies in the provision of medical care in obstetrics and gynecology: a review. Journal of Telemedicine and E-Health. 2022. (in Russian).
2. Antza C., Cifkova R., Kotsis V. Hypertensive complications of pregnancy: a clinical overview. Metabolism. 2018;86:102-111. doi: 10.1016/j.metabol.2017.11.011.
3. Rajkumar T., Hennessy A., Makris A. Remote blood pressure monitoring in pregnant women at risk of hypertensive disorders of pregnancy. PMID: 40434501.
4. Agarwal G.S., Agrawal A.K., Singhal D., Bawiskar D., Shedge S.S. Pregnancy-induced hypertension pathophysiology and contemporary management strategies: a narrative review. 2024.
5. Devane D., Lalor J.G., Daly S., McGuire W., Cuthbert A., Smith V. Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing. Cochrane Database Syst Rev. 2017.
6. Nitulescu A., Crisan-Vida M., Stoicu-Tivadar L., Bernad E. Integrated wireless sensor network for monitoring pregnant women. Stud Health Technol Inform. 2015.
7. Pilarczyk R., Strozik M., Hirnle L. Diagnostic equivalency of mobile CTG devices and remote analysis to conventional on-site nonstress test. Adv Clin Exp Med. 2020.
8. Nielsen J.H., Jepsen I., Eriksen S.A., Maimburg R.D. Development and early implementation of telemonitoring of complicated pregnancies: a qualitative study with the perspectives of health care professionals. BMC Health Serv Res. 2020.
9. Zizzo A.R., Hvidman L., Salvig J.D., Holst L., Kyng M., Petersen O.B. Home management by remote self-monitoring in intermediate- and high-risk pregnancies: a retrospective study of 400 consecutive women. Acta Obstet Gynecol Scand. 2022.
10. Torok M., Kovacs F., Doszpod J. Cost-effectiveness of home telemedical cardiotocography compared with traditional outpatient monitoring. J Telemed Telecare. 2021.
11. Alfirevic Z., Stampalija T., Medley N. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev. 2017;6:CD007529.
12. Papageorghiou A.T. et al. Uterine artery Doppler and prediction of adverse pregnancy outcomes. Ultrasound Obstet Gynecol. 2017.
13. Baschat A.A. Fetal responses to placental insufficiency: an update. BJOG. 2014.

14. Ivshin A.A., Vorobyova V.M., Malyshev N.A. Promising methods of prenatal diagnostics based on passive sensors and machine learning. Obstetrics, Gynecology and Reproduction. 2025;19(1):68-81.
15. Rolnik D.L. et al. Aspirin versus placebo in pregnancies at high risk for preterm preeclampsia. N Engl J Med. 2017;377:613-622.