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Research Article

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Intelligent Platform-Based Closed-Loop Perioperative Management of Placenta Previa

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Abstract

Background: Perioperative management of critically ill patients with placenta previa is challenging because of the risks of massive hemorrhage and placenta accreta spectrum (PAS). We evaluated an intelligent obstetric information platform designed to improve risk warning, multidisciplinary coordination, and closed-loop perioperative management.

Methods: This retrospective cohort study included 66 critically ill patients with placenta previa or suspected PAS admitted to a tertiary hospital between January 2019 and January 2024. Patients were divided into Conventional (n=32) and Platform (n=34) groups according to platform deployment. Perioperative management efficiency and maternal clinical outcomes were compared, and multivariable logistic regression was performed to identify factors associated with severe maternal adverse outcomes.

Results: Compared with conventional management, the Platform group showed significantly shorter times for risk warning (18 vs. 42 min), MDT initiation (24 vs. 58 min), blood preparation (31 vs. 67 min), blood transfusion initiation (12 vs. 29 min), and event closure (33 vs. 74 min; all $P<0.001$). Median intraoperative blood loss was also lower in the Platform group (1400 vs. 2100 mL). Platform-supported management was independently associated with a lower risk of severe maternal adverse outcomes (OR=0.29, 95% CI 0.11–0.74, P=0.010), whereas suspected PAS increased this risk (OR=3.97, 95% CI 1.42–11.08, P=0.008).

Conclusion: An intelligent obstetric information platform improved perioperative management efficiency and was associated with reduced blood loss and lower risk of severe maternal adverse outcomes. This closed-loop digital management approach may enhance multidisciplinary coordination and maternal safety in high-risk obstetric care.

Keywords: intelligent health information platform; pervasive health technology; closed-loop management

Introduction

Perioperative management of patients with placenta previa remains challenging, particularly in those with placenta accreta spectrum (PAS), a high risk of hemorrhage, or a history of cesarean delivery (Fan et al., 2024). The prevalence of placenta previa has risen significantly following China's two-child policy, amplifying clinical burdens. Short cervical length and antepartum contractions are well-established risk factors for antepartum hemorrhage in placenta previa (Im et al., 2023). High-risk cases demand close collaboration among obstetrics, anesthesiology, blood transfusion, interventional radiology, intensive care unit (ICU), and neonatology, requiring strict time control and efficient resource allocation.

Traditional department-led management is plagued by delayed communication, insufficient preparation, and information silos, leading to missed key nodes and compromised outcomes. Despite repeated process optimizations, persistent issues including massive blood loss, complex interventions, and narrow therapeutic windows remain unresolved, highlighting the urgent need to reconstruct perioperative management for critically ill placenta previa patients.

Digitalization and machine learning are reshaping biomedical diagnosis, precision treatment, and monitoring (Goecks et al., 2020). Deep learning and risk-stratification tools have been applied to predict obstetric hemorrhage; for instance, MRI-based deep learning enables bleeding severity classification in pernicious placenta previa (Liu et al., 2020). Prophylactic uterine artery embolization during cesarean section reduces intraoperative blood loss and transfusion in complete placenta previa (He et al., 2023). Imaging evaluation has gained importance in preoperative identification of placenta previa and PAS, and multi-source data integration has emerged as a research focus (Faralli et al., 2022; Wang et al., 2024; Yue et al., 2024).

Most focus on single-node risk prediction or technical efficacy rather than translating predictions into clinical workflow coordination and emergency response. A complete prediction–intervention–feedback management chain has not been established. No systematic evidence exists regarding how an information platform can integrate risk warning, automatic task distribution, intraoperative multi-department linkage, and postoperative follow-up to improve perioperative quality and maternal outcomes. This study constructs an intelligent obstetric information platform–supported closed-loop perioperative management model and evaluates its effectiveness, aiming to confirm whether the platform improves management efficiency and maternal outcomes, and to provide a clinical reference for high-risk placenta previa patients.

Literature Review

Perioperative care of placenta previa and PAS has long been a core challenge in obstetrics. Fan et al. (2021) reported substantial bleeding during cesarean delivery under anesthesia, with neuraxial anesthesia associated with less blood loss and better maternal–neonatal outcomes than general anesthesia. Previous cesarean section increases hemorrhage, hysterectomy, and preterm birth in complete placenta previa (Wei & Cheng, 2024). Prophylactic abdominal aortic balloon occlusion reduces blood loss, transfusion, and hysterectomy rates in placenta previa accreta (Yin & Hu, 2022). Targeted embolization within a multidisciplinary algorithm reduces transfusion requirements in PAS patients (Gatta et al., 2022). Uterine artery embolization is safe for PAS, with anemia management and blood conservation being critical (Neef et al., 2024). Sandwich excision is feasible for placenta percreta invading the bladder with low hysterectomy risk (Feng et al., 2022). A systematic review by Markfeld Erol et al. (2024) confirmed that PAS management requires multidisciplinary teamwork and adequate infrastructure. Although these studies confirm the value of risk recognition and multidisciplinary care, most are limited to isolated perioperative steps or single technical pathways. Efficient connection of perioperative phases, real-time information synchronization, and seamless inter-department collaboration remain understudied.

In recent years, risk prediction and multi-source data integration have become major research hotspots in obstetric critical care. Akazawa and Hashimoto (2023) developed a multimodal deep learning model that enables preoperative prediction of severe hemorrhage in women with placenta previa. Similarly, Chen et al. (2019) established a clinical–ultrasound model that accurately predicts severe postpartum hemorrhage among these patients. For placenta accreta spectrum (PAS) combined with placenta previa, Huang et al. (2022) found that cervical length is negatively associated with massive intraoperative bleeding. Several key risk factors for antepartum hemorrhage have also been identified: young maternal age (<30 years) and multiparity increase such risk (Kuribayashi et al., 2021), while complete placenta previa, short cervix, anterior placenta, and prior uterine artery embolization further elevate the hazard (Long et al., 2021). To improve quantitative risk assessment, Chen et al. (2020) constructed an MRI-based scoring system to predict massive intraoperative bleeding in placenta previa and accreta. Hessami et al. (2024) further demonstrated that a cervical length ≤ 30 mm at 28–34 weeks can predict emergency cesarean delivery for hemorrhage and adverse perinatal outcomes. In terms of laboratory indicators, Balkaş and Çelen (2025) identified preoperative inflammatory and coagulation biomarkers that effectively distinguish PAS from simple placenta previa and predict massive intraoperative bleeding. Notably, Yang et al. (2025) reported that gestational overweight is associated with a lower risk of antepartum hemorrhage in women with complete placenta previa. Beyond obstetrics, multicenter machine learning models have achieved reliable and interpretable risk assessment in oncology, further

supporting the feasibility and generalizability of data-driven predictive tools in clinical practice (Hou et al., 2024).

Current literature concentrates on individual perioperative components, lacking systematic research on intelligent platform–supported closed-loop management for critically ill placenta previa patients. Digital studies focus on model construction rather than workflow integration and outcome validation. This study addresses these gaps by using an intelligent obstetric information platform as the core intervention, combining process and outcome indicators to evaluate its value in perioperative care, providing evidence for clinical optimization.

Materials and Methods

Theoretical framework and operational mechanism of intelligent obstetric information management platform

The design core of intelligent obstetric information management platform is not simply to realize information input and storage functions, but to build a perioperative management system that meets actual clinical needs with the data-driven process engine as the core support. Clinical decision support tools improve resource utilization and case scheduling for elective procedures (Goldstein et al., 2020). The overall architecture of the platform can be divided into three interconnected levels, with clear division of labor and cooperative operation: first, the data input layer, which comprehensively covers the patient's basic medical history, ultrasound and MRI images, previous cesarean section history, laboratory examination results, anesthesia evaluation reports, blood preparation related information and detailed logs of various events during the perioperative period. After the patient is admitted to the hospital, all relevant clinical departments will fill in the above-mentioned data in real time according to diagnosis and treatment specifications to ensure the integrity, accuracy and timeliness of all information and lay a solid data foundation for follow-up management. The second is the rule processing layer, which is mainly responsible for the systematic processing of all kinds of input medical information, including automatic identification of high-risk factors, early warning and triggering of risk thresholds, collaborative start-up of MDT and accurate distribution of various diagnosis and treatment tasks. Importantly, prior cesarean count and placental location are key determinants of PAS risk in placenta previa (Kayem et al., 2024), and the platform will automatically screen out critical and high-risk cases related to placenta previa according to clinical high-risk judgment rules, immediately generate risk warning tips, and clearly assign corresponding diagnosis and treatment tasks to obstetrics, anesthesiology, blood transfusion and other related departments to avoid delays and omissions in manual distribution. Finally, the output executive layer, whose core function is to accurately push the risk warning list, intraoperative

multi-department collaborative instructions, postoperative patient follow-up plan, management quality feedback and other tasks to specific responsible persons in each link to ensure that all management measures are implemented. Through the four key steps of "identification-judgment-distribution-feedback", the platform effectively broke the information island phenomenon in the traditional management mode, and made the perioperative management process form a more compact and standardized closed-loop management mode.

The operation of the platform follows the dual-cycle management logic to ensure the continuity and dynamic optimization of the management process. The first cycle is the perioperative clinical execution cycle. When patient-related information is entered into the platform, the system will automatically identify high-risk risks, thus promoting the orderly development of preoperative preparation, intraoperative multi-department cooperation and postoperative patient follow-up, ensuring that every key management node in the perioperative period has clear records and evidence to avoid management loopholes. The second cycle is a quality feedback cycle, in which all relevant data such as perioperative management results and patients' clinical outcomes will flow back to the platform database in real time, and the platform will automatically adjust and optimize the risk early warning threshold, multi-department collaboration rules and time requirements of each management task node according to these feedback data. Through this dual-cycle model, pre-surgery, intra-surgery and post-surgery management links that were originally separated from each other were effectively opened, and the time for high-risk risk identification and multi-department collaborative response was greatly advanced, making the whole perioperative management process continuous, controllable and traceable. The core value of the platform is not only to improve the response speed of each link, but also to dynamically optimize the management rules through continuous feedback data, realize self-learning and continuous improvement of the management process, and better adapt to the needs of clinical diagnosis and treatment. The relevant operation mechanism is shown in Figure 1.

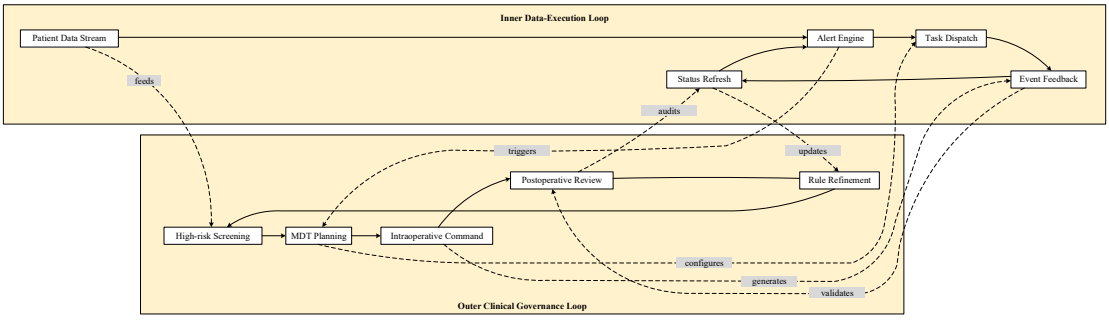


Figure 1 The double circulation mechanism diagram of perioperative management of placenta previa-related critical illness supported by intelligent obstetric information management platform

Research object, data source and key variable setting

A retrospective cohort study design was adopted in this study. The subjects were critically ill patients with placenta previa admitted to a Grade A Class 3 hospital from January 2019 to January 2024. According to the deployment time of the intelligent obstetric information management platform, the subjects were divided into two groups: patients admitted before platform deployment were included in the control group (Conventional group), and patients admitted after platform deployment were included in the platform group (Platform group). The inclusion criteria of the subjects are clearly defined as: having been clinically diagnosed with placenta previa or suspected PAS disorders, and having complete perioperative management records and clinical outcome data. Exclusion criteria include: patients with incomplete clinical data, complicated with other serious basic diseases (such as serious cardiovascular and cerebrovascular diseases, coagulation dysfunction, etc.), and cases in which the perioperative management process was interrupted for personal or other non-medical reasons. The case screening work is completed by two independent researchers respectively. If there are differences between the two researchers in the screening process, third-party experts in related fields will be invited to discuss and finally determine research cases that meet the standards to ensure the objectivity and accuracy of the screening results. Data needed in this study mainly come from hospital electronic medical record system, anesthesia information management system, blood transfusion management system, operation nursing record system, neonatal monitoring record and operation log of intelligent obstetric information management platform. The authenticity and reliability of research data are guaranteed through cross-validation of multi-source data.

In terms of variable setting, combined with research purpose and clinical practice, variables are divided into baseline variables, management process variables and outcome variables. Among them, baseline variables are mainly used to describe the basic clinical characteristics of the two groups, including the patient's age, gestational age, pregnancy times, previous cesarean section times, specific types of placenta previa, suspected PAS, preoperative hemoglobin level and fibrinogen level. Advanced age, ART, and prior early pregnancy loss predict persistent placenta previa in nulliparas, supporting the inclusion of age and reproductive history as key baseline indicators (Post et al., 2023). ABO blood type AB is associated with higher antepartum hemorrhage and preterm birth in placenta previa, further justifying the collection of comprehensive baseline clinical characteristics (Fan et al., 2023). Management process variables are mainly used to evaluate the impact of the platform on the perioperative management process, covering key indicators such as the trigger time of high-risk early warning, the completion rate of MDT discussion before surgery, the completion rate of blood preparation before surgery, the adequacy rate of surgical preparation, the start time of blood transfusion, and emergency response time during surgery. Outcome variables are used to measure the impact of platform application on the clinical outcome of patients, including intraoperative blood loss,

blood transfusion volume, hysterectomy rate, ICU transfer rate, incidence of severe maternal complications and postoperative hospitalization days. The main reason for selecting the above variables is that these variables can not only fully reflect the optimization effect of the intelligent obstetric information management platform on perioperative management process efficiency, but also objectively measure the improvement effect of platform application on maternal clinical outcome. Specific baseline characteristics and detailed definitions of variables of the two groups of subjects are shown in Table 1.

Table 1 Comparison of Baseline Characteristics of Subjects

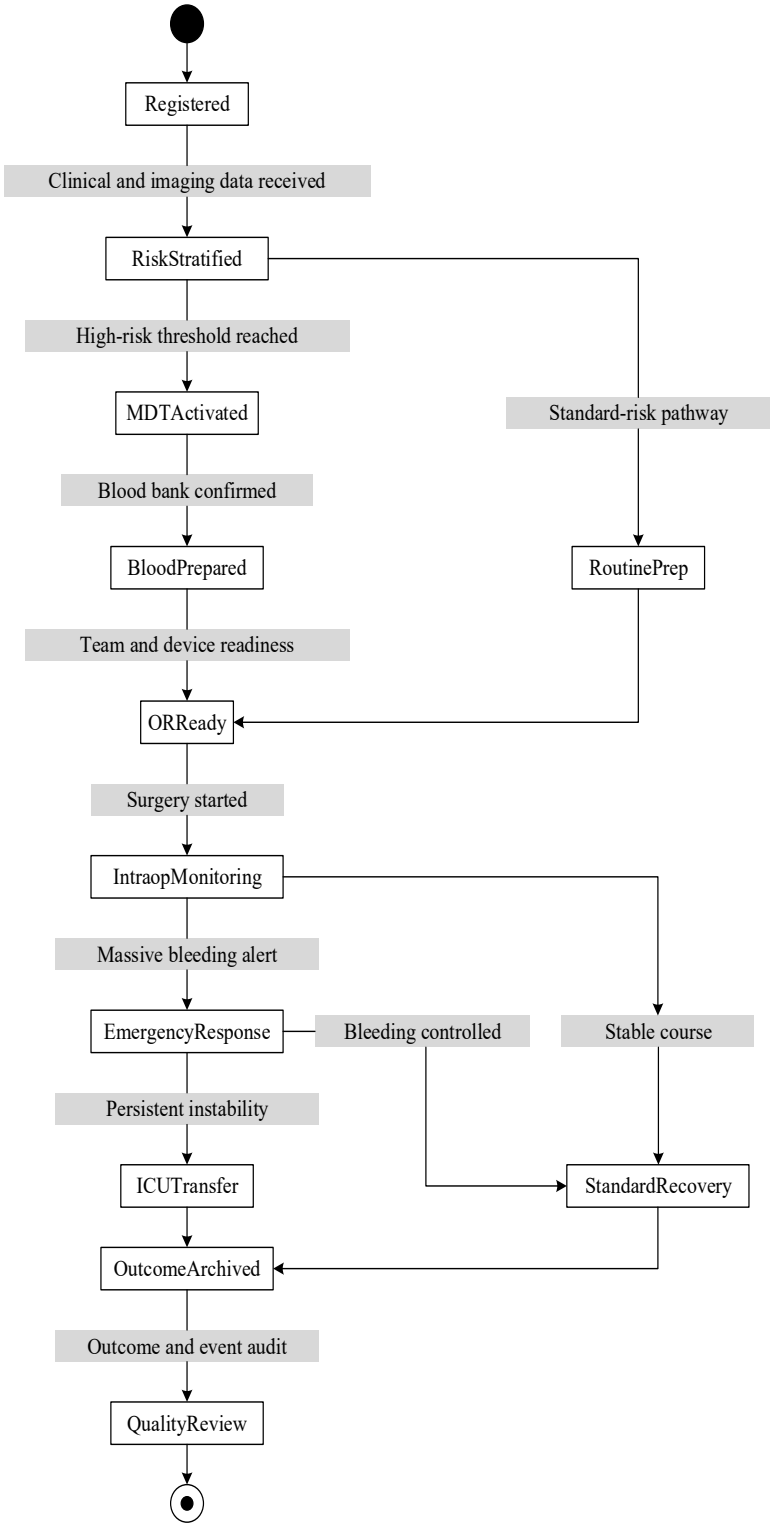
index	Conventional group (n=32)	Platform group (n=34)	statistical values	P value
Age (years)	31.8±4.2	32.1±4.0	t=0.31	0.758
Gestational weeks (weeks)	35.4±1.6	35.7±1.4	t=0.82	0.416
Number of previous cesarean sections (times)	1.6±0.7	1.7±0.8	t=0.56	0.579
Complete placenta previa [case (%)]	21(65.6)	23(67.6)	χ^2=0.03	0.858
Suspected PAS[case (%)]	14(43.8)	16(47.1)	χ^2=0.07	0.793
Hemoglobin (g/L) before operation	106.5±11.8	108.1±12.3	t=0.54	0.592

Effect evaluation index, verification path and statistical method

In order to comprehensively and systematically evaluate the application effect of the intelligent obstetric information management platform, this study has constructed an effect evaluation system that includes three levels, and indicators at each level are complementary and progressive. The first layer is the preoperative management quality index, which is mainly used to measure the optimization effect of the platform on preoperative preparation, including the timely rate of high-risk identification, the completion rate of preoperative MDT discussion, the completion rate of preoperative blood preparation and the integrity rate of image evaluation. These indicators directly reflect the standardization and adequacy of preoperative management. The second layer is the index of intraoperative management efficiency, which focuses on evaluating the platform's role in improving the efficiency of multi-department collaboration and emergency response during surgery, including the time from patient admission to surgery, the start time of blood transfusion, the time when key departments are in place and the response time of abnormal events during surgery. The efficiency of these links directly affects the safety and treatment effect of patients during surgery. The third layer is the maternal clinical outcome index, which focuses on the improvement of the clinical outcome of patients by platform application, including intraoperative blood loss, number of red blood cell infusion units, ICU

transfer rate, composite end point of serious adverse outcome and postoperative hospitalization days. In particular, this study set "severe maternal adverse outcome" as the main research endpoint, which covers serious adverse events such as ICU transfer, hysterectomy, intraoperative bleeding ≥2000mL, so as to comprehensively and comprehensively evaluate the intervention effect of the platform. Specific system composition and judgment criteria of each evaluation index are shown in Table 2.

In statistical analysis, this study strictly follows the statistical norms of clinical research, and selects appropriate statistical methods according to different types of variables. Among them, continuous variables are compared between groups by t test, and for continuous variables that do not conform to normal distribution, rank sum test is used; χ^2 test was used to compare classified variables between groups, and Fisher exact test was used when the theoretical frequency was too small. In the analysis of influencing factors, multi-factor Logistic regression model was used to analyze the influence of various factors on the clinical outcome of patients. If necessary, the propensity score matching method was used to correct the baseline difference between the two groups of subjects to ensure the reliability of research results. In order to further explore the relationship between the high-risk early warning ability of the intelligent obstetric information management platform and the clinical outcome of patients, this study also conducted additional hierarchical analysis and regression analysis to deeply explore the internal mechanism of the platform. All statistical tests were conducted by bilateral test, and the test level was set at 0.05. Statistical analysis was completed by SPSS 26.0 software. The overall analysis of this study not only pays attention to the differences between the two groups in management efficiency and clinical outcome, but also focuses on the optimization of the operation mechanism of the intelligent obstetric information management platform on the perioperative management path to ensure the scientific and clinical practicability of research conclusions. In line with clinical guidelines, at least 6 units of red blood cells should be prepared for PAS patients before delivery (Miller et al., 2023). The evaluation index system and criteria of perioperative management quality are shown in Table 2, and the perioperative management state machine supported by the platform is shown in Figure 2.



283

284 Figure 2 Migration diagram of perioperative management status of placenta
285 previa-related critical illness

286 Table 2 Evaluation indexes and criteria of perioperative management quality

Index hierarchy	Indicator name	definition mode	criterion	data source
Preoperative management	Timely rate of risk early warning	Complete the high-risk marking within 2 hours after admission.	Meet/fail to meet the standards	Platform log
Preoperative management	MDT completion rate	Complete multidisciplinary joint discussion before operation.	Completed/not completed	Consultation record
Preoperative management	Blood preparation completion rate	Complete the preparation of scheduled blood products before operation.	Completed/not completed	Blood transfusion system
Intraoperative efficiency	Start time of blood transfusion	Trigger blood transfusion to the time when the first bag of blood is sent out.	minute	Blood transfusion system
Intraoperative efficiency	Event closed-loop time	Time from abnormal trigger to disposal completion	minute	Platform log
Outcome index	Severe maternal adverse outcome	ICU transfer/hysterectomy/bleeding ≥2000mL, etc.	Yes/no	Medical record system

Results

Comparison of perioperative management quality indicators before and after platform application

After the application of the intelligent obstetric information management platform, the perioperative management quality indicators of the two groups showed significant differences, and all management indicators of the platform group were significantly improved. Taking the early warning time of high-risk as an example, the median time spent in the platform group was significantly shorter than that in the control group. At the same time, the time spent in key links such as the start-up time of MDT and the time spent on preoperative blood preparation were also shortened synchronously, and the overall preoperative preparation efficiency was greatly improved. It is particularly noteworthy that in the whole process of preoperative preparation, the platform group successfully realized the advance of each task node, effectively reduced the process waiting time and repeated communication cost common in the traditional management mode, and further improved the coherence and adequacy of preoperative

preparation. This result fully shows that the operation mechanism of intelligent obstetric information management platform can effectively strengthen the timeliness and pertinence of multidisciplinary cooperation and break the limitations of traditional management mode.

Compared with the traditional management mode before platform application, the latter relies more on the manual reminder of medical staff, and information exchange between medical systems is not smooth, which often leads to the phenomenon of "seesaw" in information transmission, resulting in low management efficiency. After the platform was launched, the perioperative management showed an obvious structural change: task distribution and node promotion realized automatic operation, and the responsibility attribution of each link became clearer and clearer, effectively avoiding omissions and delays of manual management. Figure 3 clearly shows the achievement path of the key task nodes of the two groups during the perioperative period. Through comparison, it can be found that the management process of the platform group is smoother, and the task nodes are closely connected, and there are almost no management "breakpoints" and information lag problems. Table 3 provides specific quantitative data support. The data shows that the time spent in six key links, such as high-risk early warning, MDT start-up, preoperative blood preparation, anesthesia preparation, blood transfusion start-up and event closed loop, in the platform group is significantly shorter than that in the control group, and the difference is statistically significant (P<0.001). The improvement effect of management process efficiency is intuitive. This change is not only a simple process speed increase, but also marks a fundamental change in the perioperative management mode of placenta previa-related critical illness from the traditional "passive response" mode to the "active early warning and early intervention" mode.

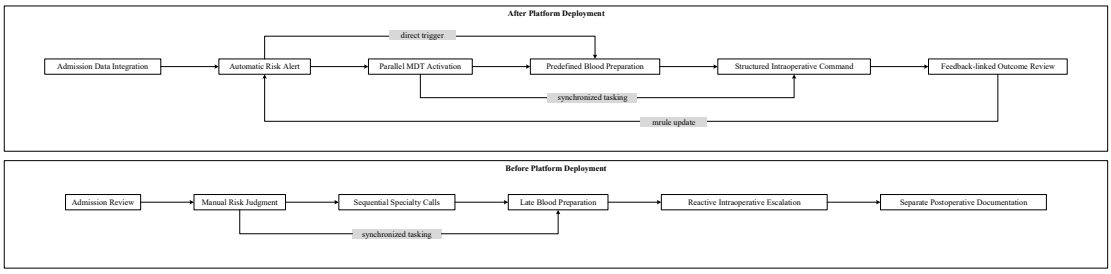


Figure 3 Comparison chart of critical mission path reconstruction before and after platform deployment

Table 3 Comparison of perioperative management quality indicators before and after platform deployment

Index	Conventional group	Platform group	statistical values	P value
Risk warning time (min)	42	18	Z=4.12	<0.001

Index	Conventional group	Platform group	statistical values	P value
MDT startup time (min)	58	24	Z=4.36	<0.001
Completion time of blood preparation (min)	67	31	Z=4.48	<0.001
Anesthesia preparation completion time (min)	36	20	Z=3.95	<0.001
Start time of blood transfusion (min)	29	12	Z=4.21	<0.001
Event closed-loop time (min)	74	33	Z=4.57	<0.001

Influence of platform on intraoperative emergency response and resource scheduling efficiency

Entering the stage of intraoperative diagnosis and treatment, the application advantages of intelligent obstetric information management platform are particularly prominent in emergency response and medical resource scheduling. Compared with the control group, the start time of blood transfusion, the completion time of anesthesia preparation and the closed-loop time of abnormal events during surgery in the platform group were significantly shortened, and management efficiency during surgery was significantly improved. Specifically, the median starting time of blood transfusion in the platform group is only 12 minutes, which is much lower than that in the control group (29 minutes). This difference can win valuable treatment time for patients with intraoperative blood loss. At the same time, the completion time of anesthesia preparation and the closed-loop time of events are also shortened synchronously, which means that in case of emergency such as sudden bleeding and condition change during surgery, all relevant departments can quickly coordinate and deal with them, effectively reducing the risk of adverse events. It should be emphasized that the improvement of intraoperative efficiency is not simply dependent on the acceleration of a certain link, but the comprehensive result of multi-node collaborative linkage driven by the platform. By constructing a unified information circulation channel, the platform realizes real-time synchronization of information in various departments, and at the same time, with the help of automatic task distribution function, it effectively solves the common problems of information transmission delay and collaborative connection fault in traditional management processes, ensuring the timeliness and effectiveness of intraoperative emergency response.

From the overall data distribution, the time spent by each management node in the platform group is generally lower than that in the control group, and the most significant differences between the two groups are concentrated in key areas such as MDT start-up, preoperative blood preparation and closed loop of intraoperative events. Figure 4 presents the median response time of the two groups of research objects in

six key management nodes in the form of heat map. It can be clearly seen from the color depth of the heat map that the color of the platform group is lighter as a whole, indicating that the process of each link is faster and more efficient. Among them, in the closed-loop time of intraoperative events, the platform group only needs 33 minutes to trigger and handle abnormal events, while the control group needs 74 minutes. This data fully shows that the intelligent obstetric information management platform can significantly enhance the closed-loop handling ability of intraoperative abnormal events and improve the level of emergency management. In addition, there are some differences in the improvement range of different management nodes, which also suggests that in subsequent platform optimization work, we should focus on the process bottleneck and redistribute medical resources reasonably to further improve the overall efficiency of perioperative management.

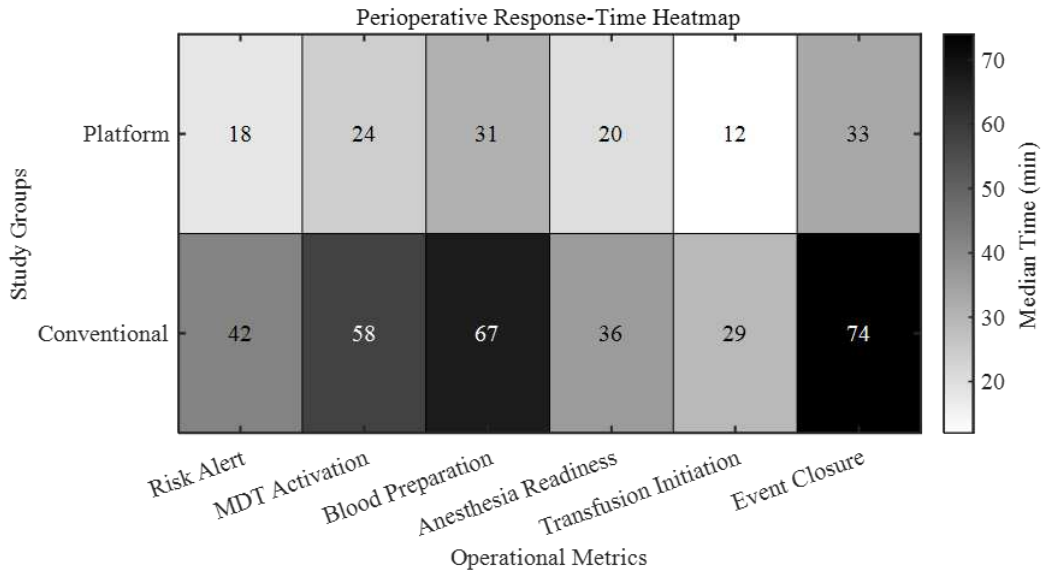


Figure 4 Thermogram of Perioperative Critical Response Time before and after Platform Deployment

The influence of platform on maternal clinical outcome and risk stratification verification

In maternal clinical outcome, all indicators of the platform group showed obvious improvement trend, which fully reflected the clinical application value of the intelligent obstetric information management platform. Specifically, the median amount of intraoperative blood loss decreased from 2100mL in the control group to 1400mL in the platform group. This change clearly suggests that perioperative management based on the platform can effectively strengthen the control of perioperative blood loss, reduce the amount of intraoperative blood loss and reduce the risk of related complications. Although some maternal clinical outcomes may still

be affected by factors such as the complexity of cases and the basic health status of patients, the overall performance of the platform group is significantly better than that of the control group in the main end point set in this study, which further confirms the intervention effect of the platform. At the same time, postoperative hospitalization days of patients in the platform group have also been shortened, which further supports the positive role of the intelligent obstetric information management platform in optimizing the perioperative management process and improving postoperative recovery efficiency of patients. It is worth noting that the results of multi-factor analysis show that platform management is an independent protective factor for serious maternal adverse outcomes in the multi-factor model. This discovery suggests that the information closed-loop management model may have stronger clinical intervention value for high-risk cases such as placenta previa-related critical illness, and can provide patients with more comprehensive and accurate management guarantee.

In order to further clarify the influence of various factors on maternal clinical outcome, this study carried out multivariate Logistic regression analysis. The results showed that platform management was an independent protective factor for severe maternal adverse outcome (OR=0.29, P=0.010), while suspected PAS was a risk factor for severe maternal adverse outcome (OR=3.97, P=0.008). In addition, factors such as the number of previous cesarean sections and preoperative hemoglobin level also have a significant impact on maternal clinical outcome. Among them, the more the number of previous cesarean sections and the lower the preoperative hemoglobin level, the higher the risk of serious maternal adverse outcomes. Figure 5 visually shows the difference in the distribution of intraoperative blood loss between the two groups. From the figure, it can be clearly seen that the dispersion of intraoperative blood loss in the platform group is smaller and the median is lower, indicating that its intraoperative blood loss control effect is more stable and better. Table 4 lists the results of multivariate Logistic regression analysis of various influencing factors in detail, and makes clear the influence degree and statistical significance of each factor. Based on the above analysis results, it can be seen that the intelligent obstetric information management platform has significant clinical application value by optimizing the perioperative management process, integrating multi-source medical information and advancing risk warning, which not only significantly improves perioperative management efficiency, but also brings substantial clinical outcome improvement to high-risk pregnant women with placenta previa.

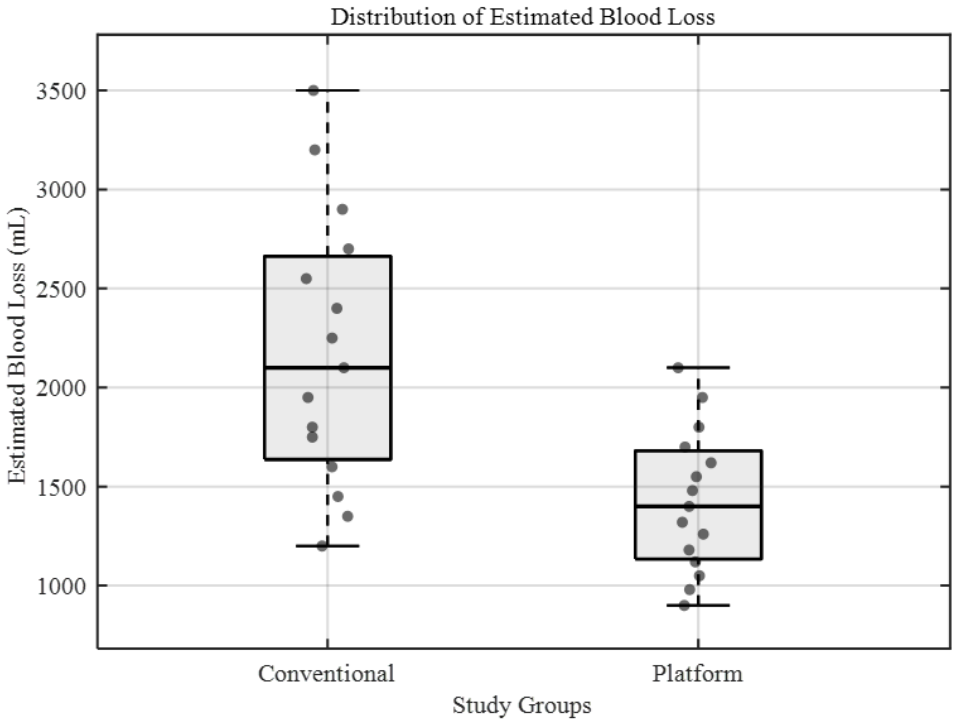


Figure 5 Comparison of intraoperative blood loss distribution before and after platform deployment

Table 4 Analysis of Influencing Factors of Severe Maternal Adverse Outcome

Variable	β value	OR value	95%CI lower limit	95%CI upper limit	P value
Platform management (Yes vs No)	-1.24	0.29	0.11	0.74	0.010
Suspected PAS (yes vs no)	1.38	3.97	1.42	11.08	0.008
Previous cesarean section times	0.64	1.89	1.03	3.46	0.039
Hemoglobin before operation	-0.03	0.97	0.95	0.99	0.021
gestational week	-0.11	0.90	0.76	1.07	0.238

Discussion

The core research findings of this study mainly focus on the optimization of intelligent obstetric information management platform in the perioperative management process of critically ill patients with placenta previa, and can be summarized from three key aspects combined with clinical practice details and research data. First of all, the platform realizes the early intervention of high-risk identification, completely breaks the limitations of traditional perioperative

management, such as over-reliance on personal clinical experience of medical staff and disjointed multi-system information, and can quickly trigger high-risk markers and various management task nodes, effectively reducing the problems of insufficient preoperative preparation and omission of key links, and further improving the perioperative safety and sense of medical safety of patients. Secondly, the platform promotes the multidisciplinary collaboration model to be explicit and nodal, which changes the loose communication between related teams in obstetrics, anesthesiology, blood transfusion and interventional departments, makes information transfer between departments more efficient and smooth, and process promotion no longer depends on the active reminder of a single department, but realizes the automatic distribution of tasks and real-time synchronization of progress through the platform. It is not difficult to see from the specific changes of process indicators in this study that the platform has significantly strengthened information cohesion and task coordination among departments, effectively avoiding management disconnection. Finally, the platform constructs a postoperative feedback and reflux mechanism, which can collect all perioperative management results and patient clinical outcome data in real time and bring them into the dynamic revision of platform management rules, forming a dynamic closed-loop management model of "intervention-feedback-optimization" to ensure that the management process can continuously adapt to clinical needs. This study not only further verified the importance of high-risk identification and multidisciplinary collaborative management in the perioperative management of placenta previa-related critical illness, but also broke through the limitations of existing studies and realized the deep integration of risk prediction and clinical management execution.

Although this study confirmed the positive application effect of the intelligent obstetric information management platform through empirical analysis, combined with the objective conditions of clinical research, there are still some limitations in this study, which need to be gradually improved in follow-up research. First of all, the samples of this study are all from a single Grade A Class 3 hospital, and the number of cases is limited, and the clinical characteristics of the subjects are relatively concentrated, so it is difficult to fully reflect the differences in perioperative management of placenta previa-related critical illness in hospitals of different regions and grades, and the external applicability of research results needs further verification. Secondly, in the current management rules of the platform, some key links still need to rely on the manual judgment of medical staff, especially when dealing with extremely complex cases with multiple basic diseases, it is still inevitable to rely on the clinical experience of medical staff, and it is difficult to fully realize automatic management. At the same time, the clinical outcomes of some mothers are greatly influenced by the operation experience of the surgical team and the level of diagnosis and treatment. Because of the retrospective design adopted in this study, there may be some retrospective bias in related variables, which will affect the accuracy of research results. In addition, the integration of image features (such as ultrasound and MRI images) and laboratory dynamic monitoring indicators is still insufficient, and the

accuracy of risk early warning model still needs to be improved, so it is difficult to fully tap the clinical value of multi-source data. Based on the above limitations, it is suggested to carry out multi-center and large-sample prospective research in the future to further verify the application effect of the platform; at the same time, promote the dynamic optimization of the platform algorithm, and incorporate more real-time monitoring data and image feature data into the risk prediction model to improve the accuracy of early warning; in addition, promote the docking of the platform with the regional referral network for critically ill pregnant women, break down the barriers of regional medical resources, and further improve the extensive applicability and intelligent level of platform management. Only by continuously improving platform functions can we truly realize the whole process and closed-loop management of high-risk pregnant women with placenta previa during the perioperative period.

Conclusion

In this study, critical patients with placenta previa were taken as the research object, and a closed-loop perioperative management framework based on the intelligent obstetric information management platform was constructed according to clinical management requirements. Through retrospective comparative analysis, the application effect of the platform in perioperative management was systematically discussed. By comparing the differences of patients' preoperative preparation quality, intraoperative coordination efficiency and maternal clinical outcome before and after platform application, it is clearly found that the intelligent obstetric information management platform can significantly improve the timeliness of high-risk risk identification and preoperative multidisciplinary coordination efficiency, speed up emergency response during surgery, and reduce the risk of serious maternal adverse outcomes to a certain extent, which provides a strong guarantee for patients' perioperative safety. The core advantage of the operating mechanism of the platform lies in the organic integration of key links such as high-risk risk identification, automatic distribution of diagnosis and treatment tasks, multidisciplinary linkage disposal and postoperative quality feedback, which breaks the information barrier of the traditional management model and forms a set of standardized perioperative management paths that can be tracked all the time, evaluated quantitatively and optimized dynamically.

The clinical value and academic significance of this study are mainly reflected in two aspects: on the one hand, aiming at clinical pain points such as difficult perioperative management, complicated process and poor coordination, this study provides a set of practical improvement schemes with informationization and process, which effectively promotes the intelligent transformation of perioperative management mode from traditional "passive response" to "active early warning and closed-loop management", and provides practical reference for clinical diagnosis and treatment. On the other hand, this study built a perfect evaluation system of platform application

effect, combined with management process indicators and clinical outcome indicators, systematically verified the application value of information tools in obstetric critical care management, and provided methodological reference for similar research. In the future, the stability and applicability of the intelligent obstetric information management platform still need to be further verified in a larger sample size and multi-center clinical scenario; at the same time, it is suggested to continuously improve the integration ability of the platform with image evaluation technology, risk prediction model and regional critical pregnant women's treatment network, continuously optimize platform functions, and promote the perioperative management level of placenta previa-related critical illness to move towards a higher quality and more intelligent direction, so as to provide better and safer medical services for high-risk pregnant women.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and confidentiality considerations but are available from the corresponding author on reasonable request.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Author contributions

Congying Qin participated in the study design, clinical data collection, and manuscript drafting. Yuan Ma was responsible for data analysis, platform application evaluation, and manuscript revision. All authors have read and approved the final manuscript.

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Clinical Trial Number

Not applicable.

Consent to Publish declaration

Not applicable.

Ethics and Consent to Participate declarations

This retrospective cohort study was approved by the Research Ethics Committee of Tangshan Maternal and Child Health Hospital (Approval No. 2024-031-01). All analyses were performed using fully anonymized de-identified clinical data, and no identifiable personal information was included. Written informed consent was formally waived by the Research Ethics Committee of Tangshan Maternal and Child Health Hospital, as this study retrospectively reviewed pre-existing medical records without additional interventions to participants. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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