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Effect of Nurse-Assisted Early Warning Intervention for Prevention of Venous Thromboembolism Following Cesarean Delivery

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Abstract

Objective: To assess the role of a nurse-assisted early warning intervention in improving prophylaxis against obstetric venous thromboembolism (VTE) and preventing VTE following cesarean delivery (CD).

Methods: A prospective cohort study conducted between January 1, 2020, and December 30, 2022, enrolled pregnant women who underwent CD in the obstetric unit of Women's Hospital of Nanjing Medical University, Nanjing Maternity and Child Health Care Hospital. The patients were assigned to a control group (routine nursing care) or the intervention group (nurse-assisted early warning intervention) depending on whether or not the nurse-assisted early warning intervention had been implemented. The χ^2 test and Student's *t*-test were used for statistical analysis. The primary outcome was the incidence of systemic VTE following CD, and secondary outcomes were the rates of mechanical or pharmacologic prophylaxis receipts for VTE and the frequency and severity of adverse events related to pharmacologic prophylaxis.

Results: A total of 27,074 cases were enrolled. The incidence of symptomatic VTE following CD was significantly lower in the intervention group (0.29 per 1000 deliveries) than in the control group (2.4 per 1000 deliveries) ($P < 0.001$). Significantly more cases received mechanical and pharmacological VTE prophylaxis in the intervention group than in the control group (respectively, 19.8% *vs.* 12.6% receiving mechanical prophylaxis and 0.9% *vs*. 0.2% receiving pharmacological prophylaxis). No cases of life-threatening bleeding occurred in either group.

Conclusion: The application of nurse-assisted early warning intervention may be an effective method for preventing VTE following CD.

Keywords: Cesarean delivery; Deep vein thrombosis; Nurse-assisted early warning intervention; Pregnancy related venous thromboembolism; Pulmonary embolism

Introduction

Venous thromboembolism (VTE) presents as either deep vein thrombosis (DVT) or pulmonary thromboembolism (PTE) is the third most common vascular disorder after acute coronary syndrome and stroke.[1] The risk of thrombosis during pregnancy is attributed to the state of physiological hypercoagulation state that functions to protect women from excessive bleeding during delivery.[2] It is reported that pregnant women have a 4–6 times greater risk of VTE than nonpregnant women, with an incidence ranging from 0.49 to 2.00 per 1000 deliveries globally.[3] The risk increases nearly 30-fold postpartum, especially after cesarean delivery (CD).[4] Retrospective studies based on hospital records have shown that the incidence of VTE after CD ranges from 0.9% to 1.8%,[5] constituting one of the more common causes of maternal morbidity and mortality.[4,6] Cesarean section has also been identified as a risk factor for VTE during pregnancy, as it causes increased tissue trauma and prolonged bed rest compared to vaginal delivery.[7] Patients are at a relatively high risk of thromboembolism postpartum if additional risk factors are present at the same time, the most significant being advanced maternal age, obesity, and prolonged immobility.[8]

There are many well-evidenced guidelines for obstetric VTE prophylaxis, including those of the Royal College of Gynecologists and Obstetricians (RCOG),[9] American College of Chest Physicians,[10] American College of Obstetricians and Gynecologists (ACOG),[11] National Partnership for Maternal Safety (NPMS), and Agency for Health Care Research and Quality,[12] but obstetric VTE prophylaxis is often neglected in our clinical practice in Chinese women because of a long-standing belief in its rare occurrence, which is at least partly due to underdiagnosis. In fact, the majority (75%) of VTE cases have been diagnosed in the postpartum period, mainly after cesarean section.[13] Therefore, the prophylaxis of perioperative VTE in women undergoing CD should be increased in current clinical practice. To achieve this, our hospital developed a novel model of nurse-assisted early warning intervention rather than routine nursing care to optimize obstetric VTE prevention strategies.

This prospective cohort study aimed to determine whether integrating the nurse-assisted early warning

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intervention protocol could provide indications for quality improvements in prophylaxis against perinatal VTE and decrease the occurrence of obstetric VTE following CD.

Materials and methods

This prospective cohort study was conducted in the Department of Obstetrics and Anesthesiology in Women's Hospital of Nanjing Medical University, Nanjing Maternity and Child Health Care Hospital, and followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[14]

Pregnant women (aged ≥18 years) who had undergone either emergency or elective CD between January 1, 2020, and December 30, 2022, were screened for enrollment. Patients were excluded who reported a history of adverse effects from unfractionated heparin or low-molecular-weight heparin (LMWH), including heparin-induced thrombocytopenia. Also excluded were those with signs or symptoms of venous thrombosis, severe renal and/or hepatic impairment, or malignancy; those with a high risk of bleeding and/or who received warfarin; and those who did not stay at least two nights as inpatients postoperatively. Cases with incomplete follow-up data were also not eligible for the present study. The recruited participants were divided into two groups: the control group received routine nursing care as the control before CD, and the intervention group received the nurse-assisted early warning intervention while in the nursing intensive care unit before CD.

Routine nursing care for cesarean VTE prophylaxis

Participants in the control group were managed using our current routine obstetric VTE prophylaxis. Within 6 h of a patient's admission, the junior doctor on the ward was responsibility for completing an initial perinatal VTE risk assessment using the modified Caprini risk assessment scale, which was automatically embedded in the electronic medical record (EMR) system, and the same doctor verbally provided health education related to perinatal VTE to the patient. Subsequently, within 24 h after the patient's admission, the attending obstetric doctor reviewed the scores and classification on the scale to prescribe VTE prophylaxis before CD based on clinical expert consensus.[15] Participants with an increased risk (VTE score ≥2) were prescribed mechanical prophylaxis, including an ankle pump exercise and wearing antithrombotic elastic stockings or pneumatic cuffs on the calves, and those at high risk (VTE score ≥3) were given subcutaneous injection of LMWH as pharmacological prophylaxis. In addition, VTE risks were assessed again within 12 h after CD by the bedside junior doctor on the parturition day, with the results sent to the attending obstetric doctor for the purpose of VTE prophylaxis prescription within 24 h following CD. All participants were invited to get out of bed as soon as possible and received mechanical prophylaxis until they could fully mobilize. Participants with VTE scores of ≥2 and ≥3 were considered at high risk and were respectively prescribed to receive LMWH for at least 2 days during hospitalization and 7–10 days after delivery. During the participants' admission for CD, the nurse practitioner took charge of the correct execution of prescriptions and the administration of routine nursing care.

Nurse-assisted early warning intervention for cesarean VTE prophylaxis

A specially assembled working group was established to perform the nurse-assisted early warning intervention. In addition to two nurses at different levels in our department, two specialists each from the obstetric, anesthesiology, ultrasound (US), and vascular surgery departments were involved in the team. All the specialists had associate chief titles or above and had engaged in clinical work for more than 10 years in our tertiary hospital. The 10 members of the multidisciplinary team shared responsibility for VTE prophylaxis during a patient's admission. The chief obstetrician and the senior nurse were designated as the team leader and deputy team leader, respectively, not only participating in the VTE early warning prevention but also assuming responsibility for team coordination. The anesthetists were in charge of the anesthetic chart during the cesarean operation, and the US experts conducted US examinations to make a definite diagnosis in suspected patients. Surgeons from the vascular surgery department carried out the corresponding treatment of patients diagnosed with VTE following CD. As a crucial element of the team, the specially trained nurse practitioners not only served as the primary health educators to enhance patients' perinatal VTE knowledge but also identified and responded to VTE risks as well as thrombotic signs as the first-line healthcare providers.

When a patient arrived at the ward, a bedside junior doctor (who had completed the standardized residents' training) verbally provided health education while taking a medical history, including a brief definition of prenatal VTE and a description of unhealthy life habits contributing to prenatal VTE. Simultaneously, the assigned nurse practitioner provided well-designed manuals to each patient in the intervention group to raise their risk awareness of perinatal VTE; the manuals described the causes and risks of VTE during the perioperative period of CD, the impact of VTE on rehabilitation after CD, the advantages of VTE prophylaxis and control, and possible thrombotic symptoms or signs. Within 6 h of admission, VTE risk was assessed (using the same standardized assessment checklist tool as in the control group) by the same junior doctor through the EMR system and by the assigned nurse practitioner using our e-office system.

The resulting VTE risk scores were automatically transmitted to the attending obstetric doctor through the abovementioned two systems to determine the final scales and subsequently prescribe the correct VTE prophylaxis before CD using the same guidelines as in the control group. Unlike in the control group, the assigned nurse practitioner also routinely monitored the assessment once per day at regular hours from 8:00 a.m. to 10:00 p.m. Thus, early identification and consequent warning were continued after CD until the patient was discharged. The corresponding VTE risk scores were transmitted on schedule for the attending obstetrician's prescription within 6 h after CD and at any change in condition.

To ensure the proper implementation of prophylaxis measures, participants identified as being at increased or

high risk in the intervention group were flagged with warning and danger indications in the nurse workstation systems. It should be noted that the assigned nurse practitioner collaborated with the junior doctor to review the anesthetic chart promptly upon the patient's return to the ward following CD so as to confirm the anesthesia records, intraoperative conditions, use of anesthetic drugs, anesthesia-related complications, etc. The mutual support group comprising the bedside junior doctor and assigned nurse practitioner communicated with the attending anesthetists for any required additional information if necessary.

For the early recognition of the occurrence of perinatal VTE during hospitalization, the assigned nurse practitioners, who had received multiple pieces of trainings through a variety of methods (including research, lectures, videos, ward rounds, discussion with experts, and examinations), took charge of making accurate assessments and identifying the signs of DVT or PTE immediately following CD. The abovementioned mutual help group liaised daily to review the results. Patients suspected of having VTE were reported to the attending obstetric doctor and subsequently underwent an immediate complete US examination of deep leg veins by a US specialist in the multidisciplinary team with at least 5 years of lower limb venous thrombosis screening experience, following the ACOG's recommended guidelines for VTE diagnosis in pregnancy and the postpartum period;[10] those who were diagnosed with perinatal VTE were treated promptly after consultation with the vascular doctor or were transferred to the vascular surgery department.

Follow-up and outcomes measurement

Patient demographic characteristics and clinical variables were retrieved from the EMR system, including maternal age; height; weight; body mass index; varicose vein of lower extremity; history of DVT/PTE; hereditary thrombophilia; antiphospholipid syndrome; surgery during pregnancy or puerperium; hyperemesis gravidarum or severe vomiting due to other factors; ovarian hyperstimulation syndrome; medical comorbidities, including tumor, cardiac failure, active systemic lupus erythematosus, polyarthritis, inflammatory bowel disease, nephrotic syndrome, sickle cell disease, and systemic infection; obstetric factors, including parity, in vitro–assisted reproductive technology, multiple gestations, premature delivery, recurrent abortion, and stillbirth; hypertensive diseases of pregnancy, including gestational hypertension, preeclampsia, and eclampsia; fetal growth restriction; prolonged labor (>24 h); postpartum hemorrhage or blood transfusion; and puerperal infection.

All the participants were informed about the possible occurrence of VTE after discharge from hospital and were advised to return for examination if suspected thrombotic symptoms were present. Additionally, each patient was followed up for a period of 14 days through telephone calls following discharge. Follow-up data were collected at 7 and 14 days during the follow-up period and recorded in the documentation of the perioperative VTE prophylaxis program. The primary outcome was the incidence of VTE following CD in the participants of the two groups. Secondary outcomes were rates of mechanical or pharmacologic prophylaxis receipts for VTE and frequency and severity of adverse events related to pharmacologic prophylaxis, including major/minor bleeding. The definition of major bleeding followed the criteria of the International Society on Thrombosis and Hemostasis:[16] (1) hemoglobin below ≥20 g/L; (2) red blood cells or whole blood transfusion ≥2 units; (3) intracranial, intraspinal, intraocular, pericardial, intra-articular, retroperitoneal, or intramuscular bleeding with compartment syndrome; and (4) fatal bleeding. Bleeding not meeting the criteria for major bleeding was predefined as minor bleeding.

Sample size calculation

The sample size was calculated using PASS software version 16 (NCDS LLC, Kaysville, UT). Previous studies report an incidence of pregnancy-related VTEs of approximately 0.12–4.48 per 1000 deliveries[13,17,18] which increases nearly 30-fold after CD. The new method would be recommended if proven slightly more effective in preventing the incidence of VTE following CD. According to the consensus reached after a series of expert discussion meetings focused on pregnancy-related VTE and based on our clinical observation, a 0.2% incidence of VTE following CD was estimated in the control group. We wanted to study the power of the one-sided Farrington-Manning test for detecting a difference significantly greater than –0.5% when the actual difference between the two modalities ranged from 0.0% to –0.5%. Therefore, with a power of 90% and one-sided type I error of 2.5%, we determined a number of 13,537 participants in each group to test the hypothesis for superiority of the difference between two proportions.

Statistical analysis

Statistics were calculated in SPSS software version 22.0 (SPSS Inc., Chicago, IL), and a P value of <0.05 was deemed statistically significance. The Kolmogorov-Smirnov Z test was employed for the normality check. Categorical data were expressed as frequencies/percentages and were compared using the χ^2 test, and normally distributed data were expressed as mean ± standard deviation and were compared using Student's t test. The risk ratio (RR) was calculated to determine the relative risk of developing VTE after CD between the two groups.

Ethical approval

Ethical approval was obtained from the institutional Ethics Committee on Human Research (NJFCETH-2019116). All participants provided informed consent. The study procedures were in accordance with the ethical standards of the *Declaration of Helsinki*.

Results

Figure 1 shows the trial's flowchart. Of 28,097 women undergoing emergency or selective CD who were identified as eligible during the study period, 1023 participants were excluded for meeting the exclusion criteria (n = 807) or having incomplete medical records or follow-up data (n = 216). The remaining 27,074 participants were included for analysis. Table 1 shows the participants' demographic, obstetric, and clinical characteristics at baseline. There were no significant differences between the two groups.

The primary outcome, the incidence of symptomatic VTE following CD, was significantly lower in the intervention group, at 0.29 per 1000 deliveries, than in the control

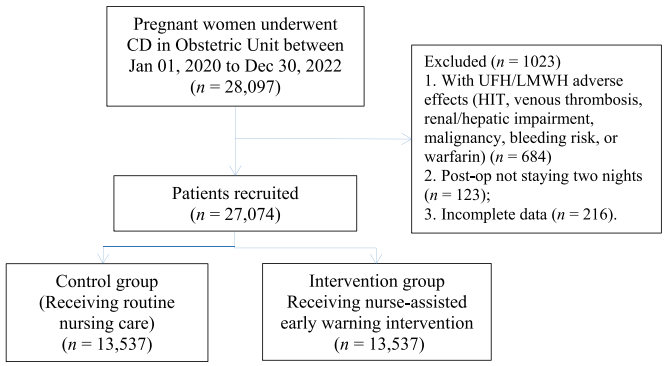

Figure 1. Flowchart of the study. CD: Cesarean delivery; HIT: Heparin-induced thrombocytopenia; LMWH: Low-molecular weight heparin; Post-up: Postoperative participants; UFH: Unfractionated heparin.

group, at 2.4 per 1000 deliveries ($P < 0.001$). The result demonstrates that participants in the control group were at significantly higher risk of developing pregnancy-associated VTE than those in the intervention group, with an RR of 8.0 (95% confidence interval: 2.828, 22.627). In addition, within the control group, 87.2% of participants who reported a VTE score of <1.0 were classified as low risk and advised for early mobilization after CD. Of the rest, 12.6% reported VTE scores of ≥2.0 and were therefore given mechanical prophylaxis, while 0.2% reported VTE

Table 1

Baseline demographic characteristics of the patients.

Characteristic	Control group (n = 13,537)	Intervention group (n = 13,537)	t/χ^2 value	P
Age (years)	31.96 ± 5.79	34.10 ± 3.57	0.181*	0.820
Weight (kg)	79.21 ± 13.7	76.84 ± 8.29	1.797*	0.765
BMI (kg/m^2)				
<25	949 (7.0)	967 (7.1)	0.432†	0.806
25–30	8963 (66.2)	8986 (66.4)		
>30	3625 (26.8)	3584 (26.5)		
Parity ≥2	173 (1.3)	158 (1.2)	0.688†	0.439
Multiple gestation	410 (3.0)	392 (2.9)	0.416†	0.519
Hyperemesis	337 (2.5)	346 (2.6)	0.757†	0.757
GHTN/PE/eclampsia	2095 (15.5)	2201 (16.3)	3.109†	0.081
GDM	1923 (14.2)	1878 (13.9)	0.620†	0.431
OHSS	157 (1.2)	140 (1.0)	0.984†	0.322
Prolonged labor (24 hours)	6616 (48.9)	6514 (48.1)		0.219
Postpartum hemorrhage/blood transfusion	210 (1.6)	185 (1.4)	1.606†	0.224
Puerperal infection	16 (0.1)	13 (0.1)	0.311†	0.584
Thrombophilia	3237 (23.9)	3140 (23.2)	1.930†	0.322
Varicose vein of lower extremity	202 (1.5)	196 (1.4)	0.092†	0.672
History of VTE	125 (0.9)	117 (0.9)	0.267†	0.651
In vitro–assisted reproductive technology	691 (5.1)	712 (5.3)	0.332†	0.583
Comorbidities				
Cardiac disease	123 (0.9)	135 (1.0)	0.564†	0.454
Tumor	26 (0.2)	33 (0.2)	0.832†	0.366
SLE	45 (0.3)	31 (0.2)	2.586†	0.135
IBD	36 (0.3)	43 (0.3)	0.622†	0.499
Nephrotic syndrome	45 (0.3)	59 (0.4)	1.892†	0.201
SSD/thalassemia	11 (0.1)	9 (0.1)	0.200†	0.644

Data are presented as either n (%) or mean ± standard deviation.

*t values.

†χ^2 values.

BMI: Body mass index; GDM: Gestational diabetes mellitus; GHTN: Gestational hypertension; IBD: Inflammatory bowel disease; OHSS: Ovarian hyperstimulation syndrome; PE: Preeclampsia; SLE: Systemic lupus erythematosus; SSD: Sickle cell disease; VTE: Venous thromboembolism.

scores of ≥3.0 and were prescribed pharmacological prophylaxis. In contrast, when the nurse-assisted warning intervention was applied to the intervention group, 79.3%, 19.8%, and 0.9% of participants who had VTE scores of <1.0, ≥2.0, and ≥3.0 received early mobilization or mechanical or pharmacological VTE prophylaxis, respectively. According to the above results, an increased probability of VTE prophylaxis was observed in the intervention group compared to the control group ($P < 0.001$) (Table 2).

No postpartum VTE events were observed during the study period. No participants receiving pharmacological VTE prophylaxis using LMWH reported serious hemorrhage or complications. Only three patients in the control group and five in the intervention group who received pharmacological VTE prophylaxis reported a <5.0-cm hematoma over the skin wound and were managed conservatively in a timely manner.

Discussion

Our results show that the adoption of perioperative cesarean thromboprophylaxis using the nurse-assisted early warning intervention played a significant role in VTE prophylaxis during antepartum and postpartum hospitalization. It was associated with significantly decreased occurrence of maternal VTE following CD by promoting improved the implementation of standardized VTE prophylaxis, improved education to identify the signs and symptoms of VTE, and improved postoperative care during the follow-up period after hospital discharge.

A recent analysis of 133,358 deliveries suggests that China's universal two-child policy resulted in a significant decrease in CD rates from 49.5 to 43.3 per 100 deliveries, still one of the highest rates of CD in the world.[19] Additionally, the proportion of older multiparous women has greatly increased since the relaxation of the one-child policy at the end of 2015. Previous studies demonstrated a significantly increased risk of postpartum VTE events in women aged 35 years and older.[20] Advanced maternal age is not only a well-known independent risk factor for pregnancy-related VTE but also associated with a higher incidence of medical comorbidities, such as gestational diabetes mellitus, gestational hypertension, and obesity.[21] Beyond that, it may increase the use of assistive reproductive technology and cesarean sections. The presence of the abovementioned additional risk factors has also been shown to be associated with an increased risk of VTE in pregnancy.[22] However, up to 75% of the analyzed 100 cases missed one or more opportunities for prophylaxis during the course of maternal healthcare according to a cross-sectional survey-based study involved 26 hospitals across the Chinese mainland, which indicates that the implementation of pregnancy-related VTE prophylaxis is insufficient.[23] Additionally, experts agree that improved clinical care is required to reduce risk, as it is unlikely that trends in VTE risk factors will reverse course anytime soon.[24] Therefore, it is necessary to improve appropriate prophylaxis through measures taken by healthcare professionals, as it is the key factor contributing to decreased maternal mortality and morbidity following obstetric VTE.

Although recommendations for antepartum and postpartum VTE prophylaxis vary, all major medical societies support cesarean VTE prophylaxis for a large minority of patients. The ACOG supports universal mechanical perioperative prophylaxis for CD; the NPMS supports either mechanical or pharmacologic prophylaxis based on risk factors, whereas the RCOG supports extensive risk factor–based pharmacologic prophylaxis.[25,26] Given the absence of specific clinical guidelines for obstetric practice in China, standardized protocols and measures to prevent and control pregnancy-associated VTE are established according to the Clinical Expert Consensus Statements.[14] Data from the Perspective database maintained by Premier Incorporated show that of 956,428 women who underwent CD, 45.4% received mechanical prophylaxis, 3.0% received pharmacologic prophylaxis, and 1.0% received both pharmacologic and mechanical prophylaxis.[27] Differing from that study, our results show that 12.7% and 19.8% of cases in the control and intervention groups, respectively, were prescribed mechanical prophylaxis and that 3.3% and 4.6%, respectively, received pharmacological prophylaxis, which shows that prophylaxis may differ across hospitals due to the varying recommendations.

The Caprini VTE risk assessment scale was developed by a group of physicians, nurses, and scientists in 1991 and has been widely used in multiple disciplines and in departments of general surgery, gynecology, urology, and thoracic surgery.[28,29] Based on the Caprini scale and the RCOG guideline, the novel modified Caprini scale specifically added pregnancy-related risk factors during the perinatal period and offers high sensitivity, feasibility, and validity than the Caprini scale to better identify pregnant women at risk of VTE.[30] Therefore, we employed the modified scale to standardize our current routine clinical care services for obstetric VTE assessment. Although preventions were implemented in adherence to evidence-based guidelines, 26.3% of hospitals had a prophylaxis rate of <20%, 26.3% had a rate of 20% to <30%, 22.5% had a rate of 30% to <40%, and 25.0% had a rate of ≥40% for antepartum hospitalization as reported by a retrospective cohort study using the Perspective database in the United States.[31] In our results, the percentage of patients in the control group who received VTE prophylaxis during their hospitalization for CD was significantly lower than that in the intervention group. Consistent with findings from previous studies, our findings demonstrate that prophylaxis for obstetric VTE during CD hospitalizations not only required the application of evidence-based guidelines but also demanded coordination in actual practice. However, quality improvement in obstetric care for VTE represents a very

Table 2

Incidence of VTE following CD and VTE scores according to the modified Caprini scale.

Outcome	Control group (n = 13,537)	Intervention group (n = 13,537)	χ^2 values	P
VTE following CD, n (%)	32 (0.2)	4 (0.0)	21.749	<0.001
VTE scores, n (%)			324.972	<0.001
<1	11,804 (87.2)	10,733 (79.3)		
≥2	1702 (12.6)	2680 (19.8)		
≥3	31 (0.2)	124 (0.9)		

CD: Cesarean delivery; VTE: Venous thromboembolism.

challenging clinical practice. Our healthcare system attempted to improve obstetric VTE prophylaxis compliance by developing an interdisciplinary team in risk assessment, prophylaxis implementation, and VTE identification with subsequent treatment.

A previous retrospective cohort study estimated physician assistant-driven VTE risk assessment and found a dramatic increase in the number of patients prescribed appropriate orders for VTE prophylaxis according to published guidelines and individual patient risk.[32] We proposed a novel model based on establishing an interdisciplinary team in which nurses as the first-line healthcare providers are teamed with the junior obstetric doctor. VTE risk assessment was reliably performed by the interaction between the paried nurse and junior doctor within 6 h after admission, at daily assessment, and at 6 h after CD. Their assessment was automatically transmitted through the system to the attending obstetric doctor for audit and appropriate timely prophylaxis prescription. Beyond that, nurses also assisted the junior doctor in initially providing health education and the identification of VTE signs to patients. Rodrigues *et al.*[33] report a similar model involving cooperation between nurse practitioners and junior doctors, who liaised daily to review the assessment and for the junior doctor to prescribe prophylaxis before patients' elective surgery. The audit was then repeated to close the loop. Their model improved VTE risk assessment and prophylaxis prescription for patients undergoing plastic surgery.[33] However, their system required regular meetings between group members. Consistent with their findings, our results show that the incidence of symptomatic VTE following CD was significantly lower in the intervention group than in the control group (0.29 per 1000 deliveries *vs.* 2.4 per 1000 deliveries), demonstrating that participants receiving nurse-assisted early warning intervention were at lower risk of developing pregnancy-associated VTE than those receiving routine nursing care. Our findings suggest that the nurse-assisted early warning intervention implemented an audit loop for obstetric VTE prophylaxis. It improved clinical care and ensured both the completeness and accuracy of VTE prophylaxis prescription, thus significantly lowering the incidence of VTE following CD.

Our study has some limitations. First, there may have been undetected confounders and potential bias due to the nature of prospective analysis with observational data. Second, there were no specific guidelines for thromboprophylaxis following CD in China. Third, the present study was carried out at the largest grade A class 3 hospital for women and children in the Nanjing area, so our conclusions may not be representative of hospitals at other levels. Fourth, a high-sensitivity multidetector CT was not used in the present study for patients in whom VTE could not be reliably excluded using the compression US method, which may affect objectivity. Notably, although extending the timeframe beyond 4 weeks may have captured a broader range of postpartum experiences and outcomes, we focused on the immediate postpartum period, because it enabled a more targeted assessment of maternal health during a critical period of adjustment and recovery. Future large-scale, long-term randomized studies are needed to validate our findings.

The strengths of the present study include that it is the first to provide evidence that the administration of a nurse-assisted early warning intervention is efficacious for VTE prophylaxis during pregnancy and the postpartum period. Furthermore, this study included a large sample of pregnant women scheduled for CD. An additional strength of the study is the consistent nurse-assisted early warning intervention, as all preventive measures were implemented by the unified protocol.

Conclusion

The application of nurse-assisted early warning intervention provided a more reliable risk assessment and subsequent thromboprophylaxis protocol for pregnant women undergoing CD and is recommended on the basis of our encouraging outcomes as reflected in the improved prevention of VTE following CD.

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None.

Author Contributions

Jianan Jiang was involved in the study's conception and design; the analysis and interpretation of the data; drafting the paper and critically revising it for intellectual content; and the final approval of the version to be published. Yingying Tian contributed to conception and design, data analysis and interpretation, and drafting the paper. Bichao Wan was involved in conception and design, data analysis and interpretation, drafting the paper, and revising it critically for intellectual content. Dongying Fu contributed to conception and design as well as data analysis and interpretation. Shijiang Chen was involved in conception and design as well as data interpretation. Fuying Tao was involved in conception and design, data interpretation, and drafting the paper. All the authors agreed to be accountable for all aspects of the work.

Conflicts of Interest

None.

Data Availability

The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author (Jianan Jiang) upon reasonable request.

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