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Original research article

Prevention of deep vein thrombosis in pregnant mothers during prolonged bedrest

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INFORMACE O ČLÁNKU

Received: 2016-02-26

Received in revised form:

2016-04-29

Accepted: 2016-07-27

Published online: 2016-09-30

Keywords:

Bedrest

Deep vein thrombosis

Compression devices

Patient education

Omaha System

ABSTRACT

Objective: Conduct and evaluate system-level evidence-based practice intervention for deep vein thrombosis (DVT) prevention.

Design: One group post-intervention survey evaluation.

Setting: A mother-baby unit in a tertiary hospital.

Interventions/measurement: Educating nurses, implementing an evidence-based deep vein thrombosis (DVT) prevention guideline in the mother-baby unit, and recommending policy changes. Outcomes were measured using Omaha System Knowledge, Behavior, and Status scales (1 = lowest – 5 = highest) for nurse DVT knowledge and practice behavior, and implementation of policy recommendations.

Results: Twenty nurses (80%) completed the evaluation survey. The nurses reported that their knowledge increased significantly (3.70 vs. 4.40; $p < 0.001$). Behavior was variable in DVT guideline adherence. After training, most nurses (65%) usually or always assessed women for DVT risk, and some (35%) usually or always applied compression boots for DVT. The majority of nurses (70%) reported that women refused compression boots. Nurses who did not usually or always assess patients were statistically less likely to apply boots ($p = 0.022$). The nurses who reported discomfort with the procedure (30%) were statistically less likely to apply stockings ($p = 0.028$). Policy implementation to support evidence-based DVT prevention increased significantly ($p = 0.008$).

Conclusion: Comprehensive evidence-based interventions resulted in practice and system change to prevent DVT. Nurses' knowledge about DVT prevention increased and some nurses consistently assessed for DVT and applied compression boots. The facility supported the implementation of the guideline and implemented unit/facility policy changes.

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<http://dx.doi.org/10.1016/j.kontakt.2016.07.003>

Introduction

Deep vein thrombosis (DVT) is a deadly and costly condition that contributes to increasing mortality among pregnant women and new mothers in the United States. The United States spends more money on maternity care, but ranks 46th in comparison with 50 countries in maternal death [1]. Evidence-based interventions exist to prevent DVT in pregnant women on bedrest through nurse education and the use of available technology such as graduated compression devices and anti-embolism stockings [2, 3]. The purpose of the study was to change healthcare system policy in order to prevent DVT in pregnant women on bed rest.

Background

DVT is one of the leading causes of maternal death and is a preventable condition [1, 4, 5]. Rates of DVT and PE in pregnant women increased from 3.7 per 10,000 deliveries in 1980 to 18.3 per 10,000 deliveries in 2005 [6]. The risk of venous thrombo-embolism (VTE) is 4–5 times higher for pregnant than non-pregnant women [7]. In pregnancy, the inferior vena cava is compressed by the enlarged uterus and there is an altered level of coagulation factors, and if coupled with decreased mobility this can lead to blood stasis and clot formation.

The cost of managing DVT is \$7–\$10 K and that of pulmonary embolism (PE) is about \$9–\$16 K [8]. It is critical to address this important issue using evidence-based methods [9]. Furthermore, DVT is one of the events for which hospitals are denied reimbursements. A Joint Commission standard holds hospitals accountable for ensuring that patients will have VTE prophylaxis in place within 24 h of hospital admission and within 24 h of transfer to critical care settings; or demonstrate a risk assessment or contraindications to justify why it is not in place [10, 11, 12].

Evidence based strategies in literature that have been found to be useful for the prevention of DVT in pregnant women include adequate risk assessment, early ambulation, active or passive range of motion exercise, mechanical prophylaxis (intermittent compression devices such as compression boots), and chemical prophylaxis (anticoagulant therapy like low molecular weight Heparin) [13,14]. Recent studies suggest that heparin prophylaxis during pregnancy may have no benefit [15, 16]. The study showed that two groups of women receiving heparin and the group not receiving heparin had similar incidences of thromboembolism, pregnancy loss and placenta-mediated pregnancy complications, and while the risk of major bleeding was not increased in both groups, there was an increased risk of minor bleeding in the heparin group [15, 16]. Compression boots and anti-embolism stockings are effective in preventing and treating DVT [2, 3]. The use of compression boots for the prevention of DVT has levels 1A and 1B in scientific evidence [17]. Anti-Embolism Stockings alone reduce the incidence of DVT by over 60% and when used in conjunction with the mechanical method

of prophylaxis they reduce the incidence further up to 85% [18]. These mechanical methods also avoid pain related to injections, the cost of the drug, potential bruising and the risk of minor bleeding related to Heparin use [15, 16].

Methods are needed to measure outcomes of health system change [19]. The Omaha System is an outcome-measure that enables the evaluation of quality improvement initiatives in healthcare systems [19, 20]. It consists of three components: the Problem Classification Scheme, the Intervention Scheme, and the Problem Rating Scale for Outcomes. The Omaha System Problem Rating Scale for Outcomes [19] was used to evaluate knowledge and behavior of participants on the use of compression boots for DVT prevention before and after training relative to the problem of circulation (defined as the movement of the blood through the heart and blood vessels) [19, p. 375].

Rationale for the study was determined through a needs assessment. The first author conducted a review of the International Classification of Diseases-9 (ICD-9) coding using one hundred (100) Primary ICD-9 codes of all patients admitted with a diagnosis of DVT or PE in the project facility. A report consisting of Primary ICD9 Diagnosis CD and Patient Type CD codes was generated from the facility EHR for a two year period between July 1, 2011 and June 30, 2013. A review of the ICD-9 data showed an equivalent of 33.3 DVT cases per 10,000. This revealed the critical need for quality improvement. Out of the 8148 pregnant women seen, 28 (0.3%) had ICD-9 coding indicating that DVT occurred. The length of days before delivery for these women was between 2 weeks and 8 months of bedrest (either at home or as inpatients). This is substantially higher than the rates of DVT and PE in pregnant patients reported in the literature [6]. The purpose of the study was to change healthcare system policy in order to prevent DVT in pregnant women during bed rest. The objectives were to educate nurses, implement an evidence-based DVT prevention guideline, increase the use of available technology (compression boots), and recommend policy changes to support evidence-based nursing practice.

Materials and methods

This was a one group post intervention survey and system change study. The Institutional Review Board (IRB) of the University of Minnesota determined that this study did not meet the definition of human subject research and was exempt from review. Participating nurses consented to participate in the survey during the education activity. All participants were antepartum registered nurses aged between 25 and 63 years ($n = 44$), with a minimum of a bachelors in nursing (some also had additional certification in obstetrics). Each of the participants provided direct patient care to perinatal women on prolonged bedrest and had worked in the study facility for between five and fifteen years (*mean* = 10 years).

Materials used to teach nurses about DVT prevention were developed for the facility and approved by mother-baby unit nursing leadership. A 1:1 training session was

offered to all mother-baby unit nurses. The nurses who agreed to participate ($n = 25$) received regular training in performing DVT risk assessment on admission, and they also learned to apply compression boots if they did not already know how to do so. Nurses participated in 1:1 training, and 20 (80%) completed the evaluation survey. The Omaha System was used to rate self-reported nursing knowledge and behavior and the observed health system status before and after the intervention.

Instrument

The Omaha System was used to design a survey which evaluated DVT-related knowledge and practice, changes in knowledge and behavior as well as health system policy changes. The questionnaire assessed self-reported knowledge and the behavior of nurses on the use of compression boots for DVT prevention before and after training (scale of 1 = no knowledge; 2 = minimal knowledge; 3 = basic knowledge; 4 = adequate knowledge; 5 = superior knowledge). Also how often participants performed risk assessments on pregnant women on bedrest, and how often they applied compression boots (1 = never; 2 = rarely; 3 = sometimes; 4 = usually; 5 = always), and barriers to the use of compression boots (a) Compression equipment not available; (b) Compression sleeves not available; (c) Patients decline the use of compression boots; (d) Discomfort with

the procedure; (e) Discomfort with patient education on compression use) (Table 1).

Results

Nurses reported an increase in knowledge about DVT prevention after the educational intervention (Chart 1). The increase was statistically significant ($p < 0.001$) and was consistent with a large effect size. Nurses also reported improvement in DVT practice behaviors. Of the 20 nurses, 13 (65%) reported that they assessed patients for DVT risk more often after educational intervention than they did prior to the intervention. However, fewer nurses improved practice behavior in applying compression boots. After the educational intervention, only 7 of 20 nurses (35%) reported that they usually or always applied boots. Nurses who did not usually or always assess patients were statistically less likely to apply boots ($\chi^2 = 5.799$; $p = 0.022$). Nurses reported discomfort with the procedure of applying boots and patient education on compression use as barriers to their use of compression boots. The nurses who reported discomfort with the procedure of applying boots (30%) were statistically less likely to apply compression boots (independent samples t -test; 2.67 vs. 3.57; $p = 0.028$).

Table 1 – Definitions of ratings for nurses' knowledge and behavior and organization policy (status)

Scale	Definition	Ratings				
		1	2	3	4	5
Knowledge	Nurses' knowledge of evidence-based DVT prevention	No knowledge of compression for pregnant women on prolonged bedrest	Minimal knowledge of compression for pregnant women on prolonged bedrest	Basic knowledge of compression for pregnant women on prolonged bedrest	Adequate knowledge of compression for pregnant women on prolonged bedrest	Superior knowledge of compression for pregnant women on prolonged bedrest
Behavior	Nurses' assessment of DVT risk and use of compression boots	Nurses never assess for DVT risks or apply boots	Nurses rarely assess for DVT risks and do not apply boots	Nurses inconsistently assess risk and may apply boots as indicated by assessment	Nurses usually assess and apply boots as indicated by assessment	Nurses always assess and apply boots as indicated by assessment
Status	Policy existence and implementation for prevention of deep vein thrombosis in pregnant women	No policy in place that is applicable to pregnant women	Policy under development	Implementation of policy in a single hospital's mother-baby unit	Widespread policy implementation in mother-baby units throughout the health system	Policy in place and followed by nurses

After the educational intervention with nurses, a system-level evaluation was conducted to develop recommendations for policy to support system change.

The recommendations were:

1. Physicians should take leadership of DVT prevention by ordering mechanical prophylaxis; and the DVT prevention protocol should be built into existing order sets. (Adopted)
2. The facility leadership should show support for DVT prevention practice by continuing to educate the health care teams across the facility. (Adopted)
3. The facility should implement the new VTE safety recommendation released in 2013 [7]. (Adopted)
4. The unit should provide patient education about DVT on the educational channel in patient rooms. (Adopted)
5. The unit should provide compression boots in every room and encourage nurses to use them. (Adopted)

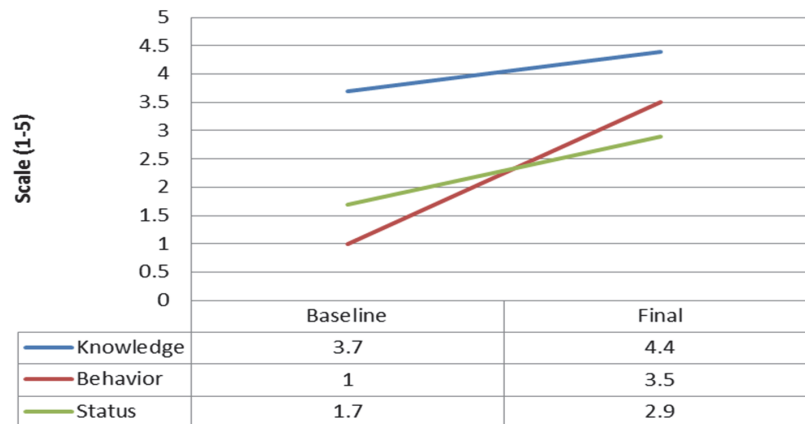


Chart 1 – Nurses reported knowledge, behavior and status on DVT prevention

6. Nurses should consider the use of compression boots during fetal monitoring (20 minutes twice a day) to ensure consistent practice and use.
7. The hospital should consider policy change for the use of anti-embolism stockings since pregnant women may be at less risk of pressure ulcers and the use of anti-embolism stockings may be more acceptable to them.

These recommendations were presented in a series of four presentations at the facility to directors, managers, and the medical director of the mother-baby unit ($n = 4$),

and also at two meetings with charge nurses and other leaders ($n = 13$ total) and obstetricians staffing the mother-baby unit ($n = 30$). To evaluate policy change using the Omaha System, the status of each recommendation was rated on a scale of 1–5 and ratings were compared before and after recommendations were shared with facility leadership (Table 2). The Institute of Clinical System Improvement (ISCI) evidence rating [21] was used to grade the recommendations to support their implementation (Table 3). Policy implementation to support evidence-based DVT prevention increased significantly ($p = 0.008$).

Table 2 – Changes in policy regarding DVT prevention after recommendations

	Before study	After study
Physician leadership: Order mechanical prophylaxis	2	3
DVT prevention protocol built into order sets	2	3
Leadership support for DVT prevention practice	3	4
Provide patient education about DVT on educational channel	1	2
Stock compression boots in every room	2	5
Use compression boots during fetal monitoring (20 minutes twice a day)	1	2
Compression/anti-embolism stockings policy change (pregnant women may be at less risk of pressure ulcers; compression stockings more acceptable to patients)	1	1
	1.71	2.86

Discussion

An evidence-based practice guideline for the prevention of Deep Vein Thrombosis (DVT) requiring risk assessment and documentation by nurses during admissions, at each shift change and on all pregnant and delivered patients was implemented in a large metropolitan hospital. An evaluation of using the Omaha System Problem Rating Scale for Outcomes showed that nurses' knowledge about DVT prevention increased significantly, and most nurses usually or always assessed patients for DVT risk. Based on study findings, recommendations for policy changes were presented to nursing leadership, obstetric providers, and

unit and hospital administrators; which resulted in policy changes at the unit and hospital level.

Practical implications of this study include the importance of educating nurses on the rationale for DVT prevention and the correct use of evidence-based prevention strategies including risk assessment, patient education, and application of compression boots while maintaining proper hydration, adequate nutrition and bedrest exercises for pregnant mothers on bedrest to promote safety. Aligning with the notion that "Failure to provide prophylactic therapy when indicated is a medical error" [9, p. 20], it is incumbent upon all nurses to support individualized DVT prevention care for pregnant women on bedrest, and hospital leadership must provide the

Table 3 – Institute of clinical system improvement (ISCI) evidence rating of recommendations

Recommendations	Strength of recommendation	Method of implementation
Physicians leadership	<i>High</i> : Strong recommendation from multiple studies	Adopted DVT prevention protocol was built into existing order sets Physicians now include order in their notes
Continuing education of health care teams across the facility	<i>High</i> : Strong recommendation from multiple evidence	Adopted A facility DVT committee exists A perinatal doctor is the champion for DVT prevention
Availability of DVT prevention protocol	<i>Moderate</i> : Institutions can adapt recommendation to suit their needs	Adopted DVT assessment at all admission levels DVT prevention protocol was built into existing order sets
The unit should provide patient education about DVT on the educational channel in patient rooms	<i>Low</i> : Recommendation has no empirical evidence	Adopted Patients are encouraged to watch the video at their leisure. Directions for video channels provided
The unit should provide compression boots in every room and encourage nurses to use them	<i>Low</i> : Observational	Adopted Each bed in the unit has a compression machine while boots are stocked in all the unit cleaning utility rooms
The use of compression boots during fetal monitoring	<i>Low</i> : Medical opinion	Not Adopted Monitoring schedules are ordered by attending physician Nurses educate patients on the need to apply boots when they want
The use of anti-embolism stockings for pregnant mothers	<i>High</i> : Strong recommendation from multiple empirical evidence	Not adopted Facility has existing policy that rejects the use of anti-embolism stocking

conditions in which nurses can implement DVT prevention interventions.

In addition, the use of EHR data for a needs assessment was an important factor in demonstrating the need for improved DVT prevention to decision makers, and demonstrates the value of using EHR data for quality improvement in healthcare settings. These data set the stage for advancing healthcare policy change. Nurses can use EHR data to document patient needs and provide rationale for evidence-based interventions.

There were inconsistencies between nursing knowledge and practice. 95% of nurses had adequate to superior knowledge about DVT prevention, 65% assessed DVT risk, and only 35% applied compression boots, which supports claims about non-compliance in the prevention of VTE requiring the education of care givers to achieve improvement [22]. This finding demonstrates the importance of an in-depth examination of nursing practice and motivation and aided in identifying recommendations for policy change. We encourage sustained efforts on risk assessment and the education of nurses and patients to improve compliance.

As in previous studies, the use of the Omaha System enabled the evaluation of three dimensions of study outcomes: Nurses' knowledge and practice behavior, and health system change [20]. The use of the Omaha System Knowledge and Behavior scales illuminated inconsistencies that led to the further examination of barriers to evidence-based practice interventions. Most of the nurses (75%)

reported that patients refused the compression boots due to being uncomfortable and interrupting sleep. The second barrier was a report of nurse discomfort with the procedure of boot application. The availability of compression device machines and sleeves formed the least of the participant's barriers. Policy recommendations were formulated specifically to address these barriers, and thus create conditions that will improve DVT prevention behavior among nurses.

System level outcomes were demonstrated by the evaluation of each policy recommendation. There was a preliminary acceptance of the recommendations by the leadership of the project facility, and a perinatologist champion was identified for an ongoing DVT prevention initiative. Charge nurses verbalized an increased awareness of problems and reminded nurses of the need to apply compression boots during bedrest on their rounds. A policy was developed to stock compression boots in the rooms of pregnant patients on bedrest to improve compliance, and this policy has been implemented. Other recommendations of this study have been implemented by the study facility, except the use of compression boots during fetal monitoring and the use of anti-embolism stockings. There is potential to use the Omaha System for other quality outcome evaluations at the health-system level.

Areas for future study include patient perspectives on acceptance and the use of compression boots, the duration of use necessary for DVT prevention during and after delivery

and how to improve compression devices to enhance nurse and patient satisfaction. Graduated compression devices and anti-embolism stockings are effective in preventing and treating DVT [2, 3]. Their anticlotting effect counteracts blood flow stasis and decreases the chance of thrombus formation. However, in this study, it was not possible to evaluate the use of anti-embolism stockings because the study facility prohibits their use due to its risk for pressure ulcers. Further research is needed to establish the safety of compression/anti-embolism stockings which may be more acceptable for the pregnant mothers, especially in patients without existing peripheral vascular compromise.

Conclusion

A system-level evidence-based practice intervention for deep vein thrombosis prevention improved nursing practice and changed the system policy. The use of EHR data revealed the need for quality improvement around DVT, and supported the necessary collaboration among management and staff to achieve these results. The Omaha System enabled the measurement of knowledge and behavior outcomes for nurses and system level outcomes for the facility. Further research is needed to evaluate the impact of the intervention on patient outcomes.

Conflict of interest

The authors have no conflict of interest to disclose.

Acknowledgements

My deep gratitude goes to Dr. Karen Monsen, my Doctor of Nursing Practice (DNP) advisor, for her professional guidance and constructive recommendations throughout the writing and dissemination of this project. Special thanks go to the academic and support staff of the School of Nursing, University of Minnesota for all the resources they provided. My gratitude is extended to the leadership of the mother-baby unit of Abbott Northwestern Hospital, her educators, nurses and especially the Certified Nurse Specialist, Ms Sandy Hoffman for the collaborative efforts and support throughout the project. I thank my DNP classmates and colleagues for their feedback and finally, I thank my family for their support and encouragement throughout my study.

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