

Nurses' objective knowledge regarding venous thromboembolism prophylaxis

A national survey study

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Abstract

Venous thromboembolism (VTE) is a common vascular disorder with high mortality and morbidity. Clinical nurses are a pivotal group that can serve as first-line health care providers. Lack of knowledge about VTE is an important barrier to effective nursing performance. This study aimed to determine nurses' knowledge of VTE prophylaxis through a nationwide survey across China, to understand gaps between current knowledge, and guidelines, and to help improve clinical nursing.

The survey included 5 topics with 68 items on VTE, including basic knowledge, risk assessment, basic prophylaxis, physical prophylaxis, and pharmacological prophylaxis.

The survey was distributed to 106 AAA-grade hospitals throughout China; 5218 valid questionnaires were submitted for analysis. There were 5097 women and 121 men respondents, with average age 30.29 ± 8.60 years. The average rate of correct responses regarding VTE knowledge was $59.90 \pm 15.63\%$; 77.81% of subjects answered more than half of the survey items correctly. Better knowledge about thromboprophylaxis was observed among nurses who were more highly educated, more experienced, had received continuing education, intensive care unit (ICU), and lead nurses. Correct response rates were $68.39 \pm 17.03\%$, $60.35 \pm 21.01\%$, $75.51 \pm 22.85\%$, $41.72 \pm 17.47\%$, and $46.01 \pm 21.22\%$ for basic knowledge, risk assessment, basic prophylaxis, physical prophylaxis, and pharmacological prophylaxis, respectively.

Respondents showed satisfactory results regarding basic prophylaxis, basic knowledge, and risk assessment for VTE; respondents had poorer knowledge regarding physical and pharmacological prophylaxis. Better mastery of knowledge about thromboprophylaxis was observed among nurses who were more highly educated, more experienced, had received continuous education, ICU, and lead nurses.

This study suggested that nurse trainers should develop comprehensive educational programs that focus on low correct rate aspects. Higher-level continuous education could improve nurses' knowledge of thromboprophylaxis.

Abbreviations: DVT = Deep vein thrombosis, GCS = Graduated compression stockings, ICU = Intensive care unit, PE = Pulmonary embolism, VTE = Venous thromboembolism.

Keywords: knowledge, nurses, prophylaxis, venous thromboembolism

1. Introduction

Venous thromboembolism (VTE), which includes deep vein thrombosis (DVT), and life-threatening pulmonary embolism (PE), is a common vascular disorder.^[1] Significant mortality, and morbidity owing to this serious medical complication exist in western countries.^[2–4] In Asia, the situation is also not optimistic,

with incidence of DVT between 3% to 28%.^[5] Further, this incidence has been consistently, and rapidly, increasing in recent years.^[4] Especially, as a complication of orthopedic surgery, the incidence of VTE has increased nearly, 6-fold in the past 30 years.^[5] Despite the importance of VTE prophylaxis, less than half of DVT patients receive reasonable prevention before diagnosis.^[4] Correct thromboprophylaxis offers a chance to

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decrease overall health care costs, and improve the safety of hospitalized patients.

VTE management, which offers nurses the opportunity to provide intensive care, is an essential professional competence of licensed nurses. Although the definitive treatment of VTE is determined by doctors, there is a clear consensus that nurses have the responsibility for primary prevention.^[6–8] This challenging topic has been closely examined by scholars. Several studies have stated that clinical nurses play a pivotal role in thromboprophylaxis through patient evaluation, risk stratification, information gathering, and by providing recommendations, and implementation.^[8–11]

Clinical nurses are a key group that can serve as first-line health care providers to identify, and respond to risks of VTE. A Canadian study indicated that nurses are the most suitable candidates to perform daily assessment of DVT prophylaxis.^[12] Direct care nurses, who have a primary obligation to patients' advocacy, can help bridge gaps between patients' specific situations and physicians' knowledge. An assessment in US demonstrated that morbidity, and mortality rates could be decreased through systematic, and consistent patient education by nurses.^[13] Lee's team found that a lack of knowledge was the main barrier to performing VTE risk assessment.^[7] Given its importance, it is troubling that some nurses continue to have unacceptable levels of knowledge with regard to VTE prophylaxis.

Research conducted worldwide overwhelmingly supports that nurses play an important role in thromboprophylaxis. Therefore, it is essential to recognize the necessity for education about VTE among nursing practitioners, and to explore various factors that impact clinical nursing. Although many studies have discussed nurses' knowledge levels regarding VTE prophylaxis, few objective studies have been reported. Hence, we conducted a nationwide survey of nurses across China to determine their knowledge of VTE prophylaxis, to understand existing gaps among current knowledge, and guidelines, and help to improve clinical nursing.

2. Methods

All experimental protocols were approved by the Institutional Review Board of Peking Union Medical College Hospital (No. S-K223). Authors obtained informed consent for all the subjects involved in this study.

2.1. Survey design

The survey was conducted based on preliminary experiments to determine knowledge of VTE prophylaxis among registered nurses, and gaps between current understanding, and guidelines. All experimental protocols were approved by the Institutional Review Board of our hospital. Authors obtained informed consent for all the subjects involved in this study.

2.2. Survey development

Before distribution, the questionnaire was evaluated, and revised with respect to methodology and content by 8 experts in nursing, medical, and surgical fields. All questions were true, or false, and response choices referenced consensus guidelines from the American College of Chest Physicians, American Association of Orthopedic Surgeons, and Chinese Orthopaedic Association. The final survey (Table 1) included 5 topics with 68 items

consisting of basic knowledge, risk assessment, basic prophylaxis, physical prophylaxis, and pharmacological prophylaxis. The content validity index of survey is 0.951. This survey was designed to be completed within 30 minutes.

2.3. Data collection

To understand participant characteristics, and quantify potential variations, we collected basic participant data including demographics, educational background, and years in nursing, leadership roles, and continuing education status.

Through official channels of the Chinese Medical Association, we distributed the questionnaire to 106 AAA-grade hospitals (the highest rated hospitals according to Chinese hospital classification). These hospitals are local medical centers in major cities of 33 Chinese provinces. Participation in this survey was voluntary and anonymous through use of an electronic link. A cover letter was sent to all eligible participants to explain the purpose of this study. Participants were asked to answer each question honestly and objectively. The survey was administered at all hospitals contemporaneously, and kept open for a period of 3 months.

2.4. Statistical analysis

Statistical analyses were performed using IBM SPSS software version 19.0 (IBM Corp., Armonk, NY). Descriptive statistics are expressed as percentages, or as mean, and standard deviation. Differences in responses were compared through analysis using a Chi-squared test to compare categorical variables and analysis of variance for continuous variables. The level of statistical significance was defined as $P < .05$.

3. Results

3.1. Demographics

All survey data were entered, and checked twice to ensure consistency, and accuracy. The survey was distributed to 6237 nurses at 106 hospitals, and 5271 questionnaires were returned for a response rate of 84.51%. After excluding unqualified questionnaires, 5218 valid surveys were included for analysis. Participants included 5097 women, and 121 men, with an average age between 30.29 ± 8.60 years. Mean nursing experience was between 8.96 ± 7.37 years. A total 58.37% of participants had received continuous education; however, only 2.68% of respondents received instruction that is recognized by national nursing associations.

3.2. Knowledge of VTE prophylaxis

The average correct response rate for knowledge of VTE was between $59.90 \pm 15.63\%$ (range 7.35%-98.53%). Whereas 77.81% of subjects answered more than half of survey items correctly, and the correct rate was mainly distributed between 60% and 70% (Fig. 1). The main variables of the study participants are shown in Table 2. The correct response rate was significantly higher among highly educated (Bachelor degree or above), more experienced (>5 years), and lead nurses than other participants ($P < .000$, $P < .000$, and $P = .001$).

A total 3046 participants who had previously received continuous education instruction received higher correct rate ($62.52 \pm 14.78\%$) than respondents who had not received any continuous education ($56.22 \pm 16.04\%$, $P < .000$). Participants

Table 1**The survey questions of venous thromboembolism prophylaxis.**

No.	Questions	Answer	Correct rate (%)
	Basic knowledge		
1	Deep vein thrombosis (DVT) is a clinical manifestation of Venous thromboembolism (VTE).	True	90.25
2	Pulmonary embolism (PE) is a clinical manifestation of VTE.	True	75.76
3	PE is the most severe complication of DVT.	True	85.05
4	Decreased blood flow velocity is 1 of the 3 main causes of VTE formation.	True	85.34
5	Blood vessel injury is 1 of the 3 main causes of VTE formation.	True	75.09
6	A high blood coagulation state is 1 of the 3 main causes of VTE formation.	True	90.57
7	Hyperlipidemia is 1 of the 3 main causes of VTE formation.	False	22.59
8	Limb redness, swelling, heat, and pain are clinical manifestations of acute DVT.	True	74.74
9	Dyspnea is a clinical manifestation of acute DVT.	False	40.57
10	Chest pain is not a clinical manifestation of acute DVT.	True	37.95
11	Chest pain is a clinical manifestation of acute PE	True	71.50
12	Dyspnea is a clinical manifestation of acute PE.	True	88.58
13	Syncope is a major clinical manifestation of acute large area PE.	True	51.11
	Risk assessment		
14	Age is a risk factor for VTE.	True	62.63
15	History of malignancy is a risk factor for VTE.	True	52.41
16	Inflammatory bowel disease is a risk factor for VTE.	True	27.83
17	Leg swelling is a risk factor for VTE.	True	65.45
18	Chemotherapy is a risk factor for VTE.	True	53.20
19	Acute myocardial infarction is a risk factor for VTE.	True	67.17
20	Congestive heart failure is a risk factor for VTE.	True	58.01
21	Leg plaster or splint fixation is a risk factor for VTE.	True	82.46
22	Stroke (<1 month) is a risk factor for VTE.	True	66.85
23	Multiple trauma (<1 month) is a risk factor for VTE.	True	74.65
24	Acute spinal cord injury with paralysis (<1 month) is a risk factor for VTE	True	79.03
25	Hip, pelvis, or leg (<1 month) fracture is a risk factor for VTE.	True	79.80
26	Heparin-induced thrombocytopenia is a risk factor for VTE.	True	52.63
27	Family history of DVT/PE is a risk factor for VTE.	True	65.10
28	History of DVT/PE is a risk factor for VTE.	True	68.24
29	Existing tumor is a risk factor for VTE.	True	61.73
30	Pregnancy or <1 month postpartum is a risk factor for VTE.	True	62.63
31	Stillbirth or miscarriage (more than 3) is risk factor for VTE.	True	45.11
32	Septicemia (<1 month) is a risk factor for VTE.	True	50.57
33	Severe lung disease, including pneumonia (<1 month) is a risk factor for VTE.	True	51.76
34	Pulmonary dysfunction (e.g., COPD) is a risk factor for VTE.	True	54.77
35	Bedridden status is a risk factor for VTE.	True	88.25
36	Varicose veins are not a risk factor for VTE.	False	50.56
37	Use of oral contraceptives is not a risk factor for VTE.	False	33.88
38	Hormone therapy is not a risk factor for VTE.	False	34.88
39	Obesity is not a risk factor for VTE.	False	47.05
40	Central venous catheter placement is not a risk factor for VTE.	False	54.37
41	There is no need to assess VTE risk factors within 24 hours after hospital admission.	False	66.16
42	Nurses should assess VTE risk in hospitalized patients.	True	87.31
43	Nurses should take preventive measures of VTE according to their own experience.	False	56.15
44	There is no need to repeatedly assess VTE risk in patients during hospitalization.	False	70.20
	Basic prophylaxis		
45	It is helpful to instruct bedridden patients in lower limb exercises to prevent VTE.	True	91.57
46	Regularly moving bedridden patients is helpful for preventing VTE.	True	91.09
47	Adequate hydration can prevent the occurrence of VTE.	True	79.51
48	Giving up smoking and drinking has no effect on preventing VTE.	False	54.22
49	Controlling blood glucose and blood lipids can help prevent VTE.	True	85.72
50	Helping hospitalized patients to perform out-of-bed activity as soon as their condition allows does not prevent VTE.	False	50.96
	Physical prophylaxis		
51	Graduated compression stockings (GCS) can be removed at night to relax muscles, with no effect on VTE prevention.	False	30.64
52	GCS require regular sun exposure for sterilization.	False	24.93
53	Alkaline detergent should be used to clean GCS.	False	30.70
54	If GCS are too long, they can be folded down at the top of the thigh.	False	47.11
55	The right way to put on GCS is to roll them from distal to proximal limb gradually (Fig. 2).	False	22.52
56	GCS should not be worn folded (Fig. 3).	True	68.44
57	The right side of the patient's GCS is wearing correctly (decompression on the outer thigh, Fig. 4).	False	37.96
58	With wearing GCS, the pressure injury can be ignored because of low incidence.	False	58.80
59	Accurate measurement should be made when choosing the size of GCS.	True	86.74

(continued)

Table 1
(continued).

No.	Questions	Answer	Correct rate (%)
60	GCS cannot continue to be applied when a patient presents VTE.	False	27.64
61	Intermittent pneumatic compression devices can be used after the occurrence of VTE.	True	51.46
62	Intermittent pneumatic compression devices should be used 24 hours a day for bedridden patients.	True	35.21
63	It is not important to be alert for complications during use of GCS or intermittent pneumatic compression devices. Pharmacological prophylaxis	False	62.00
64	The correct needle puncture angle for subcutaneous anticoagulant injection is 90 degrees.	True	51.69
65	Before the injection of pre-filled anticoagulant drugs, the air in the needle tube should be exhausted.	False	27.10
66	The most common injection site for anticoagulants is the umbilicus.	True	71.35
67	Hemorrhage is the most common complication after anticoagulant therapy.	True	84.63
68	Allergic reaction is the most common complication after anticoagulant therapy.	False	41.32

COPD=Chronic obstructive pulmonary disease, DVT=Deep vein thrombosis, GCS=Graduated compression stockings, PE=Pulmonary embolism, VTE=Venous thromboembolism.

who received training recognized by national nursing associations had higher rates of correct responses ($65.23 \pm 12.68\%$) than those trained in hospital ($62.43 \pm 14.92\%$, $P=.029$), or regional ($63.69 \pm 13.56\%$, $P=.379$) programs. We found differences among the departments of medicine, surgery, ICU, and gynecology/obstetrics. ICU and surgery nurses had the highest rates of correct answers with $62.81 \pm 15.25\%$ ($P<.001$) and $61.06 \pm 15.34\%$ ($P<.001$), respectively; these rates were between $58.38 \pm 16.06\%$ ($P<.000$) and $57.93 \pm 15.70\%$ ($P<.001$) for nurses in the departments of medicine, and gynecology/obstetrics, respectively.

Correct response rates were among $68.39 \pm 17.03\%$, $60.35 \pm 21.01\%$, $75.51 \pm 22.85\%$, $41.72 \pm 17.47\%$, and $46.01 \pm 21.22\%$ for basic knowledge, risk assessment, basic prophylaxis, physical prophylaxis, and pharmacological prophylaxis, respectively. The 5 questions with the highest accuracy were those that mainly concentrated on basic VTE knowledge (Q1, Q6, Q12, Q45, and Q46); the 5 questions with the lowest accuracy mainly concentrated on physical prophylaxis (Q7, Q52, Q55, Q60, and Q65).

3.3. Basic knowledge

DVT or PE is clinical manifestation of VTE was determined by 90.25% to 75.76% of participants. Most respondents correctly responded that slow blood flow (85.34%), blood vessel wall injury (75.09%), and hypercoagulable state (90.57%) are the 3 main causes of VTE. However, 77.41% of respondents

incorrectly believed that hyperlipidemia is 1 of the 3 main causes of VTE. Only 37.95% to 40.57% of participants correctly responded that thoracalgia and dyspnea were not symptoms of acute DVT.

3.4. Risk assessment

Respondents demonstrated 88.25% to 82.46% correct understanding for “Bedridden status” and “Leg plaster or splint fixation” is a risk factor for VTE, whereas the 5 questions about risk factors for VTE had correct response rates of less than 50%; including inflammatory bowel disease (27.83%), oral contraceptives (33.88%), hormone therapy (34.88%), stillbirth, or miscarriage (more than 3, 45.11%), and obesity (47.05%).

3.5. Basic prophylaxis

A total 91.57% of participants responded correctly to “It is helpful to instruct bedridden patients in lower limb exercises to prevent VTE.” On the contrary, 50.96% of participants responded incorrectly to “Helping hospitalized patients to perform out-of-bed activity as soon as their condition allows does not prevent VTE.”

3.6. Physical prophylaxis

A total 86.74% of respondents responded correctly that determining the correct size of graduated compression stockings (GCS) requires careful measurement. Only 27.64% of participants responded correctly to “GCS cannot continue to be applied when a patient presents VTE.” A total 68.44% of respondents knew the correct way to wear GCS (GCS should not be worn folded); however, only 22.52% of respondents gave correct answers for “The right way to put on GCS is to roll them from distal to proximal limb gradually.” With respect to questions about the care of GCS, the correct response rate was less than 30%.

3.7. Pharmacological prophylaxis

“Hemorrhage is the most common complication after anticoagulant therapy” was answered correctly, by 84.63% of participants, whereas 41.32% incorrectly, answered “Allergic reaction is the most common complication after anticoagulant therapy”. Strikingly, only 27.10% of respondents answered “F.” correctly, which referred a task that they performed each day.

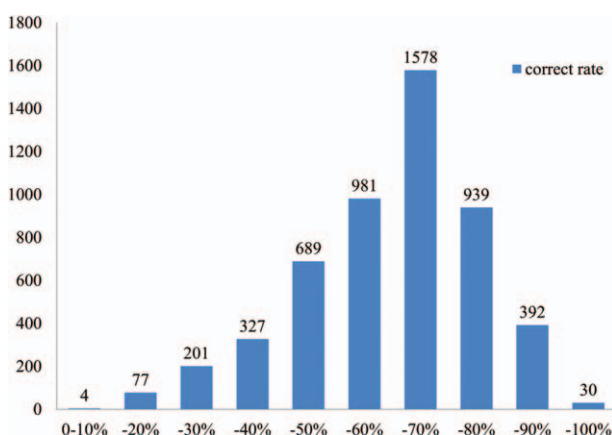


Figure 1. The distribution of correct rate among participants.

Table 2
The main variables of the study participants.

Nurse variables	Number of participants	%	Correct rate (%)
Nursing experience (years)			
> 10	1586	30.39	61.97 ± 15.00
6 – 10	1350	25.87	59.49 ± 16.15
1 – 5	2263	43.37	58.70 ± 15.63
< 1	19	0.36	59.75 ± 14.32
Educational background			
Doctor	7	0.13	67.44 ± 16.80
Master	121	2.32	67.04 ± 13.95
Bachelor	3261	62.50	61.84 ± 15.25
3-year college	1529	29.30	56.63 ± 15.51
Secondary vocational school	300	5.75	52.41 ± 15.49
Departments			
Medicine	1147	21.98	58.38 ± 16.06
Surgery	2666	51.09	61.06 ± 15.34
ICU	206	3.95	62.81 ± 15.25
Gynaecology/Obstetrics	304	5.83	57.93 ± 15.70
Other	895	17.15	58.40 ± 15.63
Leadership roles			
Chief head nurse	67	1.28	65.34 ± 13.51
Head nurse	668	12.80	63.06 ± 13.94
Clinical nursing instructor	722	13.84	61.27 ± 15.90
No	3761	72.08	58.98 ± 15.79
Continuing education			
Yes	3046	58.37	62.52 ± 14.78
Hospital	2650	87.00	62.43 ± 14.92
Regional	93	3.05	63.69 ± 13.56
National	140	4.60	65.23 ± 12.68
Other	163	5.35	61.11 ± 14.74
No	2172	41.63	56.22 ± 16.04

ICU=Intensive care unit.

4. Discussion

The present findings revealed nurses’ knowledge levels about VTE prophylaxis in China. The average correct response rate was only 59.90 ± 15.63%. Whereas 77.81% of subjects answered more than half of survey items correctly, and the correct rate was mainly distributed between 60% and 70%. Based on results of the current study, mastery of knowledge about thromboprophylaxis might vary among educational background, years in nursing, continuing education, work department, and leadership roles. Participants showed satisfactory results regarding basic prophylaxis, basic knowledge, and risk assessment, with higher correct response

rates. However, knowledge was lacking on the aspects of physical prophylaxis, and pharmacological prophylaxis.

It is easy to understand that improvement in VTE knowledge is achieved with higher levels of educational background, nursing experience, and leadership roles. The importance of continuing education has been emphasized by several scholars.^[7,14] A previous study demonstrated that only 9% of participants in South Korea received in-service continuous education.^[15] This is relatively, low compared with our results, which may be related to the fact that our respondents were recruited from the best hospitals (AAA-grade) in China. Nurses at these hospitals pay greater attention to VTE prophylaxis and receive frequent training. In fact, 58.37% of participants who had received continuous education scored higher in our survey. We believe that continuous education can improve nurses’ knowledge of thromboprophylaxis, as stated.^[14] Moreover, we found that



Figure 2. The illustrative picture of Question 55 (the right way to put on GCS is to roll them from distal to proximal limb gradually). GCS=Graduated compression stockings



Figure 3. The illustrative picture of Question 56 (GCS should not be worn folded). GCS=Graduated compression stockings



Figure 4. The illustrative picture of Question 57 (The right side of the patient's GCS is wearing correctly (decompression on the outer thigh). GCS= Graduated compression stockings)

higher levels of training can further improve knowledge. Respondents who had received nationally recognized professional training had the highest correct response rate in our study. Regional continuing education may improve knowledge than hospital training owing to a better quality of education; however, there was no significant difference found. In contrast to this encouraging figure, only 2.68% of respondents had received higher-level training, and 50.79% of participants had only trained in hospitals. These results indicate that nurses should continuously receive high-level training.

We observed significant differences among departments. ICU nurses had the highest correct response rate ($62.81 \pm 15.25\%$). This situation may be explained by the fact that ICU nurses are more aware about VTE prophylaxis because ICU patients are exposed to special conditions such as mechanical ventilation, central venous catheter placement, immobilization, sepsis, and post-operative status, which are all risk factors for VTE. Similarly, surgical patients have a high risk of VTE owing to surgical trauma, and immobility, especially for orthopedic surgery. In addition, nurses involved with vascular surgery have a professional advantage regarding VTE knowledge. Therefore, surgical nurses are extremely sensitive to VTE prophylaxis in their daily practice. These reasons may explain why surgical nurses had higher correct response rates in our survey. Unexpectedly, nurses in the departments of gynecology/obstetrics, and medicine had low score in this study. Based on consensus guidelines, there are substantial high-risk factors for VTE in gynecology/obstetrics, and medicine such as malignant tumors, inflammatory bowel disease, acute myocardial infarction, congestive heart failure, severe pulmonary disease, pregnancy, recurrent miscarriage, oral contraceptive use, hormone therapy, and so on.^[16] Lack of knowledge could lead to non-standard use of VTE prophylaxis and unsatisfactory patient care in these departments. From the results of our study, it may be necessary to revisit the traditional view that guidelines are preferable to educate in departments with high-risk factors for VTE. To improve clinical nursing, systematic training must be strengthened in all VTE-related departments.

Lee et al suggested that VTE risk factors, risk stratification, signs, and symptoms of DVT, and PE, anticoagulants, and contraindications to pharmacologic, and mechanical prophylaxes should be primary topics of professional education.^[7] These are slightly different compared with our results. VTE basic knowledge, risk assessment, and basic prophylaxis had higher scores in our survey. However, some respondents could not accurately, distinguish PE and DVT symptoms. Five risk factors were correctly, identified less than 50% of respondents, including inflammatory bowel disease, stillbirth, or miscarriage, oral contraceptives, hormone therapy, and obesity. Nurse educators

should provide comprehensive training programs addressing these aspects, to span the knowledge gap. A Korean study showed that most VTE nursing was related to the discovery, and confirmation of symptoms. Additionally, correct identification of risk factors is an important part in VTE nursing. Clinical nurses are a key group that can serve as first-line health care providers, to identify, and respond to risks for VTE. Adequate knowledge of VTE symptoms and risk factors may lead to effective nursing practice, and more favorable prognoses.

There were notably, low correct response rates regarding physical prophylaxis, and pharmacological prophylaxis. Most participants understood that GCS is 1 of the main physical methods of VTE prevention. However, participants were unclear about the details of GCS use. Only 27.64% of respondents correctly responded to "GCS can't continue to be applied when a patient presents VTE", and only 22.52% to "The right way to put on GCS is to roll them from distal to proximal limb gradually". The correct response rate was less than 30% for details about GCS care. Lavall et al^[13] stated that consistent, and systematic education of patients by nurses about VTE could decrease patient morbidity, and mortality. Without correct understanding, it is impossible to educate patients about how to actively, participate in their own physical prophylaxis treatment,^[17] therefore, improving nursing quality, and reducing unnecessary costs cannot be achieved. Concerning pharmacological prophylaxis, only 27.10% of respondents correctly answered "Before the injection of pre-filled anticoagulant drugs, the air in the needle tube should be exhausted," which concerned a procedure they perform every day. As implementers of thrombosis prevention, it is troubling to realize that nurses may be incorrectly injecting anticoagulant drugs. These details must be emphasized in daily practice. The necessity for continued nursing training remains paramount to their fundamental role in VTE prevention, with particular emphasis on the details.

There are some limitations in this research. This study was conducted at AAA-hospitals in China; the conclusions may not be representative of other level hospitals. The survey was completed by participants with no supervision, which may affect objectivity. Thirdly, survey participation was not mandatory. Nonresponse, and selection biases may have influenced our findings.

In conclusion, this study demonstrated nurses' knowledge levels about VTE prophylaxis in China. Better mastery of knowledge about thromboprophylaxis was observed among nurses who were more highly educated, more experienced, had received continuous education, ICU, and lead nurses. Respondents showed satisfactory results with regard to basic prophylaxis, basic knowledge, and risk assessment. Knowledge was lacking, mainly with respect to the aspects of physical prophylaxis, and pharmacological prophylaxis. Nurse trainers should develop comprehensive educational programs that are focused on these aspects, with the aim to improve knowledge of thromboprophylaxis.

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References

- [1] Heit JA, Spencer FA, White RH. The epidemiology of venous thromboembolism. *J Thromb Thrombolysis* 2016;41:3–14.
- [2] Heit JA, Silverstein MD, Mohr DN, et al. Predictors of survival after deep vein thrombosis and pulmonary embolism: a population-based, cohort study. *Arch Intern Med* 1999;159:445–53.
- [3] Heit JA. Epidemiology of venous thromboembolism. *Nat Rev Cardiol* 2015;12:464–74.
- [4] Lee L, Liew NC, Gee T. A survey of contemporary opinions and practices of surgical and intensive care specialists towards peri-operative venous thromboembolism prophylaxis in Asia. *Int Angiol* 2012;31:526–33.
- [5] Liew NC, Moissinac K, Gul Y. Postoperative venous thromboembolism in Asia: a critical appraisal of its incidence. *Asian J Surg* 2003;26:154–8.
- [6] Tang X, Sun B, Yang Y, et al. A survey of the knowledge of venous thromboembolism prophylaxis among the medical staff of intensive care units in North China. *PLoS One* 2015;10:e0139162.
- [7] Lee JA, Grochow D, Drake D, et al. Evaluation of hospital nurses' perceived knowledge and practices of venous thromboembolism assessment and prevention. *J Vasc Nurs* 2014;32:18–24.
- [8] Tietze M, Gurley J. VTE prevention: development of an institutional protocol and the nurse's role. *Medsurg Nurs* 2014; 23:331–3. 342.
- [9] Duff J, Walker K, Omari A. Translating venous thromboembolism (VTE) prevention evidence into practice: a multidisciplinary evidence implementation project. *Worldviews Evid Based Nurs* 2011;8:30–9.
- [10] Mason C. Venous thromboembolism: a chronic illness. *J Cardiovasc Nurs* 2009;24(6 suppl):S4–7.
- [11] Fitzgerald J. Venous thromboembolism: have we made headway? *Orthop Nurs* 2010;29:226–34. quiz 235–6.
- [12] Lloyd NS, Douketis JD, Cheng J, et al. Barriers and potential solutions toward optimal prophylaxis against deep vein thrombosis for hospitalized medical patients: a survey of healthcare professionals. *J Hosp Med* 2012;7:28–34.
- [13] Lavall KA, Costello JF. Assessment of the public's knowledge of venous thromboembolism. *J Vasc Nurs* 2015;33:68–71.
- [14] Gaston S, White S. Venous thromboembolism (VTE) risk assessment: rural nurses' knowledge and use in a rural acute care hospital. *Int J Nurs Pract* 2013;19:60–4.
- [15] Oh H, Boo S, Lee JA. Clinical nurses' knowledge and practice of venous thromboembolism risk assessment and prevention in South Korea: a cross-sectional survey. *J Clin Nurs* 2017;26:427–35.
- [16] Kahn SR, Lim W, Dunn AS, et al. Prevention of VTE in nonsurgical patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American college of chest physicians evidence-based clinical practice guidelines. *Chest* 2012;141(2 suppl):e195S–226S.
- [17] Ayhan H, Iyigun E, Ince S, et al. A randomised clinical trial comparing the patient comfort and efficacy of three different graduated compression stockings in the prevention of postoperative deep vein thrombosis. *J Clin Nurs* 2015;24:2247–57.