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Knowledge, attitudes, and practices of healthcare workers on preventing postoperative deep vein thrombosis

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This study aimed to assess the knowledge, attitudes, and practices (KAP) of healthcare workers concerning the prevention of postoperative deep vein thrombosis (DVT) in the lower extremity. A cross-sectional study was conducted from October 2023 to March 2024 in departments such as joint surgery, internal medicine, and general surgery across tertiary hospitals in the Yellow River Delta region. Data were collected using a self-designed and validated questionnaire based on the KAP model. A total of 205 valid questionnaires were collected, with 98 respondents (47.8%) being nurses. Median scores for knowledge, attitudes, and practices were 8.00 (range: 0–8), 47.00 (range: 10–50), and 46.00 (range: 10–50), respectively, indicating strong overall performance in all three domains. Multivariate logistic regression revealed that higher knowledge (OR = 2.24, *P* = 0.008) and attitude scores (OR = 1.29, *P* < 0.001) were significant predictors of better preventive practices. Conversely, working in surgical (OR = 0.17, *P* = 0.001) and working in other departments (OR = 0.28, *P* = 0.010) were associated with lower levels of preventive practice, indicating the need for targeted interventions in these high-risk units. Healthcare workers demonstrated generally adequate knowledge and attitudes toward DVT prevention. However, specific gaps in clinical practice were observed, particularly the limited use of thromboelastography. Targeted training programs focusing on practical application are recommended to strengthen preventive measures, especially in surgical and internal medicine departments.

Keywords Knowledge, attitudes, and practices (KAP), Deep vein thrombosis, Postoperative complications, Healthcare workers, Cross-sectional study, Prevention

Deep vein thrombosis (DVT) is an obstructive vascular disorder characterized by the formation of abnormal blood clots within the deep veins of the lower extremity, impeding venous return[1]. It poses a serious health risk due to its high incidence and potential for severe complications. The annual incidence of lower extremity DVT is estimated at 45 to 117 cases per 100,000 individuals[2], with a mortality rate of up to 6% within one month of diagnosis[3]. Clinically, DVT often presents with muscle soreness, swelling, or tenderness, although these symptoms lack specificity, and nearly half of patients may show no typical signs, increasing the risk of missed or delayed diagnosis.

Among surgical populations, especially orthopedic patients undergoing hip or knee procedures, the risk of DVT is elevated due to long operation times, limited mobility, and changes in coagulation dynamics. Patients with fractures, advanced age, and elevated D-dimer levels are particularly vulnerable[4]. Despite the implementation of pharmacological and mechanical preventive strategies, DVT remains a significant concern in postoperative care[5,6]. If left untreated or poorly managed, DVT may lead to post-thrombotic syndrome (PTS), characterized

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by chronic edema, pain, and skin changes, as well as pulmonary embolism (PE), a potentially life-threatening event[7–10].

The Knowledge, Attitudes, and Practices (KAP) model posits that individual behaviors are influenced by one's knowledge and attitudes. This framework is widely used in public health to assess behavioral outcomes and guide interventions through structured surveys[11–13]. In the context of DVT prevention, healthcare workers play a central role in both risk assessment and clinical implementation of prophylactic measures. Their awareness, beliefs, and actions directly affect patient outcomes and the success of institutional prevention strategies.

Despite existing research in other regions[14–16], there is a noted lack of studies focusing on the KAP towards DVT prevention among healthcare workers in China. Additionally, a study in China on the KAP regarding the use of graduated compression stockings for the prevention of venous thromboembolism showed that only 32.5% of participants had adequate knowledge and only 34.0% demonstrated appropriate practices[17], highlighting a significant knowledge-practice gap. Therefore, this study aims to investigate the KAP of healthcare workers regarding the prevention of postoperative lower extremity DVT, addressing this critical gap in a Chinese healthcare setting. This research will guide the prevention and treatment of lower extremity DVT, providing essential insights for clinical practice.

Methods

Study design and participants

This cross-sectional study was conducted from October 2023 to March 2024 and involved healthcare workers from various departments, including joint surgery, internal medicine, and general surgery at multiple tertiary hospitals in the Yellow River Delta region. The study was approved by the Ethics Committee of Dongying People's Hospital [DYYX-2023-172], and informed consent was obtained from all participants through questionnaires.

Inclusion Criteria:

1. Active healthcare workers holding a valid license from the People's Republic of China.
2. Engaged in clinical healthcare work for at least one year.
3. Voluntarily provided informed consent and participated in the study.

Exclusion Criteria:

4. Healthcare workers still in training.
5. Healthcare workers who were on leave during the study period.

Sample size calculation

Following a rule of thumb of five participants per questionnaire item[18], a minimum sample size of 175 was estimated based on the 35 items included in the survey (including baseline variables). To account for potential invalid or incomplete responses, we added a 10% contingency, resulting in a target of at least 195 participants.

Data collection

In this study, we employed the convenience sampling methodology to facilitate data collection. To streamline the process, we leveraged Wenjuanxing, an online platform, to construct an electronic questionnaire easily accessible via personalized links and QR codes. This digital approach was instrumental in enhancing participant engagement. Cooperation was facilitated through coordination with the heads of joint surgery departments at various hospitals, organized under the Joint Surgery Branch of the Medical Association. After receiving training, department heads provided standardized instructions and distributed questionnaire links to the participants. Participants completed the questionnaires anonymously using the provided links. Each participant was permitted only one submission, and completion of all items was required. The research team ensured all questionnaires were complete, internally consistent, and valid.

Questionnaire introduction

The questionnaire design was informed by relevant guidelines and literature, and refined based on feedback from three experts, including two specialists in joint surgery and one in transfusion medicine. Following the initial draft, a pilot study was conducted with 30 participants, yielding a Cronbach's α coefficient of 0.924, indicative of high internal consistency. The finalized questionnaire comprised four sections: demographic information (education level, gender, job type, institution type, professional title), and dimensions assessing knowledge, attitude, and practice. The full questionnaire is available in Supplementary Appendix 1. Preliminary validation showed high internal consistency (Cronbach's $\alpha = 0.899$) and adequate sampling suitability for factor analysis (KMO = 0.865), supporting the structural validity of the instrument.

The knowledge dimension consisted of eight questions, each correctly answered question scored 1 point, with incorrect or unclear answers scoring 0, resulting in a possible range of 0–8 points. The attitude dimension featured 10 questions, rated on a five-point Likert scale from very positive (5 points) to very negative (1 point), allowing for a total score between 10 and 50. Similarly, the practice dimension included 10 questions on a five-point Likert scale from always (5 points) to never (1 point), with scores also ranging from 10 to 50. Scores surpassing 70% of the maximum possible in each section were considered indicative of adequate knowledge, a positive attitude, and proactive practice[19].

Statistical methods

Data analysis was conducted using Stata version 18.0 (StataCorp LLC, College Station, TX, USA). Descriptive analyses of demographic data and scores for each dimension were performed initially. Normality tests determined the distribution of scores for each dimension: normally distributed data were expressed as means and standard deviations (SD), while non-normally distributed data were presented as medians along with the 25th and 75th percentiles. Categorical data related to demographic characteristics and responses to each question were expressed as counts and percentages (N (%)). For comparing dimension scores among survey respondents with different demographic characteristics, the following approaches were applied: the t-test was used for continuous variables that were normally distributed, whereas the Wilcoxon-Mann-Whitney test was used for non-normally distributed data when comparing two groups. For comparisons among three or more groups, one-way ANOVA was used for normally distributed variables, while the Kruskal–Wallis test was used for non-normally distributed variables. Multivariate logistic regression was used to analyze associations between demographic variables and practice scores. For practice scores, the median of 46 was used as the cut-off, with scores ≥ 46 indicating high practice and scores < 46 indicating low practice. Variables with $P < 0.1$ in univariate logistic regression analysis were included were included in the multivariate logistic regression analysis. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. To assess for multicollinearity in the multivariate logistic regression model, we calculated the Variance Inflation Factor (VIF) for all predictor variables. Multicollinearity analysis revealed that all GVIF^(1/(2*Df)) values were well below the threshold of 5, indicating no significant multicollinearity among the predictor variables in the model.

Results

Basic characteristics of the survey respondents

A total of [230] eligible healthcare workers were invited to participate in the study. We received [212] submitted questionnaires, of which 205 were deemed valid after screening. This resulted in a response rate of [92.17] % and an effective response rate of [89.13]%. The demographic breakdown of the 205 participants included 98 nurses (47.8%), 132 females (64.4%), and 117 individuals aged 30–39 years (57.1%). Educational qualifications showed 156 respondents (76.1%) held an associate or bachelor's degree. Professional status was indicated by 124 participants (60.5%) holding an intermediate professional title, and 79 (38.5%) reported having 10–20 years of professional experience (Table 1). Median scores for knowledge, attitudes, and practices were 8.00 [7.00, 8.00], 47.00 [43.00, 50.00], and 46.00 [39.00, 50.00], respectively. Analysis of demographic characteristics revealed significant variations in knowledge, attitudes, and practices scores across marital status ($P = 0.005$, $P = 0.002$, $P = 0.002$), department ($P = 0.037$, $P = 0.002$, $P = 0.001$), job type ($P < 0.001$, $P = 0.001$, $P = 0.002$), and years of service ($P = 0.002$, $P = 0.004$, $P = 0.021$). Additionally, significant age-related differences were observed in knowledge ($P = 0.009$) and attitudes ($P = 0.024$) scores (Table 2).

Knowledge, attitudes, and practices

In the knowledge dimension, most items were answered correctly, yet the statement "Intermuscular vein thrombosis is a type of DVT" (K4) showed a relatively high error rate of 16.6%, suggesting a persistent misconception about DVT classification (Table 3). In the attitudes section, while the overall sentiment toward DVT prevention was positive, a notable proportion of respondents remained neutral or disagreed regarding the effectiveness of existing measures (A4: 16.1% neutral, 5.9% strongly disagreed) and availability of resources (A6: 13.2% neutral), highlighting potential skepticism or perceived limitations in workplace support (Table 4). In the practices dimension, most respondents reported consistent implementation of preventive behaviors, but items involving thromboelastography—both in risk assessment (P6: 10.7% rarely, 4.9% never) and in monitoring post-treatment (P10: 9.3% seldom, 5.9% never)—indicate underutilization of advanced diagnostic tools in clinical routines (Table 5).

Spearman's correlation analysis of knowledge, attitudes, and practices

Spearman's correlation analysis revealed modest yet significant positive relationships among all three KAP domains: knowledge–attitude ($r = 0.237$, $P < 0.001$), knowledge–practice ($r = 0.311$, $P < 0.001$), and attitude–practice ($r = 0.391$, $P < 0.001$). These findings indicate that higher knowledge levels and more favorable attitudes are associated with better preventive practices (Table 6).

Univariate and multivariate analysis of knowledge, attitudes, and practices dimensions

Multivariate logistic regression showed that no demographic or professional factors were independently associated with knowledge or attitude scores. However, both higher knowledge scores (OR = 2.24, 95% CI: [1.24, 4.06], $P = 0.008$) and higher attitude scores (OR = 1.29, 95% CI: [1.16, 1.43], $P < 0.001$) were significant predictors of better preventive practices. In contrast, working in surgical departments (OR = 0.17, 95% CI: [0.06, 0.47], $P = 0.001$), internal medicine departments (OR = 0.28, 95% CI: [0.11, 0.73], $P = 0.010$), or other departments (OR = 0.13, 95% CI: [0.04, 0.41], $P < 0.001$) was associated with lower levels of DVT preventive practice (Table 7). These findings suggest that while knowledge and attitude positively influence preventive behaviors, targeted efforts are still needed in specific clinical settings where practice levels remain insufficient.

Discussion

Healthcare workers demonstrated generally satisfactory knowledge, attitudes, and practices (KAP) regarding the prevention of postoperative lower extremity DVT. It is recommended to enhance educational interventions and resources particularly in surgical and internal medicine departments to further improve practice scores and compliance, as these factors were strongly associated with better preventive measures against DVT.

N = 205	*N*(%)
Total Score	205(100.0)
Gender	
- Male	73(35.6)
- Female	132(64.4)
Age	
<=29	23(11.2)
30–39	117(57.1)
40–49	48(23.4)
>=50	17(8.3)
BMI	
<=18.5	10(4.9)
18.5–23.9	99(48.3)
24.0–27.9.0.9	73(35.6)
>=28.0	23(11.2)
Education Level	
- Associate/Bachelor's Degree	156(76.1)
- Master's Degree and Above	49(23.9)
Marital Status	
- Single	22(10.7)
- Married	183 (89.3)
Department	
- Joint Surgery	64(31.2)
- Transfusion Medicine	19(9.3)
- Surgical Department	41(20.0)
- Internal Medicine Department	45(22.0)
- Other Departments	36(17.6)
Job Type	
- Physician	80(39.0)
- Nurse	98(47.8)
- Other Personnel	27(13.2)
Professional Title	
- Junior	40(19.5)
- Intermediate	124(60.5)
- Senior	41(20.0)
Years of Service	
< 5years	21(10.2)
5 ~ 10 years	61(29.8)
10 ~ 20 years	79(38.5)
≥ 20 years	44(21.5)

Table 1. Basic information of participants.

Our findings are consistent with several previous studies. In Saudi Arabia[15], researchers reported high levels of knowledge and practice among nurses, highlighting the beneficial effects of experience and prior education on DVT management proficiency. Similarly, a study from Northern Cyprus[14] showed high general knowledge, which parallels our results. In contrast, research from Pakistan[16] revealed a significant discrepancy: despite widespread recognition of the clinical importance of DVT prophylaxis, actual implementation was notably deficient. This reflects similar attitude gaps identified in our study regarding the perceived effectiveness of existing DVT prevention measures. However, comparisons across studies should be interpreted with caution, as differences exist in the validation of KAP instruments, healthcare roles involved, and cultural or institutional settings. For example, some studies cited used non-validated tools or focused on nursing staff only, whereas our study involved a broader range of healthcare workers in a tertiary hospital context.

Significant differences in KAP scores emerged across various demographic and professional dimensions. For example, married participants displayed higher KAP scores than their single counterparts. This could be attributed to greater emotional and social support systems available to married individuals, which may enhance their professional engagement and commitment to best practices in patient care. The literature supports that

	Knowledge		Attitude		Practice	
N = 205	Median [25%,75%] or mean ± SD	*P*	Median [25%,75%] or mean ± SD	*P*	Median [25%,75%] or mean ± SD	*P*
Total Score	8.00 [7.00, 8.00]		47.00 [43.00, 50.00]		46.00 [39.00, 50.00]	
Gender		0.480[a]		0.702 [a]		0.290 [a]
- Male	8.00 [7.00, 8.00]		47.00 [43.00, 50.00]		46.00 [40.00, 50.00]	
- Female	8.00 [7.00, 8.00]		47.50 [43.00, 50.00]		45.00 [37.00, 50.00]	
Age		**0.009[b]**		**0.024[b]**		0.362 [b]
<=29	8.00 [7.00, 8.00]		43.00 [38.50, 48.50]		40.00 [36.00, 50.00]	
30–39	8.00 [8.00, 8.00]		48.00 [44.00, 50.00]		46.00 [39.00, 50.00]	
40–49	8.00 [7.00, 8.00]		47.00 [43.00, 49.25]		44.50 [37.00, 48.25]	
>=50	8.00 [7.00, 8.00]		47.00 [45.00, 50.00]		47.00 [41.00, 50.00]	
BMI		0.813 [b]		0.789 [b]		0.742 [b]
<=18.5	8.00 [8.00, 8.00]		49.00 [43.00, 49.75]		40.00 [36.00, 47.50]	
18.5–23.9	8.00 [7.00, 8.00]		46.00 [43.00, 50.00]		45.00 [37.50, 50.00]	
24.0–27.9.0.9	8.00 [7.00, 8.00]		48.00 [44.00, 50.00]		46.00 [40.00, 50.00]	
>=28.0	8.00 [7.00, 8.00]		48.00 [43.00, 49.50]		46.00 [39.00, 50.00]	
Education Level		0.409 [a]		0.757 [a]		0.165 [a]
- Associate/Bachelor's Degree	8.00 [7.00, 8.00]		47.00 [43.00, 50.00]		46.00 [40.00, 50.00]	
- Master's Degree and Above	8.00 [7.00, 8.00]		48.00 [45.00, 49.00]		43.00 [35.00, 50.00]	
Marital Status		**0.005[a]**		**0.002[a]**		**0.002[a]**
- Single	7.00 [7.00, 8.00]		42.50 [38.00, 48.00]		37.50 [30.00, 45.00]	
- Married	8.00 [7.00, 8.00]		48.00 [44.00, 50.00]		46.00 [40.00, 50.00]	
Department		**0.037[b]**		**0.002[b]**		**0.001[b]**
- Joint Surgery	8.00 [7.00, 8.00]		47.00 [43.00, 50.00]		48.00 [42.75, 50.00]	
- Transfusion Medicine	7.00 [6.50, 8.00]		42.00 [38.00, 46.00]		40.00 [28.00, 47.50]	
- Surgical Department	8.00 [7.00, 8.00]		48.00 [44.00, 50.00]		42.00 [36.00, 50.00]	
- Internal Medicine Department	8.00 [7.00, 8.00]		47.00 [43.00, 49.00]		45.00 [39.00, 50.00]	
- Other Departments	8.00 [8.00, 8.00]		48.50 [46.00, 50.00]		45.00 [37.00, 49.25]	
Job Type		**<0.001[b]**		**0.001[b]**		**0.001[b]**
- Physician	8.00 [7.00, 8.00]		48.00 [43.00, 50.00]		46.00 [40.75, 50.00]	
- Nurse	8.00 [8.00, 8.00]		48.00 [44.00, 50.00]		46.00 [39.00, 50.00]	
- Other Personnel	7.00 [6.00, 7.00]		42.00 [39.50, 46.50]		40.00 [30.00, 44.00]	
Professional Title		**0.030[b]**		0.153 [b]		0.352 [b]
- Junior	8.00 [7.00, 8.00]		46.00 [41.75, 50.00]		41.00 [36.50, 50.00]	
- Intermediate	8.00 [8.00, 8.00]		48.00 [44.00, 50.00]		46.00 [39.00, 50.00]	
- Senior	8.00 [7.00, 8.00]		46.00 [44.00, 49.00]		46.00 [41.00, 50.00]	
Years of Service		**0.002[b]**		**0.004[b]**		**0.021[b]**
< 5years	7.00 [7.00, 8.00]		43.00 [38.00, 48.00]		40.00 [30.00, 46.00]	
5 ~ 10 years	8.00 [8.00, 8.00]		48.00 [44.00, 49.00]		47.00 [40.00, 50.00]	
10 ~ 20 years	8.00 [7.00, 8.00]		48.00 [44.00, 50.00]		45.00 [37.50, 50.00]	
≥ 20 years	8.00 [7.00, 8.00]		46.00 [42.00, 49.00]		46.00 [41.00, 50.00]	

Table 2. Comparison of Knowledge, Attitude, and practice (KAP) scores based on participant Characteristics. [a]Wilcoxon-Mann-Whitney test; [b]Kruskal–Wallis test; Bold all significant P-values ($P < 0.05$).

married individuals often have better psychological well-being, which can positively influence their work performance[20,21].

Participants from the surgical and internal medicine departments showed higher practice scores compared to those from other departments. This finding likely reflects the critical nature of DVT prevention in these high-risk department, where professionals are routinely involved in postoperative care and are thus more vigilant in implementing prevention measures. Previous study found that professionals in high-stakes environments tend to have more rigorous adherence to protocols due to the immediate consequences of medical oversights[22,23]. Nurses and physicians exhibited higher KAP scores compared to other healthcare personnel. This variation can be explained by the direct involvement of these professionals in patient care and their consequent exposure to DVT prevention protocols. Direct care providers are often more knowledgeable and proactive due to their frontline roles in managing patient outcomes[24,25]. Additionally, our multivariate analysis showed that working in surgical or internal medicine departments (compared to joint surgery as the reference group) was independently associated with lower odds of better preventive practices. This highlights the importance of department-specific

Knowledge				
	Headache	Diarrhoea	Pulmonary Embolism	Gastric Ulcer
1. What serious complications may postoperative DVT cause?	3(1.5%)	1(0.5%)	201(98%)	0 (0.0%)
	Yes	No	Unclear	
2. Prolonged surgical procedures can easily induce postoperative DVT.	201(98%)	1(0.5%)	3(1.5%)	
3. Hypertension and hyperlipidaemia are risk factors for postoperative DVT.	201(98%)	2(1%)	2(1%)	
4. Intermuscular vein thrombosis is a type of DVT.	166(81%)	34(16.6%)	5(2.4%)	
5. Postoperative ankle pump exercises can reduce the incidence of DVT.	204(99.5%)	0 (0%)	1(0.5%)	
6. Active fluid replacement postoperatively can reduce the incidence of DVT.	194(94.6%)	6(2.9%)	5(2.4%)	
7. Improper use of anticoagulant drugs can exacerbate the occurrence of DVT.	192(93.7%)	8(3.9%)	5(2.4%)	
8. Thromboelastography can assist in the diagnosis of DVT.	198(96.6%)	2(1%)	5(2.4%)	

Table 3. Knowledge dimension of the participants.

Attitude	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I believe that it is important to take interventions to prevent DVT.	189(92.2%)	14(6.8%)	1(0.5%)	1(0.5%)	0 (0%)
2. I think that anticoagulant drugs can be used for postoperative patients to prevent DVT.	153(74.6%)	36(17.6%)	12(5.9%)	0 (0%)	4(2%)
3. In clinical practice, I prefer to recommend non-pharmacological measures for DVT prevention (e.g., exercise, compression stockings).	152(74.1%)	41(20%)	10(4.9%)	0 (0%)	2(1%)
4. I believe that the existing DVT prevention measures are sufficiently effective.	86(42%)	72(35.1%)	33(16.1%)	2(1%)	12(5.9%)
5. I consider the prevention of postoperative DVT to be the responsibility of healthcare workers.	136(66.3%)	39(19%)	19(9.3%)	1(0.5%)	10(4.9%)
6. I believe that there are sufficient resources and support in my current work environment to implement DVT prevention measures.	106(51.7%)	67(32.7%)	27(13.2%)	0 (0%)	5(2.4%)
7. I think that patient adherence to medical advice affects the effectiveness of postoperative DVT prevention.	147(71.7%)	49(23.9%)	8(3.9%)	0 (0%)	1(0.5%)
8. I believe that raising awareness and providing training for healthcare workers can improve the level of DVT prevention.	162(79%)	41(20%)	2(1%)	0 (0%)	0 (0%)
9. I think that postoperative DVT prevention should be part of standard care.	154(75.1%)	46(22.4%)	5(2.4%)	0 (0%)	0 (0%)
10. I believe that the prevention of DVT can improve the quality of life for postoperative patients.	164(80%)	37(18%)	4(2%)	0 (0%)	0 (0%)

Table 4. Attitude dimension of the participants.

Likert scale scoring: Strongly Agree=5, Agree=4, Neutral=3, Disagree=2, Strongly Disagree=1˙

Practice	Never	Occasionally	Sometimes	Often	Always
1. I will explain to patients the incidence and hazards of DVT before surgery.	16(7.8%)	6(2.9%)	14(6.8%)	50(24.4%)	119(58%)
2. I will recommend DVT prevention measures for postoperative patients.	11(5.4%)	2(1%)	9(4.4%)	45(22%)	138(67.3%)
3. I will provide education on DVT prevention for postoperative patients.	10(4.9%)	2(1%)	13(6.3%)	44(21.5%)	136(66.3%)
4. I will actively monitor whether postoperative patients adhere to DVT prevention measures.	9(4.4%)	3(1.5%)	16(7.8%)	55(26.8%)	122(59.5%)
5. I will regularly assess the risk of DVT in postoperative patients.	9(4.4%)	2(1%)	18(8.8%)	45(22%)	131(63.9%)
6. I will assess the risk of DVT in patients using thromboelastography, as well as coagulation and platelet function analysis.	10(4.9%)	22(10.7%)	36(17.6%)	47(22.9%)	90(43.9%)
7. For patients at high risk of DVT, I will take preventive measures before surgery.	9(4.4%)	3(1.5%)	26(12.7%)	46(22.4%)	121(59%)
8. I will choose different drug treatments for DVT based on the patient's condition.	13(6.3%)	11(5.4%)	22(10.7%)	44(21.5%)	115(56.1%)
9. I will use D-dimer levels to guide the use of treatment drugs postoperatively.	13(6.3%)	8(3.9%)	23(11.2%)	49(23.9%)	112(54.6%)
10. After patients develop DVT and receive timely medication, I will use thromboelastography, as well as coagulation and platelet function tests, to assess the effects of the drugs.	12(5.9%)	19(9.3%)	31(15.1%)	49(23.9%)	94(45.9%)

Table 5. Practice dimension of the participants. **Likert scale scoring: Never=1, Occasionally=2, Sometimes=3, Often=4, Always=5˙**

N = 205	Knowledge	Attitude	Practice
Knowledge	1.000		
Attitude	0.237 (*P*<0.001)	1.000	
Practice	0.311 (*P*<0.001)	0.391 (*P*<0.001)	1.000

Table 6. Spearman's Rho correlation analysis of KAP scores.

Practice	Single factor logistic regression		Multifactor logistic regression	
	OR(95%CI)	*P*	OR(95%CI)	*P*
Knowledge	2.54 (1.55,4.14)	**< 0.001**	2.24 (1.24,4.06)	**0.008**
Attitude	1.24 (1.14,1.35)	**< 0.001**	1.29 (1.16,1.43)	**< 0.001**
Gender				
- Male	ref			
- Female	0.75 (0.42,1.34)	0.333		
Age				
<=29	ref			
30–39	1.81 (0.74,4.67)	0.201		
40–49	1.21 (0.44,3.41)	0.712		
>=50	2.22 (0.63,8.29)	0.221		
BMI				
<=18.5	ref			
18.5–23.9	2.20 (0.57,10.64)	0.274		
24.0–27.9.0.9	2.68 (0.69,13.17)	0.177		
>=28.0	3.03 (0.66,16.99)	0.170		
Education Level				
- Associate/Bachelor's Degree	ref			
- Master's Degree and Above	0.75 (0.39,1.43)	0.392		
Marital Status				
- Single	ref			
- Married	3.01 (1.18,8.70)	**0.028**	1.01 (0.26,3.90)	0.994
Department				
- Joint Surgery	ref			
- Transfusion Medicine	0.21 (0.07,0.61)	**0.005**	0.77 (0.14,4.28)	0.767
- Surgical Department	0.29 (0.13,0.65)	**0.003**	0.17 (0.06,0.47)	**0.001**
- Internal Medicine Department	0.43 (0.20,0.95)	**0.038**	0.28 (0.11,0.73)	**0.010**
- Other Departments	0.32 (0.14,0.75)	**0.009**	0.13 (0.04,0.41)	**< 0.001**
Job Type				
- Physician				
- Nurse	0.88 (0.48,1.59)	0.671	0.91 (0.42,1.96)	0.812
- Other Personnel	0.22 (0.07,0.58)	**0.003**	0.31 (0.07,1.44)	0.135
Professional Title				
- Junior	ref			
- Intermediate	1.65 (0.81,3.46)	0.174		
- Senior	1.74 (0.72,4.25)	0.220		
Years of Service				
< 5years	ref			
5 ~ 10 years	3.60 (1.28,11.29)	**0.020**	1.63 (0.39,6.82)	0.501
10 ~ 20 years	2.20 (0.81,6.71)	0.139	0.83 (0.19,3.57)	0.802
≥ 20 years	3.00 (1.02,9.76)	0.054	1.30 (0.27,6.30)	0.747

Table 7. Factors of practice based univariable and multivariable logistic regression. Bold all significant P-values ($P < 0.05$); Nagelkerke $R^2 = 0.379$;Hosmer-Lemeshow $X^2 = 7.7302$ (df = 8, $P = 0.4603$) ** AIC = 249.5404 ** BIC = 306.0316.

training programs, particularly in high-risk clinical settings where awareness and implementation of DVT prevention are most critical.

Higher KAP scores were associated with intermediate and senior professional titles and with increasing years of service. This trend underscores the role of experience and professional development in enhancing competence and confidence in clinical practices. Experienced staff are often more adept at navigating clinical challenges and integrating new evidence into practice. Older age groups generally showed better attitude and practice scores, possibly due to the accumulation of clinical experience and maturity, which contribute to better judgment and adherence to clinical guidelines[26,27].

Relationship among KAP were revealed through multivariate logistic regression, and correlation analyses. Positive correlations were found among all three KAP components, suggesting that improving knowledge and attitudes may promote better preventive practices[26,28,29]. These findings align with the KAP framework, which

posits that increased knowledge and favorable attitudes lead to improved practices, reinforcing the model's relevance in predicting clinical behavior change.

In evaluating the knowledge, attitudes, and practices of healthcare workers regarding postoperative DVT prevention, our study identifies both strengths and areas needing enhancement. Generally, knowledge levels were high on most topics, with particularly strong awareness of postoperative interventions like ankle pump exercises and the risks associated with prolonged surgical procedures. However, the understanding of intermuscular vein thrombosis as a type of DVT exhibited relatively lower accuracy, reflecting a persistent misconception that deserves attention in future training. Attitude scores demonstrated a robust belief in the necessity of DVT prevention, though certain aspects, such as the perceived effectiveness of current prevention measures and the adequacy of resources for implementation, suggested potential for improvement. In terms of practices, most healthcare workers consistently educated patients about DVT and recommended preventive measures, but the use of thromboelastography for assessing DVT risk was infrequent. Similarly, the previous study[14] also reported high general knowledge while highlighting gaps in understanding specific DVT risks and prevention strategies.

Based on these insights, we propose several targeted recommendations. To address the underutilization and limited understanding of diagnostic tools like thromboelastography, targeted training sessions should be implemented that focus on the benefits and technical aspects of advanced diagnostic tools in DVT prevention[18,30]. These workshops could include hands-on sessions to enhance comfort and proficiency among healthcare workers. To tackle concerns about insufficient resources for DVT prevention, hospital administrations should conduct audits to identify resource gaps and explore partnerships with medical suppliers to ensure the availability of necessary equipment and materials, such as compression stockings and anticoagulants. Furthermore, continuous professional development programs that keep healthcare workers up-to-date with the latest DVT prevention protocols are essential for maintaining high knowledge levels and integrating the latest research findings into daily practice. These programs should be mandatory and include periodic assessments to reinforce learning. Additionally, educational outreach to patients on the importance of adhering to prescribed DVT prevention strategies post-surgery should be improved. This could involve digital brochures, interactive apps, and follow-up consultations to emphasize the importance of compliance with prophylactic measures[31–33].

This study has several limitations that should be considered when interpreting the findings. First, the use of a self-designed questionnaire, though carefully crafted, may not have been validated externally, potentially affecting the reliability and generalizability of the results. Second, the study's focus on tertiary hospitals in the Yellow River Delta region may not reflect the practices or attitudes of healthcare workers in other regions or in non-tertiary hospitals, limiting the applicability of the findings across different healthcare settings. Lastly, the cross-sectional nature of the study restricts the ability to infer causality between the knowledge, attitudes, and practices observed among the participants. Given the use of convenience sampling, the findings may not be fully generalizable to all healthcare workers in the region, and selection bias cannot be ruled out. Future studies employing randomized or stratified sampling methods are recommended to enhance representativeness. Future longitudinal or interventional studies are warranted to explore whether improvements in knowledge and attitudes can lead to sustained changes in preventive practices over time.

In conclusion, while healthcare workers demonstrated encouraging overall levels of knowledge, attitudes, and practices (KAP) regarding postoperative lower extremity DVT prevention, specific gaps such as the limited use of thromboelastography indicate the need for targeted improvements in clinical practice.

Data availability

All relevant data and materials, including the questionnaire instrument, are included in this article and supplementary files.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent

The study was approved by Ethics Committee of Dongying People's Hospital (DYYX-2023-172). All participants were informed about the study protocol and provided written informed consent to participate in the study. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained electronically through the questionnaire platform prior to participation. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Additional information

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