Journal of Clinical Medicine: Current Research **ISSN: 2832-7551**
Volume 3 (2024) 14 Pages
DOI: http://dx.doi.org/10.53043/2832-7551.JCMCR.4.001

Research Article* | *Open Access

Summary of the Best Evidence for Mechanical Prophylaxis of Venous Thromboembolism In Adult Hospitalized Patients

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Received: December 13, 2023
Accepted: December 29, 2023
Published: January 02, 2024

Citation: Boya Li , Xiaogui Tang, Feng Fu, Lingyun Tian, Hongying Tang, Yue Zhao, Yinglan Li. Summary of the Best Evidence for Mechanical Prophylaxis of Venous Thromboembolism In Adult Hospitalized Patients. J Clin Med Current Res. (2024);4(1): 1-14

Key words: Venous thromboembolism; mechanical prophylaxis; hospitalized patients; evidence

1. Abstract

Objectives: To obtain domestic and international evidence on mechanical prophylaxis of venous thromboembolism in adult inpatients and to summarize the best evidence.

Methods: By the "6S" pyramid model, domestic and international guidelines and databases were systematically searched, with a time frame from the establishment of the database to January 31, 2023, and evidence with a more recent time frame was preferred. Two researchers (Master) with evidence-based training independently searched, screened, and evaluated the evidence, and a third (Doctor) reviewed, extracted, and graded the evidence for the included literature.

Results: A total of 3590 documents were obtained from the Chinese and English databases retrieved, and after screening and evaluation, 22 documents were finally included, which were summarized to form 7 key elements and 28 pieces of best evidence.

Conclusions: This study summarizes the evidence related to mechanical prophylaxis of venous thromboembolism in hospitalized patients to provide an evidence-based basis for standardizing clinical mechanical prophylaxis, and healthcare professionals need to select the best evidence in a targeted manner by taking into account the characteristics of the hospital and the clinical environment.

2. Introduction

Venous thromboembolism (VTE), which encompasses deep vein thrombosis DVT and pulmonary thromboembolism PTE, is an important cause of death in hospitalized patients, affecting nearly 10 million people worldwide each year. Surgery, trauma, acute medical illnesses, some chronic diseases, and malignant tumors are all risk factors for VTE 1. An estimated annual global incidence of venous thromboembolism of approximately 115 to 269 cases per

100,000, and an incidence of DVT and PTE of approximately 0.87-1.82 cases per 1,000 person-years (p.y.) and 0.45-0.95 cases per 1,000 p.y., respectively, in the Western world; in the U.S., the annual number of 300,000-600,000 cases of VTE in the U.S. 2 In Asian populations, Japan reported 3 an annual incidence of 10.0/100,000 patients with VTE. A Korean study 4 showed that the annual incidence of VTE increased to 42.2/100,000 cases in 2016. An observational study from the University of Hong Kong 5 concluded that the incidence of VTE increased to 48.3 / 100,000 in 2016, with an increasing trend in those aged 75 years or older.

Venous thromboembolism is a recurrent, chronic disease associated with death, hemorrhage associated with anticoagulation therapy, and long-term disability. The total annual healthcare costs associated with venous thromboembolism have been estimated at €1.5-3.3 billion in Europe and $7-10 billion in the United States 6. In Europe, 8-13 per 1000 women aged 15-55 years and 2-7 per 1000 men die from pulmonary embolism 7. At the same time, thrombus recurrence reduces quality of life and leads to a huge economic healthcare burden. Therefore, proper prevention of VTE plays an important role in reducing its economic burden and improving the quality of life of hospitalized patients.

In recent years, as one of the national medical quality and safety improvement goals, "improving the standardized prophylaxis rate of venous thromboembolism" has received wide attention in China, which points out that improving the standardized prophylaxis rate of VTE and realizing early intervention of VTE can effectively reduce the incidence, disability, and death rate of VTE. Prophylactic measures should be given according to the assessment situation and the relevant clinical guidelines, including drug prevention, mechanical prevention, and so on 89.

At present, drug prevention was more mature and widely used in clinical practice, while mechanical prevention was relatively under-appreciated. Research showed that 10 nurses in China have a positive attitude toward mechanical prophylaxis, but there are problems of insufficient knowledge and behavioral norms. Therefore, there is a need to develop inpatient mechanical prophylaxis strategies based on a large body of evidence to standardize the prevention behaviors of healthcare professionals. This study summarized the evidence on mechanical prophylaxis of VTE in hospitalized patients to standardize the process of mechanical prophylaxis of VTE in patients, improve nurses' adherence to the implementation of mechanical prophylaxis of VTE, and promote the improvement of nursing quality.

3. Methods

3.1 Establishing the problem

The clinical questions were structured following PIPOST guidelines. Target population of the evidence (P): hospitalized patients; Intervention method (I): mechanical prophylaxis; Population using the evidence (P): healthcare professionals; Outcome (O): incidence of venous thromboembolism; Site of application of the evidence (S): hospitals; Type of evidence (T): clinical decision making, guideline, expert consensus, best practice, summary of evidence, systematic evaluation, and so on.

3.2 Literature search strategy

Following the "6S" evidence model, the study computerized searches retrieved resources including BMJ Best Practice, UpToDate, Joanna Briggs Institute (JBI) Evidence-Based Health Care Database, Guidelines International Collaborative (GIN), Agency for Healthcare Research and Quality (AHRQ), National Institute of Clinical Medicine Guidelines Network (NICE), United Kingdom (NICE), Registered Nurses Association of Ontario (RNAO), Canada, Scottish Intercollegiate Guidelines Network (SIGN), New Zealand Guidelines Collaborative Group (NZGG), Canadian Medical Association Clinical Practice Guidelines (CMA), Australian Clinical Practice Guidelines (ACPG), MediPulse, Cochrane Library, PubMed, Embase, Web of Science, CINAHL, China Knowledge Network (CNN), Wanfang, VIP, and China Biomedical Literature Database (CBM). The English search terms were: venous thromboembolism/venous thrombosis/deep venous thrombosis/pulmonary embolism/ VTE/DVT/PTE/intermittent pneumatic compression / compression stocking/intermittent pneumatic compression device/pneumatic graduated compression stocking/elastic stocking/IPC/GCS/; Chinese search terms: Thrombosis / venous thromboembolism / pulmonary embolism / deep vein thrombosis / intermittent pneumatic compression pump / elastic stocking / mechanical prophylaxis / physical prophylaxis. Search time frame: The library was built on January 31, 2023, preferring evidence with a more recent time frame.

We used the "Web of Science" as an example: (TS=((venous thromboembolism OR venous thrombosis OR deep venous thrombosis OR pulmonary embolism OR VTE OR DVT OR PTE)) AND TS= (intermittent pneumatic compression OR compression stocking OR intermittent pneumatic compression device OR pneumatic graduated compression stocking OR elastic stocking OR IPC OR GCS) Publication Date:1950-01-01---2022-12-31.

3.3 Criteria for inclusion and exclusion of evidence

Inclusion criteria: (i)Study population: evidence involving mechanical prophylaxis of venous thromboembolism in hospitalized patients; (ii) Type of evidence; guidelines, systematic evaluations, evidence summaries, recommended practices, expert consensus, etc.; (iii)Publication language in Chinese or English.

Exclusion criteria: (i) guideline interpretations, plans, etc.; (ii) evidence of low-quality evaluation of the literature; (iii) literature not available in full text; (iv) duplicated, unpublished manuscripts.

3.4 Criteria for evaluating the quality of literature

The Chinese version of the 2017 revised APPRAISAL OF GUIDELINES FOR RESEARCH AND EVALUATION AGREE II (AGREE II) was used in the study 11 to assess the quality of the guidelines, which consists of 6 dimensions and 23 items, each of which is rated on a scale ranging from 1 to 7 (where 1 indicates strong dissatisfaction and 7 indicates a high degree of agreement). 2 researchers independently rated each item separately, and the score for each item was the cumulative score of all the scores of the items within the dimension, i.e., the proportion of the highest possible score for that dimension. Based on the scoring results, different levels of recommendations or conclusions can be obtained and thus used as a reference. The calculation method is as follows: highest possible score: 7 times the number of items multiplied by the number of evaluators; lowest possible score achieved: 1 times the number of items multiplied by the number of evaluators; the standardized percentage is obtained by multiplying (the actual score minus the lowest possible score) ÷ (the highest possible score minus the lowest possible score) by 100%, and the evaluation result of the guidelines is obtained based on the above calculation. A guideline was excluded if the standardized percentage of scores was less than 30% for three or more domains; if this lower score requirement was not met, additional scores or adjustments to the weighting factors could be considered to ensure accuracy. Systematic assessments and expert consensus were evaluated according to evaluation criteria provided by the Australian JBI Centre for Evidence-Based Health Care; quality results from primary literature were used to assess the quality of best practices and evidence summaries 12.

3.5 Literature Quality Assessment

The screening and evaluation of the literature were done independently by two master's degree students, and the evaluation results were reviewed by one doctoral student, when there was a disagreement in the evaluation, all the members would decide whether to exclude or include the relevant literature through a collective discussion. Each member of the research team was trained in evidence-based related courses and followed the principle of prioritizing the use of the most recent and high-quality evidence when obvious conflicts arose from the retrieved evidence.

3.6 Summary and Grading of Evidence

The research team independently created an evidence extraction form with headings, country/region information, and evidence specifics, and refined and summarized relevant evidence based on the core themes of this study. The JBI Evidence Pre-grading and Recommended Levels System (2014 version) was used to grade the evidence 13. Quality assessment and grading of evidence was done independently by 2 researchers (Masters). In case of disagreement, a 3rd researcher (Ph.D.) was sought to participate in decision-making, and adjudication should follow the principle of prioritizing evidence-based evidence, high-quality evidence, and the latest published authoritative literature.

4. Results

4.1 Results of Literature Search and Screening

A total of 3590 articles were retrieved from the Chinese and English databases, and all of them were imported into the NoteExpress software, 1609 articles were obtained after eliminating duplicates, reading the titles and abstracts, and 135 articles were obtained after eliminating reviews, original studies, irrelevant articles, and language discrepancies, and 21 articles were finally included in the final list of articles after reading the full-text re-screened articles, including 1 article on clinical decision-making 14, 8 articles on guidelines 1522, 4 articles on systematic evaluation 23-26, and 9 articles on expert consensus 27-34. The specific literature screening flowchart was shown in Figure 1, and the general characteristics of the included literature were shown in Table 1.

4.2 Results of Literature Quality Evaluation

4.2.1 Results of guideline evaluation: a total of 8 guidelines were included in the study 15-22, respectively, from the Expert Committee on Chinese Guidelines for the Prevention and Treatment of Thrombophilia, ASH, SICN, NICE, Dominique Farge, et al, Arash A share et al, ASCO, and the scores for each dimension are shown in Table 2.

4.2.2 Evaluation results of systematic evaluation: In this study, four systematic evaluations 23-26 were included,

Table 1: General characteristics of the included literature.

Database sources	Inclusion of literature	Year of publication	Research Topics	Nature of evidence
BMJ	Jane Burch and others[14]	2019	Venous thromboembolism prophylaxis	clinical decision
Wan Fang (1916-), PRC politician	Expert Committee on the Chinese Guidelines for the Prevention and Treatment of Thrombotic Diseases[15]	2018	Thrombophilia prevention	guidebook
BMJ	American Society of Hematology (ASH)[16]	2018	Prevention of venous thromboembolism in hospitalized and ambulatory patients	guidebook
BMJ	American Society of Hematology (ASH)[17]	2019	Prevention of venous thromboembolism in surgical inpatients	guidebook
Scottish Intercollegiate Guidance Network (SICN) Website	Scottish Intercollegiate Guide Network (SICN)[18]	2014	Prevention and management of venous thromboembolism	guidebook
BMJ	NICE UK National Institute for Health and Clinical Excellence[19]	2019	Risk management of hospital-acquired deep vein thrombosis or pulmonary embolism	guidebook
BMJ	Dominique Farge et al.[20]	2022	Treatment and prophylaxis of venous thromboembolism in cancer patients, including COVID-19 patients	guidebook
BMJ	Arash Afshari et al.[21]	2017	Mechanical prophylaxis of perioperative venous thromboembolism	guidebook
Database sources	Inclusion of literature	Year of publication	Research Topics	Nature of evidence
Pulse of Medicine (TCM)	European Society of Anesthesiology (ASCO)[22]	2019	Prevention and treatment of venous thromboembolism in cancer patients	guidebook
Cochrane Library	Tian Bo et al.[23]	2021	Mechanical prevention of thrombosis after orthopedic surgery	Systematic evaluation/ Meta-analysis
Cochrane Library	Sachdeva A et al.[24]	2018	Mechanical prophylaxis of deep vein thrombosis	Systematic evaluation/ Meta-analysis
Wan Fang (1916-), PRC politician	Zhang Hongying et al.[25]	2021	Mechanical prophylaxis of deep vein thrombosis after knee arthroplasty	Systematic evaluation/ Meta-analysis
Web of Science	Shannon M. Fernando et al.[26]	2021	Prevention of venous thromboembolism in critically ill adults	Systematic evaluation/ Meta-analysis
Wan Fang (1916-), PRC politician	China Health Promotion Foundation Thrombosis and Vascular Special Fund Expert Committee[27]	2020	Mechanical prophylaxis of venous thromboembolism	expert consensus
Wan Fang (1916-), PRC politician	Pressure Group of the Peripheral Vascular Disease Specialized Committee of the Chinese Microcirculation Society[28]	2021	Vascular Pressure Therapy	expert consensus
Pulse of Medicine (TCM)	Nursing Specialty Committee of the International Vascular Federation, China Division[29]	2021	Preventive care and management of venous thromboembolism in hospitalized patients	expert consensus
Wan Fang (1916-), PRC politician	Shanghai Alliance for the Prevention and Treatment of Pulmonary Embolism and Deep Vein Thrombosis[30]	2022	Intermittent pneumatic compression for venous thromboembolism prophylaxis	expert consensus
Database sources	Inclusion of literature	Year of publication	Research Topics	Nature of evidence
Pulse of Medicine (TCM)	Chavarin Amarase et al.[31]	2021	Mechanical prophylaxis of venous thromboembolism in knee and hip replacement and hip fracture surgery	expert consensus
Wan Fang (1916-), PRC politician	China Health Promotion Foundation Thrombosis and Vascular Special Fund Expert Committee[32]	2018	Prevention and management of venous thromboembolism in hospitals	expert consensus
CNKI	Surgical Nursing Committee of the Chinese Nursing Association[33]	2022	Risk assessment and preventive care of venous thromboembolism in general surgery patients	expert consensus
Wan Fang (1916-), PRC politician	Gynecologic Tumor Expert Committee of Shandong Society of Clinical Oncology[34]	2022	Perioperative venous thromboembolism in gynecologic oncology patients take precautions against	expert consensus
Pulse of Medicine (TCM)	Nursing Specialty Committee of the International Vascular Federation, China Division[35]	2019	Prevention of venous thromboembolism by gradient compression stockings	expert consensus

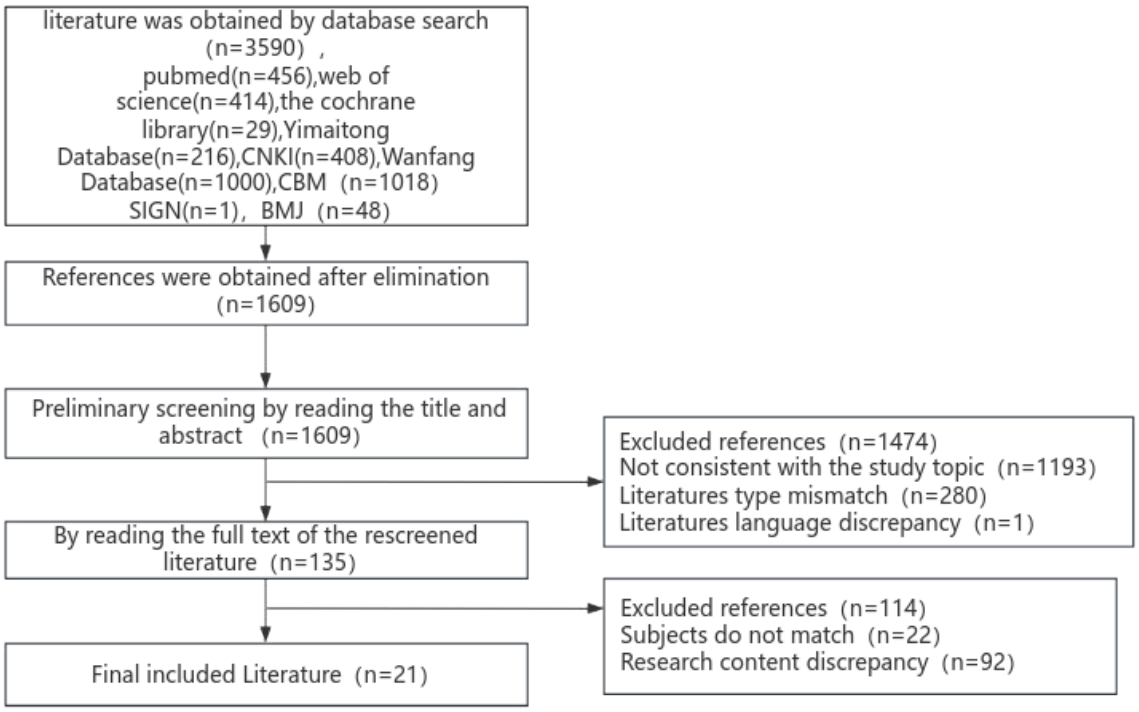

Figure 1: Flow chart of literature screening.

Table 2: Results of the quality evaluation of the guidelines.

Evaluation literature	Standardized score for each dimension (%)						≥60% Leader of a group domain number (math.)	≥30% Leader of a group domain number (math.)	Is it or isn't integrate into
	Scope and purpose	Participate (in sth) officers	Formulated rigor	Clarity	Applicability	Editorial independence			
Expert Committee on the Chinese Guidelines for the	91.67	69.44	73.96	80.56	56.25	91.67	5	6	YES
Prevention and Treatment of Thrombotic Diseases Cynthia B Bautista et al.	91.67	86.11	71.88	77.78	54.17	91.67	5	6	YES
ASH 2018 (hospitalized vs. ambulatory)	86.11	80.56	70.83	72.22	70.83	83.33	6	6	YES
ASH 2019 (Surgery)	80.56	75.00	75.00	83.33	70.83	83.33	6	6	YES
SIGN Guide	91.67	88.89	67.71	72.22	68.75	83.33	6	6	YES
NICE Guidelines	86.11	80.56	71.88	80.56	64.58	75.00	6	6	YES
ITAC Guidelines	75.00	72.22	72.92	72.22	70.83	83.33	6	6	YES
European Society of Anesthesiology	91.67	77.78	58.33	72.22	54.17	91.67	4	6	YES

which came from Cochrane Library, Wanfang, Web of Science and other databases, which there were differences in the evaluations of entry ① (whether the evidence-based questions posed were clear and unambiguous) and entry ⑩ (whether the proposed policy or practice recommendations were based on the results of the systematic evaluations), and were still included in the study after comprehensive consideration (Table 3).

4.2.3 Results of expert consensus evaluation: A total of 9 expert consensus articles 27-34 were included in this study.

Table 3: Quality assessment results of systematic evaluations.

Inclusion of literature	Evaluator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Tian Bo et al.	Evaluator 1	no	yes	yes	yes	yes	yes	no	yes	yes	yes	yes
	Evaluator 2	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes
Shannon M. Fernando et al.	Evaluator 1	currently unknown	yes	yes	yes	yes	yes	yes	yes	yes	currently unknown	yes
	Evaluator 2	currently unknown	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sachdeva A et al.	Evaluator 1	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	Evaluator 2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Zhang Hongying et al.	Evaluator 1	currently unknown	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	Evaluator 2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: (1) whether the evidence-based question posed is clear and unambiguous; (2) whether the literature inclusion criteria are appropriate for the evidence-based question; (3) whether the search strategy is appropriate; (4) whether the literature search is adequate; (5) whether the criteria for evaluating the quality of the literature are appropriate; (6) whether the evaluation of the quality of the literature is done independently by two or more evaluators; (7) whether measures are taken to minimize the error in the extraction of the data; (8) whether the methodology for combining the studies is appropriate; (9) whether the publication of the study is assessed to yes biased; (10) whether recommendations for policy or practice are based on the results of the systematic evaluation; and (11) whether directions for further research are appropriate. (viii) Whether the recommendations for policy or practice are based on the results of the systematic evaluation, and (ix) Whether the proposed directions for further research are appropriate.

These were from the Expert Committee of Thrombosis and Vascular Special Fund of China Health Promotion Foundation, Pressure Group of Peripheral Vascular Disease Specialized Committee of Chinese Microcirculation Society, Nursing Specialized Committee of International Vascular Federation China Division, Shanghai Alliance for Prevention and Control of Pulmonary Embolism and Deep Vein Thrombosis, Chavarin Amarase et al, Surgical Nursing Specialized Committee of Chinese Nursing Society, Shandong Clinical Oncology Society, and Gynecologic Oncology Specialist Committee of Shandong Province. Gynecologic Oncology Expert Committee, etc., in which there were differences in the evaluation of entry ③ (appropriateness of the search strategy) and entry ⑥ (whether there was any inconsistency between the ideas presented and previous literature) of some studies, which were still included according to the criteria of this study, based on a comprehensive consideration (Table 4).

4.3 Evidence aggregation and generation

The evidence was evaluated and summarized by the evidence-based panel of this study, resulting in 7 key components involving risk assessment, indications and contraindications, device usage, prevention in different clinical situations, common problems and strategies, health education and informed consent, and organizational safeguards, and 28 pieces of best evidence (Table 5).

5. Description and analysis of evidence

At present, the visible domestic summary of evidence related to thrombosis prevention is mostly summarized in terms of risk assessment, preventive measures and methods, health education, organizational safeguards, etc. Based on the extracted content of the evidence and combined with the existing literature, this study summarizes the evidence for mechanical prevention of VTE in hospitalized patients into the following seven aspects: risk assessment, indications, and contraindications, methods of device use, prevention in different clinical situations, frequently asked questions and strategies, health education and informed consent, and organizational safeguards.

5.1 Risk assessment

In evidence 1-4, we mainly summarized the risk assessment related to mechanical prevention of VTE in hospitalized patients, including the selection of assessment tools, timing of assessment, assessment risk analysis early identification of VTE, etc. It emphasized the importance of risk assessment in mechanical prevention, and at the same time pays attention to the observation of patients' new-onset DVT in the course of hospitalization, as well as timely assessment of patients' whether they suffer from DVT as well as PTE. We suggested that clinical Nursing staff should assess the risk of VTE in an early, timely, comprehensive, and dynamic manner before implementing mechanical prophylaxis for patients, pay attention to the assessment of VTE risk grading, and master the assessment method to improve the efficiency of prophylaxis.

5.2 Indications and contraindications

In evidence 5-6, we summarized the indications and contraindications for the implementation of mechanical

Table 4: Results of the quality evaluation of the expert consensus.

Inclusion of literature	evaluator	(1)	(2)	(3)	(4)	(5)	(6)
China Health Promotion Foundation Thrombosis and Vascular Special Fund Expert Committee	Evaluator 1	yes	yes	yes	yes	yes	no
	Evaluator 2	yes	yes	yes	yes	yes	yes
Pressure Group of the Peripheral Vascular Disease Specialized Committee of the Chinese Microcirculation Society	Evaluator 1	yes	yes	yes	yes	yes	currently unknown
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
China Health Promotion Foundation Thrombosis and Vascular Special Fund Expert Committee, etc.	Evaluator 1	yes	yes	yes	yes	yes	no
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
Nursing Specialty Committee of the International Vascular Federation, China Division	Evaluator 1	yes	yes	yes	yes	yes	currently unknown
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
Shanghai Alliance for the Prevention and Treatment of Pulmonary Embolism and Deep Vein Thrombosis	Evaluator 1	yes	yes	yes	yes	yes	currently unknown
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
Inclusion of literature	evaluator	(1)	(2)	(3)	(4)	(5)	(6)
Chavarin Amarase et al.	Evaluator 1	yes	yes	yes	yes	yes	currently unknown
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
China Health Promotion Foundation Thrombosis and Vascular Special Fund Expert Committee	Evaluator 1	yes	yes	yes	yes	yes	no
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
Surgical Nursing Committee of the Chinese Nursing Association	Evaluator 1	yes	yes	currently unknown	yes	yes	no
	Evaluator 2	yes	yes	yes	yes	yes	currently unknown
Gynecologic Tumor Expert Committee of Shandong Society of Clinical Oncology	Evaluator 1	yes	yes	currently unknown	yes	yes	currently unknown
	Evaluator 2	yes	yes	currently unknown	yes	yes	currently unknown
Nursing Specialty Committee of the International Vascular Federation, China Division	Evaluator 1	yes	yes	yes	yes	yes	currently unknown
	Evaluator 2	yes	yes	currently unknown	yes	yes	currently unknown

Notes: ① Are the sources of the ideas clearly layesled;② Are the ideas derived from influential experts in the field;③ Are the ideas presented centered on the interests of the population to which the study relates;④ Are the stated conclusions based on the results of the analysis? Are the ideas expressed logically:⑤ Are other existing literatures referred to,⑥ Are there any inconsistencies yestween the presented ideas and previous literatu

Table 5: Summary of evidence for mechanical prophylaxis of venous thromboembolism.

sports event	Content of evidence	Level of evidence	recommended level
risk assessment	**ASSESSMENT TOOLS**: It is recommended to use risk assessment scales (surgical - Caprini Assessment Scale, medical - Padua Assessment Scale, patients with suspected acute PTE - Wells Assessment Scale or Geneva Assessment Scale; or both Caprini Assessment Scale) for thrombotic risk assessment, and to further refine the assessment of the risk of bleeding (according to surgical and non-surgical patients).[1819272932]	**Level 2**	**Grade A Recommendation**
	Timing of assessment: It is recommended that the nurse assesses the patient at the appropriate time based on the patient's condition (when the patient is admitted to the hospital, preoperatively, on the day of the procedure, 6 hours after the procedure, transfer to a different department, discharge from the hospital, and if there is a serious change in condition, etc.) and that the assessment should be performed at least every 48 hours.[181933]	**Level 2**	**Grade A Recommendation**
	Assessing risk analysis: It is recommended that hospitals with the right conditions use an intelligent electronic assessment system for continuous, dynamic, and precise management to solve the problem of VTE risk assessment.[33]	**Level 2**	**Grade B Recommendation**
	Early identification and screening for VTE: It is recommended that before prophylaxis in high-risk patients, lower extremity venous ultrasound be performed to screen for pre-existing DVT and that suspected signs of VTE be evaluated during prophylaxis, if present.[2734]	**Level 2**	**Grade A Recommendation**

Indications and contraindications **How to use the device**	Indications: For patients at risk of VTE according to the risk stratification for graded prevention. ① Low-risk patients can choose mechanical prevention; ② intermediate-risk or high-risk patients with contraindications to anticoagulation, it is recommended to use mechanical prevention alone; ③ High-risk without contraindications to the application of anticoagulant drugs, it is recommended to use a combination of mechanical prevention and drug prevention. [272930]	**Level 5**	**Grade B** **Recommendation**
	Contraindications: congestive heart failure, pulmonary edema, abnormal conditions of the lower extremities (e.g., dermatitis, infection, gangrene, recent skin grafts, new-onset DVT, thrombophlebitis, severe atherosclerosis of the lower extremities or other ischemic vascular disease, and severe deformities of the lower extremities) that preclude the use of GCS and IPC are contraindicated; severe lower-extremity edema is a trade-off for identification of the cause of the disease.[272930]	**Level 5**	**Grade B** **Recommendation**
	Prophylactic devices: Mechanical devices commonly used for effective venous thromboembolism prophylaxis include intermittent pneumatic compression devices (IPCs), plantar vein pumps (VFPs), and graduated compression stockings (GCSs).[31]	**Level 1**	**Grade A** **Recommendation**
	GCS prevention: ① **length selection**: for patients at risk of lower limb DVT, it is recommended that below-knee, low-pressure GCS is relatively more effective; for patients at high risk of DVT, it is recommended that above-knee GCS and anticoagulant drugs are used in combination; for stroke patients, it is recommended that above-knee GCS should be used, taking into account the patient's preference, lifestyle, wearing time, leg circumference and leg shape and other factors to determine **the** overall situation. **Duration of wear**: The GCS should be worn throughout the day from the time of admission to the hospital until the patient's activity level is no longer reduced or returns to the pre-disease activity level, and the condition of the patient and the GCS (e.g., whether there are any complications) should be evaluated daily during wear.[142324272829,35]	**Level 1**	**Grade A** **Recommendation**
	IPC prevention: ① **Pressurization set and pressure selection**: the pressure set can be selected according to the patient's needs, comfort, and clinical experience; the recommended range of pressure is 35-40 mmHg. ② **Timing of pressurization**: it is recommended that for surgical patients (those with moderate to high risk of VTE), it should be started before anesthesia until the patient can be active/activity level is restored to the status before the disease, and at the same time, it can be combined with the use of GCS (intra-operative and post-operative); for patients with acute patients with medical diseases, starting from admission until 30 d of admission/patient discharge; daily use ≥18 h, with appropriate extension for critically ill patients based on mobility.[27282930]	**Level 2**	**Grade A** **Recommendation**
	VFP prophylaxis: When VFP is applied, general pressure: is about 130 mmHg, duration of use: 30-60 min/d, 2-3 times/d, or according to medical advice.[25272829]	**Level 2**	**Grade B** **Recommendation**
Prevention in different clinical situations	**Prophylaxis in hospitalized patients:** mechanical prophylaxis alone is recommended for acute or critically ill patients not receiving pharmacologic prophylaxis for venous thromboembolism, using IPC or GCS for prophylaxis. [1617,33]	**Level 1**	**Grade A** **Recommendation**
	Surgical inpatients: mechanical prophylaxis for patients not receiving pharmacologic prophylaxis (use of mechanical prophylaxis is more effective); IPC prophylaxis for patients receiving mechanical prophylaxis; for patients undergoing major surgery, a combination of mechanical and pharmacologic prophylaxis or mechanical prophylaxis alone is recommended depending on the risk of VTE occurrence and bleeding, the individual patient, and the type of surgical procedure, and prolonged thrombotic prophylaxis (typically for more than 3 weeks (range:19-42 days).[1617,33]	**Level 1**	**Grade A** **Recommendation**
	Intraoperative prophylaxis: IPC prophylaxis is recommended as the first choice, followed by GCS, which is preferable to no prophylaxis.[1527]	**Level 2**	**Grade B** **Recommendation**
	Orthopedic surgery: ① orthopedic major surgery VTE medium and high-risk patients, it is recommended that mechanical and drug prophylaxis is used in combination, low risk and other patients with high risk of bleeding can be used mechanical prophylaxis alone; ② spinal surgery, it is recommended that mechanical prophylaxis is initiated first, and then when the risk of bleeding is reduced, the addition of drug prophylaxis; if mechanical prophylaxis devices can not be used in the affected side of the limb, can be carried out on the healthy side, the general recommended duration of the application ≥ 10 ~ 14 days, and Even extended to 28~35 days postoperatively.[152731]	**Level 3**	**Grade B** **Recommendation**
	General surgery and abdominal and pelvic surgery: mechanical prophylaxis with optimal IPC is recommended for intermediate- and high-risk patients with VTE when there is a high risk of bleeding or serious consequences of bleeding complications, and pharmacological prophylaxis may be initiated in high-risk patients when the risk of bleeding is reduced.[152733]	**Level 1**	**Grade B** **Recommendation**

Prevention in different clinical situations	**Cardiac Surgery**: In patients undergoing cardiac surgery, mechanical prophylaxis alone with appropriate use of IPC is recommended if the postoperative recovery process is simple; in those with prolonged hospitalization and no bleeding complications, the addition of medications such as LDUH or LMWH is recommended for prophylaxis. [1527]	**Level 2**	**Grade B Recommendation**
	Thoracic surgery: Those without high perioperative bleeding risk, with moderate risk of VTE: pharmacologic (LDUH, LMWH) prophylaxis/appropriate application of mechanical prophylaxis is recommended; high risk of VTE: pharmacologic (LDUH or LMWH) prophylaxis is applied with the addition of mechanical prophylaxis. [1527]	**Level 2**	**B Grade Recommendation**
	Neurosurgery: Mechanical prophylaxis is recommended for all patients undergoing neurosurgery, with IPC as the first choice and those at high risk of VTE are recommended for bleeding risk reduction with the addition of pharmacologic prophylaxis. [1527]	**Level 2**	**Grade B Recommendation**
	Severe trauma and surgery: in patients at high risk of VTE, mechanical prophylaxis is recommended in addition to pharmacological prophylaxis when no relevant contraindications exist; mechanical prophylaxis is recommended when contraindications to pharmacological prophylaxis exist, and IPC is preferred. [1527]	**Level 2**	**Grade B Recommendation**
	Internal medicine and ICU patients: it is recommended to start prophylaxis as early as possible, mechanical prophylaxis/pharmacological prophylaxis can be chosen, and mechanical prophylaxis alone can be used for those who have contraindications to pharmacological prophylaxis, IPC is the first choice/option of the GCS leg-length type is recommended to start from the time of the patient's admission to the hospital until he/she can be normally active.[1527]	**Level 1**	**Grade A Recommendation**
	Oncology: drug combined with mechanical prophylaxis is recommended, or drug alone; in patients with contraindications to anticoagulation, mechanical methods alone can be used for prophylaxis, and when the risk of bleeding decreases, replacement or additional drug prophylaxis should be considered; and in gynecologic oncology patients undergoing pelvic surgery, IPC combined with LDUH or LMWH is the best way to prevent venous thromboembolism.[152734]	**Level 2**	**Grade A Recommendation**
	Perinatal: Mechanical prophylaxis, such as GCS or IPC, is recommended for pregnant women at risk of VTE; combined mechanical and pharmacologic prophylaxis is recommended in the postpartum period (more so when undergoing cesarean section), in miscarriage or termination of pregnancy, and in those who have a predicted time of reduced activity of ≥3 days or more, IPC is preferred among mechanical prophylactic devices.[1527]	Level 2	**Grade B Recommendation**
Frequently Asked Questions and Strategies	**Common problems of mechanical prophylaxis**: **Problems** ① low compliance, ② adverse reactions at the site of use (a small number of patients); **Influencing factors**: ① insufficient knowledge of medical staff, ② lack of understanding of patients and their families, ③ hospitals themselves are not equipped with adequate equipment, etc.[27]	**Level 5**	**Grade B Recommendation**
	Operation Notes: ① application of GCS, according to the doctor's judgment combined with the patient's preference to choose the appropriate length (thigh or below-knee type), and according to the instructions of the standard measurement of the leg circumference; the use of the patient at least 1 time a day to assess the local situation; ② IPC treatment, the leg sleeve wrapped in the outer layer of the thin and flat patient pants to avoid direct contact with the patient's lower limb skin leg sleeve; treatment, pay attention to warmth, close observation of the patient's lower limb condition; ③ timely paperwork records. During the treatment, keep warm and closely observe the condition of the patient's lower limbs; ③ Timely recording of paperwork.[29,3035]	**Level 5**	**Grade B Recommendation**
Health Education and Informed Consent	**Health education:** informing patients and their families/long-term primary caregivers about the risks and consequences of VTE taking mechanical precautions, focusing on patient safety during treatment, and informing participation in necessary follow-up visits before discharge.[293035]	**Level 5**	**Grade B Recommendation**
	Informed consent: educating the patient and/or family about the knowledge and condition. [2732]	**Level 5**	**Grade B Recommendation**
organization safeguards	**Evaluation of the results of VTE prevention in hospitals and treatment of related adverse events: Evaluation of the results:** evaluation of adherence to prevention, monitoring of prevention safety, etc., and evaluation of prevention effects (incidence of symptomatic VTE, incidence of lethal PTE, etc.). **Treatment of adverse events:** the hospital establishes a VTE risk assessment and prevention system and incorporates it into medical quality control to ensure implementation.[32]	**Level 5**	**Grade B Recommendation**
	1. **Standardized training:** Enhance standardized management of VTE through standardized training; implement risk assessment of VTE through real-time quality monitoring.[33]	**Level 2**	**Grade A Recommendation**

prophylaxis and suggested that the selection of prophylaxis should be based on the patient's VTE risk stratification and that contraindications need to be ruled out before the implementation of mechanical prophylaxis. It is worth mentioning that the presence of intermuscular venous thrombosis may allow the application of mechanical devices (lower extremity pneumatic compression pumps, etc.) to reduce the risk of thrombus propagation, although the presence of deep vein thrombosis is one of the contraindications to mechanical prophylaxis [36]. Experts advised [37] that mechanical treatment of isolated distal DVT can be used to further reduce symptoms and prevent the development of DVT and its complications by wearing compression stockings after the acute phase (within 2 weeks of disease onset), which still needs to be validated by high-quality evidence.

5.3 Methods of use of the device

In evidence 7-10, we summarized the current use of commonly used mechanical prophylactic devices, including the selection of device type, duration of use, and frequency of use of three devices, including the graduated compression stocking (GCS), the intermittent pneumatic compression device (IPC), and the venous plantar pump (VFP). Current research showed that GCS is more effective in surgical patients [23]. One study compared the preventive effect of intermittent inflation devices and medical compression stockings on DVT, and the results showed that intraoperative intermittent inflation can effectively reduce the incidence of lower extremity DVT, improve coagulation and fibrinolytic indexes, and the effect is better than the use of GCS [38]. As for the duration and frequency of use, some studies have also verified that the IPC treatment time of 40 min each time and the frequency of 2 times can significantly improve the coagulation function of patients without increasing the incidence of deep tissue injury in the lower limbs [39,40]. The patient's coagulation function can be significantly improved without increasing the incidence of deep tissue injury. The appropriate mechanical prophylaxis device, the appropriate type of device, and the reasonable duration and frequency of use should be selected according to the patient's condition.

5.4 Prevention in different clinical situations

In evidence 11-22 ,we summarized the recommendations for the application of mechanical prophylaxis for inpatients with different clinical conditions, and this section is the core of the evidence summary, covering mechanical prophylaxis for patients undergoing orthopedic surgery, cardiac surgery, thoracic surgery, general surgery, neurosurgery, severe trauma and surgery, internal medicine and ICU, obstetrics and gynecology, and oncology, which will help clinical staff to choose appropriate prophylactic strategies on the basis of the patient's condition in their department. Considering the specificity of surgical patients (there are differences in preventive measures for different surgical procedures and sites), the evidence was subdivided according to the content of the evidence, and the integration of the evidence was carried out.

In summary, for hospitalized patients, VTE prevention should be performed as early as possible, and several lines of evidence recommend that the preferred mechanical prevention device is the intermittent pneumatic compression device (IPC) [16,20,33]. The preferred mechanical prevention device is the intermittent pneumatic compression device (IPC). Prevention strategies vary among patients, which mainly in terms of whether mechanical prophylaxis is the preferred measure and whether a combination of pharmacologic and mechanical prophylaxis is used. Evidence supported the use of mechanical combined with pharmacologic prophylaxis in surgical patients, with pharmacologic prophylaxis preferred in ICU and oncology patients, and mechanical prophylaxis as an alternative for patients with a high risk of bleeding [15,20,27]. The reasons for this were analyzed and may be related to the presence of different risk factors in patients.

The content of the evidence mentions that prophylaxis should be started as early as possible, and mechanical prophylaxis should be applied until the patients reach normal mobility, discharge, or continue after discharge. [30,31]At present, due to the implementation of the concept of accelerated rehabilitation and the limitations of the number of hospitalization days in the clinic, the mechanical prophylactic devices cannot reach the length of time required by the guideline to be used, and it can be considered that the time point of the VTE risk assessment and screening could be shifted forward, at the same time, the patient should be immediately screened with the image of DVT to use the prophylactic measures at an earlier stage and prolong the duration of the use of the prophylactic measures after the patient is admitted and assessed to be at high risk. Meanwhile, do a good job in the health education of the patients and their families, and carry out post-discharge continuation of prophylaxis timely.

5.5 Frequently Asked Questions and Strategies

In exhibits 23-24, our study summarized the common problems and strategies in the use of mechanical prophylaxis.

They mainly including common problems, influencing factors and recommendations, precautions during operation, and recommendations for strengthening the training of medical staff and the configuration of mechanical prophylaxis equipment to facilitate the implementation of mechanical prophylaxis. Medical personnel, as the leading actors in the application of mechanical prophylaxis, must hold the necessary knowledge and master the skills to improve the efficiency of the use of mechanical prophylaxis.[41,42] Therefore, medical staff are required to acquire knowledge about mechanical prevention through continuous training in multiple stages and to update their knowledge. Mechanical prophylaxis equipment is an indispensable resource to support the implementation of mechanical prophylaxis [43]. The use of mechanical prophylaxis equipment also brings certain maintenance costs, so it is recommended that healthcare organizations should be equipped with adequate equipment for the implementation of mechanical prophylaxis, taking into account the cost and benefit of patients.

5.6 Health Education and Informed Consent

We described the evidence 25-26 in terms of health education and informed consent, healthcare professionals were required that they should inform patients and their families/long-term primary caregivers of the risks and consequences of VTE and the necessity of taking mechanical prophylaxis, and provide guidance on the proper application of mechanical prophylaxis, precautions to be taken during the application period, possible adverse reactions, and response options, etc. At the same time, the patients and/or their families should be educated and informed about their conditions to ensure the rights and interests of patients. Some studies [44] showed that there is still a difference in behavior among nurses even though the department has the corresponding evaluation standards due to the lack of relevant processes, although clinical nurses can grasp the basic content of health education on mechanical prevention and can correctly implement preventive measures. Therefore, when providing health education to patients, administrators need to develop clear processes or standardized health education tools (such as manuals, flow charts, and standardized terminology forms) to regulate nurses' behaviors to promote consistency in nurses' health education.

5.7 Organizational safeguards

In evidence 27-28, we summarized the organizational safeguards required for mechanical prevention. The evidences were summarized in terms of the assessment of VTE prevention outcomes and the management of related adverse events in hospitals, the establishment of VTE risk and prevention systems in hospitals, and standardized training, as well, the important role of hospital policies and supervision was emphasized in the implementation of mechanical prevention. It makes implementation of the evidence difficult that discrepancies between guidelines and clinical practice persist in clinical practice. Therefore, Therefore, the establishment of VTE risk assessment and prevention system is the guarantee to improve the use rate of mechanical preventive measures.

6. Limitations

There are some limitations in this study, due to the limitations of the language of the literature included in this study and the limitations of the search strategy, there may be other relevant evidence content that has not been retrieved and included; secondly, there may be evidence that has been updated after the cut-off time of this study, so the later study will be based on the new evidence that emerges to update the evidence content of this study.

7. Strengths

In the literature included in this study, guidelines were mostly selected from international authoritative guidelines, and expert consensus was mostly selected from those published by domestic authoritative organizations related to thrombosis. On the one hand, the guidelines from International authoritative databases ensure the reliability of the evidence. On the other hand, the expert consensus is selected to be published by domestic authoritative organizations, which makes the applicability of the evidence in domestic applications better.

8. Conclusions

This study summarizes the evidence related to mechanical prevention of VTE in hospitalized patients with the core content of mechanical prevention of VTE in hospitalized patients in different clinical situations, which provides an evidence-based basis for standardizing the practice of clinical mechanical prophylaxis and helps clinical healthcare professionals to select the best evidence in a targeted manner.

9. Author Contributions

Boya Li and **Xiaogui Tang** are contributed equally to this manuscript, they contributed to the conceptualization of the study, literature retrieval, screening and quality evaluation, original draft preparation; **Feng Fu:** extract and summarize evidence; **Lingyun Tian** and **HongyingTang** : revise the manuscript; **Yinglan Li** and **Yue Zhao** are corresponding

author of the article, reviewing the manuscript and approved the submission of the manuscript.All authors have read and agreed to the published version of the manuscript.

10. Acknowledgements and statements of interest

We thank all the students for agreeing to participate in this study. We also thank our partners who provided valuable contributions in developing and conducting the research. There are no interested parties in this study.

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