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Visualization analysis of prevention of deep venous thrombosis of lower limbs based on CiteSpace

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Abstract: Objective This study conducts a visual analysis to explore the research focus on deep vein thrombosis (DVT) prevention in China. **Methods** Literature related to DVT prevention published on China National Knowledge Infrastructure (CNKI) from 2012 to 2024 were searched. The data of authors, research institutions, and keywords were visual analysed using CiteSpace 6.3.R3 software. **Results** A total of 2,056 eligible studies were included in the analysis. The publication volume showed an increasing trend from 2014 to 2018 but started declining in 2019. Visual maps revealed 260 contributing authors, with 4 authors publishing two or more articles and six authors publishing at least three articles. Notable authors included LI Na, FU Yahui, and SUO Na. The research involved 189 institutions, with 21 institutions publishing three or more articles. Fujian University of Traditional Chinese Medicine and Guangzhou University of Chinese Medicine each contributed over 15 articles. A total of 262 keywords were identified, with 69 keywords appearing ten or more times, including “nursing”, “nursing interventions”, “lower limb fractures”, and “cesarean section”. **Conclusion** Research interest in DVT prevention has shown a declining trend in recent years but remains significant. Collaboration between research institutions is limited, and studies primarily focus on clinical aspects with varying evaluation standards. Basic research is still insufficient. Enhancing collaboration, standardizing evaluation criteria, and strengthening foundational research can provide comprehensive and effective measures for clinical DVT prevention in future studies.

Keywords: Deep vein thrombosis; Lower limb fractures; Cesarean section; Traditional Chinese medicine; Prevention; CiteSpace software

Deep vein thrombosis (DVT) is a serious obstructive condition caused by blood clot formation in the deep vein system, leading to symptoms such as limb swelling, localized pain, and walking difficulties [1]. When the clot travels through the veins and lodges in the pulmonary artery, it can lead to pulmonary embolism, which may even be life-threatening [2]. According to a study by Jagdesh *et al.*, the incidence of DVT in orthopedic patients was approximately 15.3% [3], and in China, with changes in living environments and conditions, as well as continuous advancements in medical technology, the annual incidence of DVT has been steadily rising [4]. Therefore, preventing DVT is of paramount importance. Research on DVT prevention is thriving, with numerous and complex related publications, and a comprehensive visual analysis of the literature in this field has not yet been fully explored. In this study, the CiteSpace 6.3.R3 software was used to conduct a bibliometric analysis of the current state of research based on the China National Knowledge Infrastructure (CNKI) database. This analysis aims to provide an intuitive understanding of the development trends, research teams, institutions, and related research areas. It also offers some references and suggestions to further promote the development of DVT prevention.

1 Materials and Methods

1.1 Literature Source

All the literature was sourced from the core collection of the CNKI database. The search strategy was TS=(deep vein thrombosis) AND TS=(prevention), with the search covering the period from the establishment of the database until January 2024. A total of 5,369 records were retrieved.

1.2 Inclusion and Exclusion Criteria

Inclusion criteria: Literature related to DVT prevention. Exclusion criteria: Articles with irrelevant research topics, duplicate articles already published or retrieved; letters, withdrawals, corrections, conference proceedings, and abstracts were excluded.

1.3 Data Collection

Literature from the core collection of the CNKI database was collected, and the retrieved articles were

exported in form of Refworks and renamed as download_(xx).txt. The export was done using the complete record option. CiteSpace 6.3.R3 was used to convert the data, with the duplicate entries removed, and the final dataset included 1,717 articles after the filtering process.

1.4 Parameter Settings

The time range for the CiteSpace parameters was set from January 2012 to January 2024, with each year being treated as a separate time segment. Authors, institutions, and keywords were selected as nodes. The g-index was used for node selection, with other parameters set to default settings, and the software was used to generate the visual maps.

2 Results

2.1 Trend of Publications

After screening, a total of 2,056 articles were included in the study, which included 2,004 research papers and 52 reviews. The deduplicated results are shown in **Figure 1**. Since 2014, the number of publications on DVT prevention has shown an annual increase. There was an explosive growth in this field between 2014 and 2015. In 2018, the number of publications reached its peak, and the research topics began to diversify. From 2017 to 2019, the number of publications remained relatively stable, with 290, 390, and 307 papers published respectively. Since 2019, the number of publications on DVT prevention has significantly decreased.

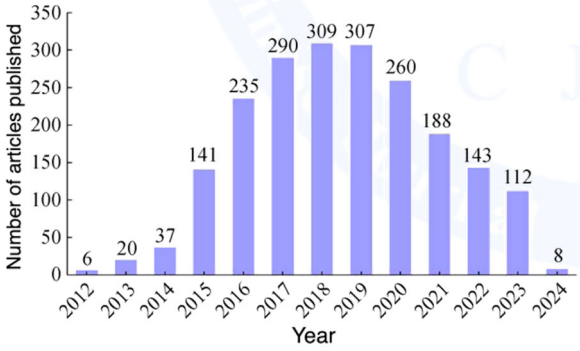

Fig.1 Trend chart of DVT prevention publication volume

2.2 Author Collaboration Analysis

Figure 2 showed the author collaboration network, where the lines between names reflect the collaborative relationships between authors. In this network, 4 authors have published at least three articles: LI Na (6 papers), FU Yahui (3 papers), LI Juan (3 papers), ZHANG Yanzhao (3 papers). Researches were primarily conducted by independent researchers, with a few teams adopting a group approach, and collaboration was relatively sparse. Furthermore, the majority of collaborative teams consist of 2-3 members, and their publication volume was low, making a limited impact. A further analysis of research teams that have published at least three papers reveals the following: LI Na's team focuses on the role of nursing interventions in the prevention and treatment of DVT patients. FU Yahui's team specialized in risk assessment and clinical evaluation for DVT patients after orthopedic surgery. LI Juan's team mainly studied the preventive effect of different nursing intervention models on DVT. ZHANG Yanzhao's team is studying the preventive effects of various Chinese medicines such as *Huoxueling* formula and *Shengtong Zhuyu* formula on DVT.

Fig.2 Author cooperation diagram of DVT prevention

2.3 Research Institution Analysis

Figure 3 showed the institutional collaboration map, which includes 189 institutions. Among them, 34 institutions have published three or more articles, with Fujian University of Traditional Chinese Medicine and Guangzhou University of Chinese Medicine exceeding 15 articles. The major research institutions include Fujian University of Traditional Chinese Medicine (22 articles), Guangzhou University of Chinese Medicine (17 articles), Hebei Medical University (11 articles), Shandong University of Traditional Chinese Medicine (11 articles), Qingdao University (10 articles), Chengdu University of Traditional Chinese Medicine (9 articles), and Shanxi Medical University (8 articles). The betweenness centrality of Fujian University of Traditional Chinese Medicine is 0.06, slightly higher than the 0.02 of Shandong University of Traditional Chinese Medicine and Guangzhou University of Chinese Medicine; while the betweenness centrality of all other institutions is 0.

2.4 Keyword Analysis

Figure 4 was the keyword co-occurrence map, which includes 262 keywords. **Figure 4** showed that when the number of published articles reaches over 10, 69 keywords are considered significant. The top ten keywords were: DVT (309), prevention (255), nursing

(180), nursing intervention (127), lower limb fractures (95), risk factors (91), cesarean section (88), low molecular weight heparin (67), rivaroxaban (64), hip replacement surgery (59). These keywords can be categorized into five main groups: disease classification, nursing interventions, drug-related information, perioperative management, and age factors (**Table 1**). DVT was most common in gynecological and hip fracture patients, with betweenness centrality of 0.46 and 0.36, respectively. Therefore, it could be inferred that current research in the field of gynecology and prevention of DVT in hip fractures was relatively hot; Next was cerebral hemorrhage, with a betweenness centrality of 0.22; Next were lung cancer and spinal fractures, with betweenness centrality of 0.10 for both. In recent years, the importance of preventive care in DVT prevention had become increasingly prominent, with a betweenness centrality of 0.23. In addition, evidence-based nursing and high-quality nursing also had high betweenness centrality of 0.22 and 0.13, respectively. Regarding medication, traditional Chinese medicine ranks second among all keywords with a centrality of 0.32, suggesting that it is widely used in the clinical field of DVT prevention. Perioperative measures for DVT prevention are also very important. As shown in **Table 1**, although the frequency of occurrence was only 5 times, the betweenness centrality was as high as 0.10, which is crucial for surgeons in DVT prevention. Lastly, age factors also play a role in DVT prevention, with a betweenness centrality of 0.01.

Figure 5 and **Figure 6** present the keyword cluster analysis results in the field of DVT prevention. Using the LLR method in CiteSpace, ten consecutive keyword clusters were identified. Each cluster represents a research hotspot and development direction in this field: #3, #8 and #9 emphasized nursing intervention, while # 6 and #7 focused on the research of DVT in fracture surgery and joint replacement; #0 involved research related to DVT risk factors, #4 concerned intracerebral hemorrhage in DVT prevention, and #1 explored the influence of gynecology on DVT prevention.

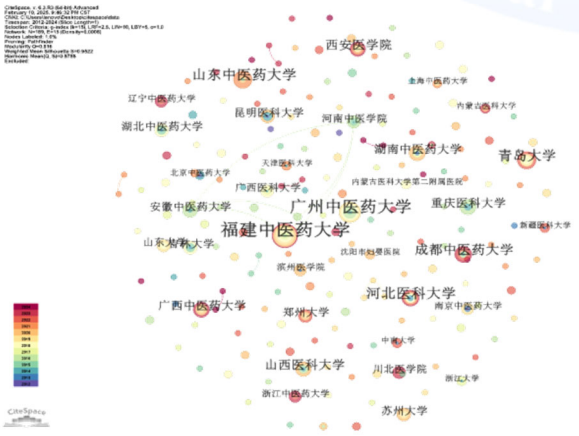

Fig.3 Cooperation diagram of DVT prevention agencies

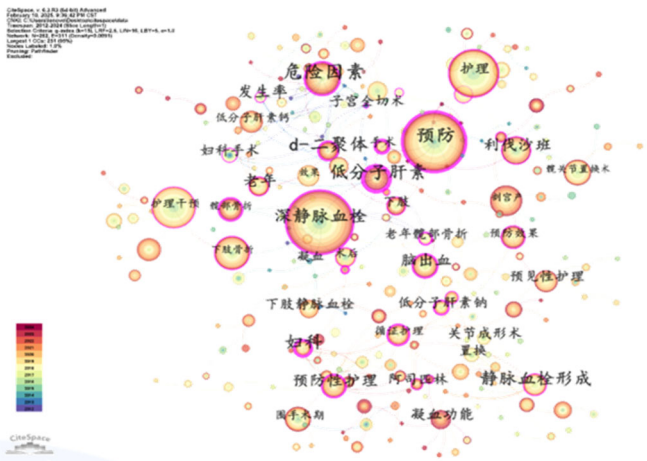

Fig.4 DVT prevention keyword co-occurrence chart

Tab.1 Summary of high-frequency keywords

No.	Classification	Keywords	Frequency	Betweenness Centrality
1	Disease type	Gynaecology	21	0.46
		Hip fracture	46	0.36
		Cerebral hemorrhage	44	0.22
		Lower limb fracture	95	0.18
		Gynecological surgery	14	0.13
		Intertrochanteric fracture	1	0.10
		lung cancer	1	0.10
		Cesarean section	88	0.10
		Spinal fracture	12	0.10
		Malignant tumor	4	0.01
		Oophoritis cyst	4	0.01
2	Nursing intervention methods	Preventive care	44	0.23
		Evidence based nursing	34	0.22
		High quality care	22	0.13
		Proactive care	48	0.10
		Comprehensive nursing	23	0.06
		Ankle pump exercise	22	0.06
3	Drug related	Low molecular weight heparin	67	0.67
		Traditional Chinese Medicine	3	0.32
		Rivaroxaban	64	0.12
		Aspirin	11	0.12
4	Perioperative period	Perioperative period	5	0.12
5	Age	Old age	38	0.18

Fig.5 DVT prevention keyword cluster diagram

2.5 Keyword Burst Term

Figure 7 showed that the initial DVT prevention research mainly focused on the gynecology, lasting for 3 years. At the same time, the research expanded to areas such as orthopedic surgery, stroke, pharmacological prevention, and ankle pump exercises. Nursing interventions deepened, with new areas such as bundled care emerging. In recent years, the important role of pneumatic pumps in treatment has started to gain attention. Coagulation indicators have also been regarded as one of the key metrics for assessing DVT patients. In the past three years, " Blood flow velocity," "ankle pump exercises," and "nursing satisfaction " have garnered significant attention and become ongoing focal points for discussion.

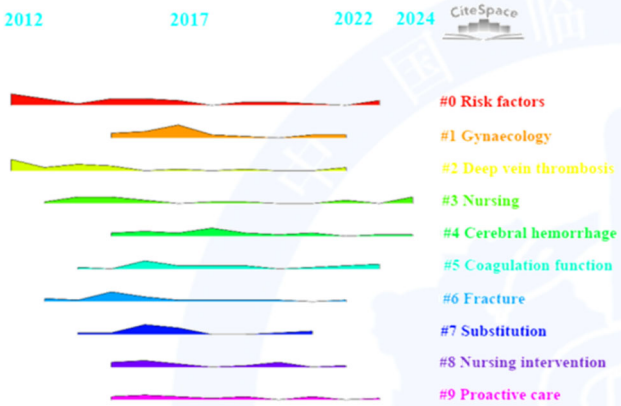

Fig.6 DVT prevention keyword landscape view

Keywords	Year	Strength	Begin	End	2012—2024
Gynecological surgery	2012	3.30	2012	2015	
Nursing	2015	5.28	2015	2017	
Orthopaedics	2015	2.72	2015	2017	
Orthopedic major surgery	2016	4.66	2016	2017	
Nursing intervention	2015	3.81	2016	2017	
High quality care	2016	3.98	2017	2019	
Pressure therapy device	2016	4.44	2020	2022	
Bundle expansion	2017	3.73	2020	2021	
Cerebral apoplexy	2016	3.47	2020	2022	
Coagulation function	2016	7.90	2021	2024	
Low molecular weight heparin	2012	6.03	2021	2024	
Quality of life	2021	5.99	2021	2024	
Ankle pump exercise	2016	4.93	2021	2024	
Nursing satisfaction	2018	3.23	2021	2024	
Blood flow velocity	2022	3.53	2022	2024	

Fig.6 Burst term of DVT prevention keyword

3 Discussion

3.1 Current Research Status

Analysis of annual publication volumes shows that the number of papers related to DVT prevention has experienced a rapid increase followed by a decline in recent years. The main content of these papers includes literature reviews and clinical research. The publication volume in 2022 and 2023 dropped to less than 100 papers, indicating that the progress in this field has slowed and stagnated, leaving significant room for exploration and development in the future. Through an analysis of the author and institution collaboration network, it is found that Fujian University of Traditional Chinese Medicine and Guangzhou University of Chinese Medicine are leading in terms of publication volume in the field of DVT prevention, each with more than 15 papers. Among the top five institutions, four are traditional Chinese medicine universities, suggesting that research on DVT prevention in the field of traditional Chinese medicine is active and may become a breakthrough in solving this problem in the future. However, cooperation between these traditional Chinese medicine universities is limited, and a unified research team has not yet been formed. The teams of SUO Na, ZHU Xiaoli, and JIAO Jiaxun are the most prolific in publications, with their main research focus being the use of bitter melon combined with heparin injections to prevent postoperative DVT in orthopedic surgery patients, making them the core research teams in China's DVT prevention field [5].

3.2 Research Hotspots

Through the analysis of high-frequency keywords, keyword clustering maps, and keyword burst term, the research focuses on DVT prevention over the past 20 years can be summarized as follows.

3.2.1 Research on Chinese Medicine in DVT Prevention

Although DVT is not explicitly mentioned in Chinese medicine theory, it falls under the categories of meridian obstruction, swelling, blood stasis, and poor blood circulation according to Chinese medicine principles [6]. Chinese medicine methods for DVT prevention mainly include single herbs, insect drugs, Chinese medicine formulas, topical herbal applications, and integrative Chinese medicine and Western medicine treatments. Among these, blood-activating and stasis-dispelling single herbs are the most widely used, and modern pharmacological studies have confirmed their effectiveness in preventing DVT. Formulas such as *Yiqi Huoxue* formula, as well as compounds like tetramethylpyrazine, curcumin, and achyranthes, help improve coagulation function and reduce the risk of DVT [7-8]. Insect drugs, an important component of traditional Chinese medicine, has blood-activating, meridian-unblocking, and dispersing properties, offering unique therapeutic effects for DVT treatment. Leeches, earthworms, ground beetles, and centipedes fall into this category [9]. Chinese medicine compound formulas are among the most widely used DVT prevention preparations. These include classic formulas such as Compound *Huoxue Ling*, *Quyu Xiaozhong* Decoction, and *Baihe* Formula, which have anti-inflammatory and antioxidant effects, improve hypercoagulability, and alleviate limb edema [10-12]. Furthermore, topical herbal applications and integrative Chinese medicine and Western medicine treatments can also achieve good preventive effects.

3.2.2 DVT Prevention in Lower Limb Fractures

Due to prolonged bed rest and trauma, patients with lower limb fractures are at an increased risk for DVT [13]. Preventive measures mainly include pharmacological prevention, physical prevention, and basic prevention

strategies. Pharmacological options include low-molecular-weight heparin (LMWH), rivaroxaban, unfractionated heparin, aspirin, and warfarin. Due to the various side effects of unfractionated heparin, LMWH and rivaroxaban have become the main drugs used in clinical practice. LMWH is a class of heparins with a lower molecular weight, prepared from the depolymerization of unfractionated heparin, and is a widely used anticoagulant. Rivaroxaban directly inhibits coagulation factor Xa with high selectivity and specificity, has a bioavailability of over 80%, and offers high safety, low side effects, ease of use, and does not increase the risk of bleeding [14-16]. Physical preventive measures include intermittent pneumatic compression devices, gradient compression stockings, and foot venous pumps. These preventive methods primarily work by enhancing the muscle pump action to accelerate blood return [17]. Basic preventive measures mainly include proper protection of the affected limb veins and early mobilization.

3.2.3 DVT Prevention in Pregnant and Postpartum Women

The risk of DVT during pregnancy is 10 times higher than that in non-pregnant women, and it increases to 20 times during the postpartum period. Additionally, the risk of DVT after cesarean section is 10 times higher than that after vaginal delivery [18]. The main preventive methods include mechanical prevention, health education, and pharmacological prevention. Mechanical prevention methods are similar to those used for lower limb fracture prevention and include intermittent pneumatic compression devices, gradient compression stockings, and foot venous pumps. According to the *Guidelines for the Prevention and Treatment of Thrombotic Diseases*, it is recommended that women who are not suitable for oral anticoagulant medications should wear elastic stockings before delivery [19].

Health education involves setting up DVT outpatient clinics for pregnant and postpartum women, distributing DVT prevention guidelines, and holding themed lectures on DVT prevention [20]. Given the special status of pregnant and postpartum women, pharmacological prevention of DVT has certain limitations. Heparin drugs do not cross the placenta and only enter breast milk in small amounts; with low bioavailability, their application in pregnant and postpartum women is relatively safe and reliable [21]. LMWH has higher bioavailability and fewer side effects compared to unfractionated heparin [22]. Warfarin is contraindicated during pregnancy because it can cross the placenta and cause fetal malformations [23]. However, the amount of warfarin in breast milk is low, making it safe for breastfeeding women to use warfarin [24]. In recent years, new oral anticoagulants such as rivaroxaban and edoxaban have been widely used, but the efficacy of these new oral anticoagulants is not yet fully established, and some studies have found that these drugs may cross the placenta; therefore, new oral anticoagulants are not recommended for DVT prevention in pregnant and postpartum women [25].

3.2.4 DVT Prevention in Malignant Tumors

DVT is one of the most common complications in cancer patients, with an incidence ranging from 4% to 20%. The highest incidence is observed in hematologic cancers, followed by lung and gastrointestinal cancers. In these patients, some coagulation factors, such as TNF, factor VIIa, factor XIIa, and thrombin-antithrombin III complex, are expressed at higher levels [26]. DVT prevention measures mainly include mechanical prevention, pharmacological prevention, combined prevention, and inferior vena cava filters. Mechanical prevention can be divided into active and passive prevention. Active prevention includes early postoperative mobilization and other measures taken by the patient to effectively avoid DVT, showing significant effects. Passive prevention refers to using tools such as intermittent pneumatic compression devices and gradient compression stockings to prevent DVT. In recent years, new DVT prevention drugs have been gradually applied. Compared to non-pharmacological interventions, some drugs may increase the risk of bleeding. Dual prevention, which combines mechanical and pharmacological interventions, shows positive significance when assessing high-risk cancer patients for decision-making. For patients who have already developed DVT or have contraindications to anticoagulants, the placement of an inferior vena cava filter may be considered, such as in cases of hemorrhagic stroke, recent or planned high-risk surgeries with persistent bleeding, and active bleeding.

3.3 Research Limitations

CiteSpace software enables large-scale literature visualization analysis, helping researchers quickly understand the current state and development trends of research, as well as predict future directions. However, this article also has some limitations: Firstly, this study only collected data from the CNKI Core Collection database, resulting in a relatively limited data source. Secondly, during the analysis, some recently published high-quality articles, which had low citation frequencies due to their short publication time, were overlooked, meaning that the analysis results may not completely reflect reality. Therefore, it is necessary to comprehensively analyze domestic and international research literature to improve the accuracy of the study's results.

In summary, over the past 20 years, research on DVT prevention has seen an initial increase in interest, followed by a slight decline. DVT prevention in areas such as traditional Chinese medicine, lower limb fractures, pregnancy and postpartum, and malignant tumors has been a focus of research in recent years. Traditional Chinese medicine shows great potential in preventing DVT and may become an important research direction in this field in the future.

Conflict of Interest None

References

[1] Zhou EH, Zhang LW, Li XL, et al. Endovascular interventional therapy for acute deep venous thrombosis of lower limbs[J]. J Med Theory Pract, 2024, 37(10): 1655-1657. **[In Chinese]**

[2] Broderick C, Watson L, Armon MP. Thrombolytic strategies versus

standard anticoagulation for acute deep vein thrombosis of the lower limb[J]. Cochrane Database Syst Rev, 2021, 1(1): CD002783.
[3] Kumar J, Sahito B, Katto MS, et al. The prevalence of deep Venous thrombosis of the lower extremity in hospitalised bedridden orthopaedic patients: a pilot study[J]. J Pak Med Assoc, 2023, 73(6): 1251-1254.
[4] Sun M, Zhang XY, Zhang JL. Clinical, imaging and risk stratification characteristics of patients with acute non-high-risk pulmonary embolism[J]. Chin J CT MRI, 2024, 22(3): 58-60, 67. **[In Chinese]**
[5] Jiao JX, Zhu XL, Suo N. Clinical observation of *Kudiezi* combined with low molecular weight heparin on preventing deep venous thrombosis of lower extremities after pelvic and acetabular fractures in elderly patients[J]. Chin J Surg Integr Tradit West Med, 2020, 26(5): 878-882. **[In Chinese]**
[6] Liu YD. The clinical research of traditional Chinese medicine combined low molecular heparin calcium in the prevention of lower extremity deep vein thrombosis after total hip arthroplasty[J]. Zhengzhou: Henan University of Chinese Medicine, 2016. **[In Chinese]**
[7] Wang CS, Zeng XF, Zhang H. Research progress on the combination of traditional Chinese and Western medicine in preventing postoperative venous thrombosis in orthopedics [J]. Chin J Clin, 2016, 44(11): 19-21. **[In Chinese]**
[8] Xu MH. Effect of traditional Chinese medicine *Yiqi Huoxue* formula on preventing deep vein thrombosis in lower limbs of ICU high-risk bleeding patients [J]. Chin J Clin Ration Drug Use, 2023, 16(35): 107-110. **[In Chinese]**
[9] Wang ST, Zhang Y, Zhang XS, et al. Research progress on the treatment of deep vein thrombosis with insect drugs [J]. Chin J Surg Integr Tradit West Med, 2023, 29(4): 564-567. **[In Chinese]**
[10] Xiao JY, Guo XJ, Luo M. Clinical study on the treatment of thrombotic external hemorrhoids with Yizi decoction combined with Simiao Yong'an decoction combined with traditional Chinese medicine sitz bath[J]. China Mod Dr, 2022, 60(28): 95-98. **[In Chinese]**
[11] Yu N, Chen J, Cao YM, et al. Study on mechanism of Baihe formula in treating superficial thrombophlebitis based on network pharmacology and molecular docking[J]. J Med Inf, 2022, 35(23): 11-17. **[In Chinese]**
[12] Fan YM, Guo JY, Li F, et al. Study on Compound Huoxueling for preventing deep venous thrombosis after fracture[J]. China J Tradit Chin Med Pharm, 2019, 34(12): 5889-5892. **[In Chinese]**
[13] Zhang L, Liu XB, Pang P, et al. Incidence and risk factors of admission deep vein thrombosis in patients with traumatic fracture: a multicenter retrospective study[J]. Clin Appl Thromb Hemost, 2023, 29: 107602962311671.
[14] Liu RD, Liu X, Zhao L, et al. Study of preoperative application of low molecular heparin calcium in the prevention of deep vein thrombosis in patients with hip fracture[J]. Heilongjiang Med J, 2023, 47(20): 2454-2456. **[In Chinese]**
[15] Li CH. The study of the bundles of care to the prevention of deep venous thrombosis in mid-elderly patients undergoing total joint replacement [J]. Suzhou: Soochow University, 2014. **[In Chinese]**
[16] Luo HT, Yu GZ, Wang H, et al. A meta-analysis of rivaroxaban effectiveness and safety for the prevention of thromboembolism after total hip or knee arthroplasty[J]. Chin J Bone Jt, 2020, 9(2): 135-144. **[In Chinese]**
[17] Gu SQ, Kong D, Li JH, et al. Research progress on the hemodynamic mechanism and application of ankle pump exercise in preventing deep vein thrombosis[J]. West China Med J, 2023, 38(7): 1096-1099. **[In Chinese]**
[18] Zheng YX, Li FL, Xiong T, et al. Bibliometric analysis of prevention and management of maternal venous thromboembolism in China[J]. Chin J Fam Plan, 2023, 31(1): 4-9. **[In Chinese]**
[19] Zhang Z, Liu XF, Gu XF, et al. Prevention and treatment of senile thrombotic diseases[J]. Chin J Clin Healthc, 2019, 22(3): 311-315. **[In Chinese]**
[20] Gris JC, Aoun J, Rzaguliyeva L, et al. Risk assessment and management of venous thromboembolism in women during pregnancy and puerperium (SAVE): an international, cross-sectional study[J]. TH Open, 2018, 2(2): e116-e130.
[21] Lim W. Using low molecular weight heparin in special patient populations[J]. J Thromb Thrombolysis, 2010, 29(2): 233-240.
[22] Yang HL. Effect analysis of glucose combined with low molecular weight heparin in oligohydramnios pregnant women[J]. J Mod Med Health, 2020, 36(18): 2967-2969. **[In Chinese]**

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·论　著·

基于 CiteSpace 的下肢深静脉血栓形成预防可视化分析

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摘要：目的　通过可视化分析，探讨国内关于下肢深静脉血栓形成（DVT）预防的研究重点。**方法**　检索中国知网（CNKI）2012 年至 2024 年发表的 DVT 预防相关的文献，并利用 CiteSpace 6.3.R3 软件对作者、研究机构和关键词等数据进行可视化分析。**结果**　共有 2 056 篇符合标准的文献被纳入研究，2014 年至 2018 年，发文量呈增长趋势，2019 年开始出现下降。通过可视化图谱显示，在该领域共有 260 位作者参与了研究，其中 4 位作者发表了至少 3 篇文章；代表性作者包括李娜、付亚辉、李娟和张延召。涉及机构有 189 个，34 个机构发表了 3 篇及以上文章，其中福建中医药大学和广州中医药大学的发文量超过 15 篇。共有 262 个关键词，69 个关键词频率达到或超过 10 次，包括“护理”、“护理干预”、“下肢骨折”以及“剖宫产”等。**结论**　近年来 DVT 预防研究热度呈现下降趋势，但仍备受关注；研究机构间合作有限；研究主要集中于临床方面，评价标准存在差异；基础研究仍存在一些不足；因此，在未来的研究中，需要进一步加强各机构之间的合作，统一评价标准，加强基础研究，为临床 DVT 预防提供更全面、有效的措施。

关键词： 下肢深静脉血栓；下肢骨折；剖宫产；中医药；预防；CiteSpace 软件
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Abstract: Objective　This study conducts a visual analysis to explore the research focus on deep vein thrombosis (DVT) prevention in China. **Methods**　Literature related to DVT prevention published on China National Knowledge Infrastructure (CNKI) from 2012 to 2024 were searched. The data of authors, research institutions, and keywords were visual analysed using CiteSpace 6.3.R3 software. **Results**　A total of 2 056 eligible studies were included in the analysis. The publication volume showed an increasing trend from 2014 to 2018 but started declining from 2019. Visual maps revealed 260 contributing authors, with 4 authors publishing at least 3 articles. Notable authors included LI Na, FU Yahui, LI Juan and ZHANG Yanzhao. The research involved 189 institutions, with 34 institutions publishing three or more articles. Fujian University of Traditional Chinese Medicine and Guangzhou University of Traditional Chinese Medicine each contributed over 15 articles. A total of 262 keywords were identified, with 69 keywords appearing ten or more times, including “nursing”, “nursing interventions”, “lower limb fractures”, and “cesarean section”. **Conclusion**　Research interest in DVT prevention has shown a declining trend in recent years but remains significant. Collaboration between research institutions is limited, and studies primarily focus on clinical aspects with varying evaluation standards. Basic research is still insufficient. Enhancing collaboration, standardizing evaluation criteria, and strengthening foundational research can provide comprehensive and effective measures for clinical DVT prevention in future studies.

Keywords: Deep vein thrombosis; Lower limb fractures; Cesarean section; Traditional Chinese medicine; Prevention; CiteSpace software

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下肢深静脉血栓(deep vein thrombosis, DVT)是一种严重的阻塞性疾病,由于深静脉系统中血液凝结导致血栓形成,引起肢体肿胀、局部疼痛和行走障碍等症状[1]。当通过静脉的血栓停留在肺动脉中时,可能导致肺栓塞,甚至危及生命[2]。据 Kumar 等[3]的调查数据显示,DVT 在骨科患者中的发病率约为 15.3%,而在我国,随着生活环境和条件变迁以及医学技术不断进步,DVT 的年发病率也逐年上升[4-5]。因此预防 DVT 至关重要,当前 DVT 预防研究蓬勃发展,相关文献报道众多且复杂,对该领域的文献可视化分析尚未充分展开。因此,本文采用 CiteSpace 6.3.R3 软件对中国知网(CNKI)数据库中该领域研究现状进行文献计量学分析,通过绘制可视化图谱来直观地了解该领域的发展趋势、研究团队、机构以及相关研究领域等信息。为了进一步促进该领域的发展,提供一些参考和建议。

1　资料与方法

1.1　文献来源　所有文献均来源于 CNKI 数据库核心合集,检索策略为 TS=(下肢深静脉血栓形成) AND TS=(预防),检索时间为从建库时起至 2024 年 1 月。结果共获得 5 369 条记录。

1.2　文献筛选标准　纳入准则:涉及 DVT 预防的相关文献。排除准则:剔除研究主题不符、已发表或已检出的重复文章;书信、撤销、校正、会议纪要以及文献摘要。

1.3　数据采集　采集 CNKI 核心数据库的核心合集文献,利用 Refworks 格式导出检索到的文献,并将其重新命名为 download_(xx).txt 格式。导出的文献选择导出方式为完整记录。利用 CiteSpace 6.3.R3进行数据转化,选择去除重复项并保存去重后记录,筛选后最终纳入 2 056 篇文献。

1.4　参数设置　CiteSpace 参数设定的时间范围为 2012 年 1 月至 2024 年 1 月,选择以 1 年作为一个时间段进行切割。选取作者、机构、关键词作为节点。节点筛选方式使用 g-index,其他参数设置为默认设置,使用软件绘制可视化图谱。

2　结　果

2.1　发文量趋势　经过筛选,共计 2 056 份文献被纳入研究。其中包括 2 004 篇研究论文和 52 篇综述。去重后的结果如图 1 所示,自 2014 年起,DVT 预防研究发文量呈逐年上升趋势。该领域在 2014—2015 年间出现爆发式增长,2018 年发文数量达到顶峰,并且研究内容开始多样化。从 2017 年至 2019 年,每年的发文数量相对稳定,在此期间分别为 290 篇、309 篇和 307 篇;自 2019 年以来,DVT 预防研究发文量出现了显著回落。

2.2　作者合作分析　图 2 展示了 260 位作者合作网络图谱,人名之间的连线反映作者之间的合作关系。在这个网络中,有 4 位作者发表了至少 3 篇文章,分别是李娜(6 篇)、付亚辉(3 篇)、李娟(3 篇)、张延召(3 篇)。研究主要由独立的研究者构建,少数人采用团队形式,并且联系较为稀少。此外,合作规模多由 2~3 名成员组成,文章发布量偏低,并未产生较大影响。李娜领导的团队主要关注护理干预在预防和治疗 DVT 患者中的作用;而付亚辉团队专注于对骨科手术后 DVT 患者进行风险评估和临床评价;李娟团队主要研究不同护理干预模型对 DVT 的预防效果;张延召团队则研究各种中药如活血灵方、身痛逐瘀汤等对 DVT 的预防效果。

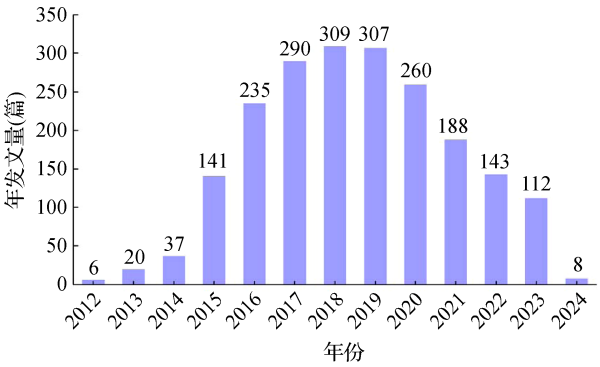

图 1　DVT 预防发文量趋势图

Fig. 1　Trend chart of DVT prevention publication volume

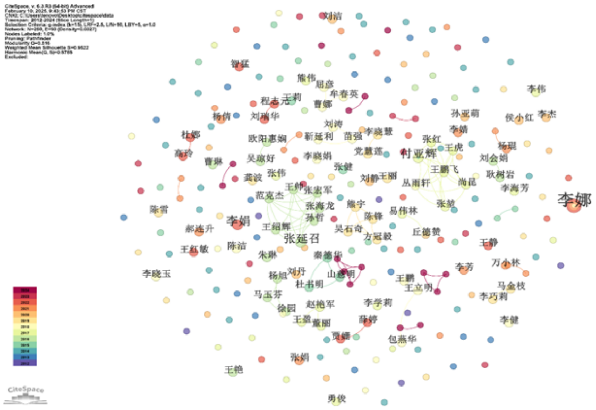

图 2　DVT 预防作者合作图

Fig. 2　Author cooperation diagram of DVT prevention

2.3　研究机构分析　图 3 展示了机构合作图谱，共包含 189 个机构。其中，有 34 个机构发表文章数量达到或超过 3 篇，其中福建中医药大学和广州中医药大学的发文数量超过 15 篇。主要研究机构包括福建中医药大学（22 篇）、广州中医药大学（17 篇）、河北医科大学（11 篇）、山东中医药大学（11 篇）、青岛大学（10 篇）、成都中医药大学（9 篇）以及山西医科大学（8 篇）。福建中医药大学的中介中心值为 0.06，略高于山东和广州两所高校的 0.02；而其他所有机构的中介中心值均为 0。

2.4　关键词分析　图 4 为关键词共现图，其中包含了 262 个关键词。由图可见，在发表文章数量达到 10 篇以上的情况下，有 69 个关键词被列为重要之选。排名前十位（括号内为频次）分别是深静脉血栓（309）、预防（255）、护理（180）、护理干预（127）、下肢骨折（95）、危险因素（91）、剖宫产（88）、低分子肝素（67）、利伐沙班（64）、髋关节置换术（59）。总结这些关键词，可将其分为疾病分类、护理干预措施、药物相关信息、围手术期管理以及年龄因素五个主要类别（表 1）。DVT 在妇科和髋部骨折患者中最为普遍，中介中心值分别为 0.46 和 0.36。因此可以推断，目前妇科领域和髋部骨折 DVT 预防的研究较为火热；其次是脑出血，其中介中心值为 0.22；接着是肺癌与脊柱骨折，其中介中心值均为 0.10。近些年来，预防性护理在 DVT 预防方面的重要性日益凸显，其中介中心值为 0.23。此外循证护理、优质护理等也具有较高的中介中心值，分别为 0.22 和 0.13。药物方面，在纳入关键词范围内，中医药以 0.32 的中介中心值在所有关键词中排名第二。围手术期处理措施对于 DVT 预防同样非常重要，在表 1 可见虽然出现频次仅有 5 次，然而其中介中心值高达 0.12，这对于外科医生对于 DVT 预防至关重要。最后年龄因素在 DVT 预防也发挥了一定作用，其中介中心值为 0.18。

图 5 和图 6 展示了 DVT 预防领域的关键词聚类分析结果。通过使用 CiteSpace 中的 LLR 方法，得出了连续的 10 个关键词聚类。每个聚类代表着该领域内一个研究热点和发展方向：#3、8、9 强调护理干预措施，#6、7 侧重于骨折手术及关节置换中 DVT 的研究；#0 涉及与 DVT 危险因素相关的研究；#4 是有关脑出血在 DVT 预防方面的研究；而#1 则探讨妇科领域对 DVT 预防的研究。

2.5　关键词突现　图 7 表明，最初的 DVT 预防研究主要集中在妇科领域，并持续了 3 年；同时，该研究也扩展到骨科手术、脑卒中、药物预防以及踝泵运动等方面。护理干预方式不断深化，出现了集束化护理等新领域，并且近年开始重视气压泵在治疗中的重要作用。凝血指标也被视为评估 DVT 患者的重要指标之一。近 3 年来，“血流速度”、“踝泵运动”和“护理满意度”备受关注，成为持续讨论的焦点话题。

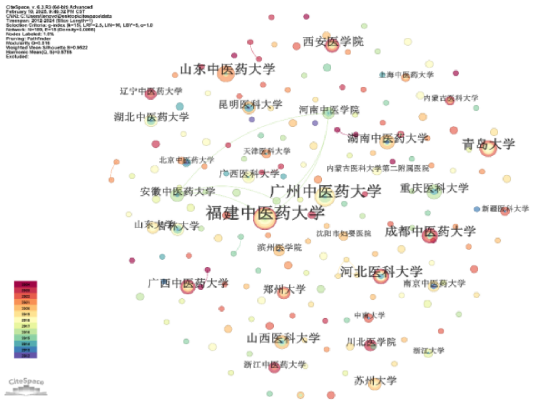

图 3　DVT 预防机构合作图

Fig. 3　Cooperation diagram of DVT prevention agencies

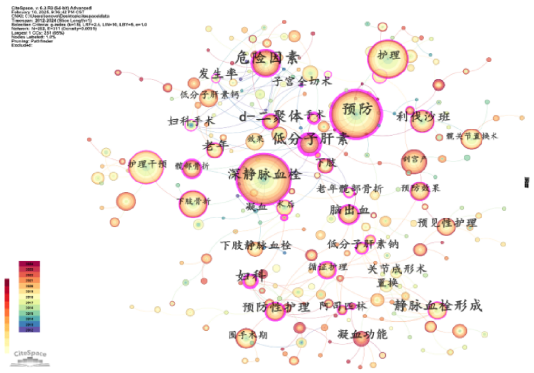

图 4　DVT 预防关键词共现图

Fig. 4　DVT prevention keyword co-occurrence chart

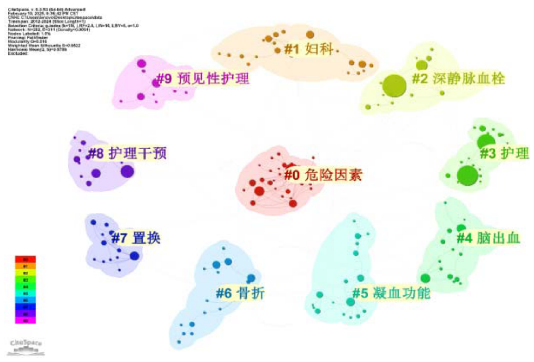

图 5　DVT 预防关键词聚类图

Fig. 5　DVT prevention keyword landscape view

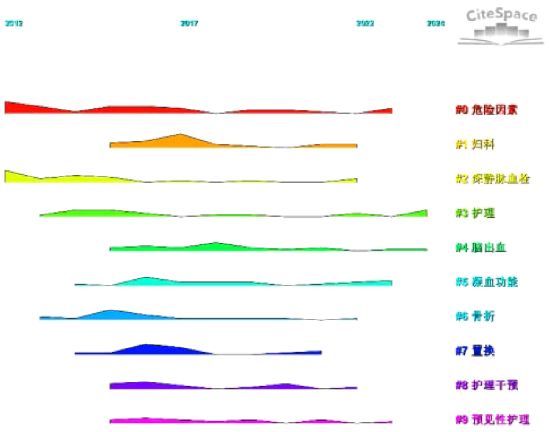

图 6　DVT 预防关键词聚类峰峦图

Fig. 6　DVT prevention keyword landscape view

表 1　高频关键词分类汇总表

Tab. 1　Summary of high-frequency keywords

序号	分类	关键词	频次	中介中心值
1	疾病类型	妇科	21	0.46
		髋部骨折	46	0.36
		脑出血	44	0.22
		下肢骨折	95	0.18
		妇科手术	14	0.13
		粗隆间骨折	1	0.10
		肺癌	1	0.10
		剖宫产	88	0.10
		脊柱骨折	12	0.10
		恶性肿瘤	4	0.01
		卵巢囊肿	4	0.01
2	护理干预方法	预防性护理	44	0.23
		循证护理	34	0.22
		优质护理	22	0.13
		预见性护理	48	0.10
		综合护理	23	0.06
		踝泵运动	22	0.06
3	药物相关	低分子肝素	67	0.67
		中医药	3	0.32
		利伐沙班	64	0.12
		阿司匹林	11	0.12
4	围手术期	围手术期	5	0.12
5	年龄	老年	38	0.18

图 7　DVT 预防关键词突现图

Fig. 7　DVT prevention keyword outburst chart

3　讨　论

3.1　*研究现状*　根据年发文量分析显示，近年来 DVT 预防相关论文数量呈现迅速增长后回落趋势，主要内容为文献整理和临床研究等。2022 年和 2023 年的发文量更是下降至不到 100 篇，表明目前该领域的研究进展缓慢停滞，在未来有较大的探索和发展空间。通过作者和机构合作网络图谱分析得知，福建和广州两所中医药大学在 DVT 预防领域的发文量处于领先地位，均超过 15 篇；其中前五名中有 4 个是中医药大学，这表明当前 DVT 预防在中医药领域的研究活跃，并有望成为未来解决这一难题的突破口。然而各中医药大学之间合作较少，尚未形成统一的研究团队。李娜团队是发文量最多的团队。

3.2　研究热点　透过高频关键词、关键词集群图谱以及突现分析，可以总结过去 20 年来对 DVT 预防的研究重点如下。

3.2.1　中医药在 DVT 预防方面的研究　在中医理论中虽未明确提及 DVT 这一病名，但根据其理论，DVT 属于脉络阻塞、肿胀、瘀滞和血液循环不畅的范畴[6]。预防 DVT 的中医药方法主要包括单味中药、虫类药、中药复方、中药外敷以及中西医结合等。在现代药理学研究已证实对预防 DVT 具有确切疗效；益气活血方、灯盏花素、姜黄素、牛膝等均有助于改善患者凝血功能，降低发生 DVT 的风险[7-8]。作为传统中医药重要组成部分的虫类中药具有活血通络和疏散攻逐特性，在 DVT 治疗上具备独特的疗效；水蛭、地龙、土鳖虫和蜈蚣等均属于此类[9]。复方是应用最广泛的预防 DVT 制剂之一，包括复方活血灵、祛瘀消肿汤和白鹤方等经典配方，具有抗炎和抗氧化作用，并能改善患者高凝状态并缓解肢体水肿[10-12]。此外，中药外敷和中西医结合治疗也可取得良好的预防效果。

3.2.2　下肢骨折 DVT 预防　由于长期卧床和创伤等原因，下肢骨折患者 DVT 易感性增加[13]。预防措施主要有药物预防、物理预防和基础预防等。药物有低分子量肝素、利伐沙班、普通肝素、阿司匹林和华法林等。由于普通肝素的多种副作用，低分子肝素及利伐沙班已成为临床主要用药。低分子肝素是由普通肝素解聚制备而成的一类分子量较低的肝素的总称，是一种广泛应用的抗凝剂；利伐沙班通过高度选择性和特异性直接抑制凝血因子 Xa，生物利用率达 80%以上，并且安全性高、副作用低、使用方便，并且不增加出血风险[14-16]。物理预防有间歇气压装置、梯度压力袜和足底静脉泵等，这些预防措施主要是通过促进肌肉泵的推送作用来加速血液回流[17]。基础预防措施主要包括正确的体位、保护患肢静脉、早期活动等方式。

3.2.3　孕产妇 DVT 预防　孕妇 DVT 的发生风险是非孕期的 10 倍，产褥期更增至 20 倍；此外，剖宫产 DVT 的风险为阴道分娩的 10 倍[18]。预防主要方法包括机械性预防、健康教育和药物预防等。机械预防方式同上述下肢骨折预防方式基本相同，包括间歇气压装置、梯度压力袜和足底静脉泵等。根据《血栓性疾病防治指南》，建议不适合口服抗凝药物的女性，分娩前均应穿戴弹力袜[19]。

健康教育包括设立孕产妇 DVT 门诊、分发 DVT 预防指南、举办关于 DVT 预防的主题讲座等[20]。鉴于孕产妇的特殊身份，药物预防 DVT 有一定的局限性，肝素类药物不能穿过胎盘，只能少量排入母乳中；且生物利用度较低，其在孕妇和产妇中的应用较为安全可靠[21]。低分子肝素相对于普通肝素而言，其生物利用度更高，药物不良反应更少[22]。华法林禁用于孕妇，因为其可通过胎盘传递并导致胎儿发生畸形[23]。然而，在母乳中华法林的含量较低，所以哺乳期妇女使用华法林是安全的[24]。近年来，一些新型口服抗凝药如利伐沙班和依度沙班已广泛应用。然而，关于这些新型口服抗凝药的疗效还不确切，并且部分研究发现这些药物可能会通过胎盘；因此，孕产妇不建议采用新型口服抗凝药预防 DVT[25]。

3.2.4　恶性肿瘤 DVT 预防　DVT 是恶性肿瘤患者常见的并发症之一，其发生率介于 4%～20%。其中，血液肿瘤的发生率最高，其次是肺部和胃肠道肿瘤。在患者体内，一些凝血因子如 TNF、Ⅶa、Ⅻa 凝血酶-抗凝酶Ⅲ复合物表达水平较高[26]。DVT 预防措施主要包括机械预防、药物预防、联合预防以及下腔静脉滤器。机械预防分为主动预防和被动预防两种形式。主动预防包括术后早期活动等一系列由患者自身采取的措施来有效避免 DVT，并且效果显著。被动预防则指使用间歇性气压装置、梯度压力袜等工具来进行 DVT 预防。近年来，新型的 DVT 预防药物逐渐得到应用。与非药物干预相比，部分药物可能会增加出血风险。双重预防即同时结合机械和药物干预措施，在对高危恶性肿瘤患者进行决策评估时显示出积极意义。对已经发生 DVT 或存在抗凝禁忌证的患者可考虑实施下腔静脉滤器置入，如出血性中风、近期或计划中的高风险持续出血手术及活动性出血情况下。

3.3　研究局限性　CiteSpace 软件能够进行大规模文献可视化分析，帮助研究人员快速了解研究现状和发展趋势，并对未来的发展方向做出预测，但本文也存在一些局限性：首先，本文仅收集了 CNKI 核心合集数据库的数据，数据来源较单一；其次，在分析时，一些近期发布的高质量文章因发布时间较短，被引频次较低而被忽视，分析结果可能并不完全与实际相符。因此，需要综合国内外的研究文献，分析所得到的结果，以求研究的准确性能够得到进一步提高。

综上所述，近 20 余年来 DVT 预防有关领域研究热度先持续增高又出现小幅度下降，中医药、下肢骨折、孕产妇、恶性肿瘤等的 DVT 预防为该领域近年来的研究热点。中医药在预防 DVT 方面具有很大的潜力，未来可能成为该领域的重要研究方向。

利益冲突　无

参考文献

[1] 周尔豪,张立伟,黎小龙,等.急性下肢深静脉血栓形成的腔内介入治疗[J].医学理论与实践,2024,37(10):1655-1657.

[2] Broderick C, Watson L, Armon MP. Thrombolytic strategies versus standard anticoagulation for acute deep vein thrombosis of the lower limb[J]. Cochrane Database Syst Rev, 2021, 1(1): CD002783.

[3] Kumar J, Sahito B, Katto MS, et al. The prevalence of deep Venous thrombosis of the lower extremity in hospitalised bedridden orthopaedic patients: a pilot study[J]. J Pak Med Assoc, 2023, 73(6): 1251-1254.

[4] 孙淼,张昕旸,张金玲.急性非高危肺栓塞患者的临床、影像及风险分层特征分析[J].中国 CT 和 MRI 杂志,2024,22(3):58-60,67.

[5] 焦甲勋,朱小丽,索娜.苦碟子预防老年骨盆髋臼骨折术后下肢深静脉血栓形成的临床研究[J].中国中西医结合外科杂志,2020,26(5):878-882.

[6] 刘亚东.中药联合低分子肝素钙预防髋关节置换术后下肢深静脉血栓的临床研究[D].郑州:河南中医药大学,2016.

[7] 王长松,曾宪发,张辉.中西医结合对预防骨科术后静脉血栓形成的研究进展[J].中国临床医生杂志,2016,44(11):19-21.

[8] 徐蒙辉.中药益气活血方用于预防 ICU 高出血风险患者下肢深静脉血栓形成的效果[J].临床合理用药,2023,16(35):107-110.

[9] 王思婷,张玥,张筱杉,等.虫类中药治疗深静脉血栓形成的研究进展[J].中国中西医结合外科杂志,2023,29(4):564-567.

[10] 肖金银,郭夏君,罗敏.乙字汤合四妙勇安汤加减联合中药坐浴治疗血栓性外痔的临床研究[J].中国现代医生,2022,60(28):95-98.

[11] 俞宁,陈健,曹烨民,等.基于网络药理学和分子对接探讨白鹤方治疗血栓性浅静脉炎的作用机制[J].医学信息,2022,35(23):11-17.

[12] 范仪铭,郭珈宜,李峰,等.复方活血灵预防骨折后深静脉血栓的研究[J].中华中医药杂志,2019,34(12):5889-5892.

[13] Zhang L, Liu XB, Pang P, et al. Incidence and risk factors of admission deep vein thrombosis in patients with traumatic fracture: a multicenter retrospective study[J]. Clin Appl Thromb Hemost, 2023, 29: 107602962311671.

[14] 刘仁德,刘选,赵亮,等.术前应用低分子肝素钙在髋部骨折患者深静脉血栓预防中的应用研究[J].黑龙江医学,2023,47(20):2454-2456.

[15] 李春会.中老年髋、膝关节置换术后下肢深静脉血栓的集束化干预策略研究[D].苏州:苏州大学,2014.

[16] 骆洪涛,于国政,王瀚,等.利伐沙班预防关节置换术后静脉血栓形成有效性与安全性的 Meta 分析[J].中国骨与关节杂志,2020,9(2):135-144.

[17] 谷思琪,孔丹,李佳惠,等.踝泵运动预防深静脉血栓形成的血流动力学机制及应用研究进展[J].华西医学,2023,38(7):1096-1099.

[18] 郑予希,李奉玲,熊桃,等.我国孕产妇静脉血栓栓塞症预防与管理的文献分析[J].中国计划生育学杂志,2023,31(1):4-9.

[19] 张至,刘旭峰,谷雪芳,等.老年人血栓性疾病的防治——依据《中国血栓性疾病防治指南(2018 年)》的临床指导[J].中国临床保健杂志,2019,22(3):311-315.

[20] Gris JC, Aoun J, Rzaguliyeva L, et al. Risk assessment and management of venous thromboembolism in women during pregnancy and puerperium (SAVE): an international, cross-sectional study[J]. TH Open, 2018, 2(2): e116-e130.

[21] Lim W. Using low molecular weight heparin in special patient populations[J]. J Thromb Thrombolysis, 2010, 29(2): 233-240.

[22] 杨慧丽.葡萄糖联合低分子肝素在羊水过少孕产妇中应用效果分析[J].现代医药卫生,2020,36(18):2967-2969.

[23] 陈少敏,冯新恒.妊娠与心脏瓣膜病[J].临床内科杂志,2021,38(1):19-22.

[24] 刘映玲,黄郁馨,赵胡英,等.产后肺栓塞一例[J].中华产科急救电子杂志,2020,9(2):118-120.

[25] 王燕,徐红兵.孕产妇静脉血栓栓塞症的诊治[J].现代医药卫生,2016,32(9):1352-1355.

[26] Senescent cancer cells are vulnerable to extrinsic apoptosis pathway activation[J]. Cancer Discov, 2023, 13(2): 256.

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