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EDITORIAL

Should surgical inpatients still wear compression stockings?

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Abstract

Surgical inpatients are at increased risk of venous thromboembolism (VTE). Current national guidelines recommend a combination of pharmacological (chemoprophylaxis) and mechanical thromboprophylaxis to reduce VTE risk. For most patients, mechanical thromboprophylaxis is provided via application of graduated compression stockings (GCS). This editorial reviews the evidence surrounding the efficacy and safety of GCS in VTE prevention, and makes a recommendation regarding their continued use in surgical inpatients.

Key words: Health care; Medical conditions; Circulatory conditions; Medical procedures; Surgery

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Main text

Surgical intervention and venous thromboembolism (VTE) are intrinsically interlinked, with a reported 64.4% of surgical inpatients judged to be at risk of VTE development according to the American College of Chest Physicians (ACCP) criteria (Cohen et al, 2008). This carries serious health implications, where mortality from VTE is estimated at 10–30% within 30 days of event incidence (Beckman et al, 2010). Long-term morbidity in the form of VTE recurrence, post-thrombotic syndrome and pulmonary hypertension are also common. This has a significant negative impact on patients' quality of life, with changes comparable to those seen in chronic heart and lung disease (Cohen et al, 2007). To reduce the risk of VTE, the National Institute for Health and Care Excellence (2018) recommends a combination of mechanical and pharmacological thromboprophylaxis (chemoprophylaxis) for most surgical inpatient groups whose VTE risk outweighs their bleeding risk. For mechanical compression, the application of graduated compression stockings (GCS) vs intermittent pneumatic compression (IPC) is left to clinician discretion in orthopaedic, major abdominal, vascular and thoracic operations. GCS are thought to reduce the diameter of major veins in the lower limbs, increasing volume and velocity of blood to improve venous stasis (Lim and Davies, 2014). However, over the last decade, a growing body of evidence has suggested that mechanical prophylaxis with GCS is not supported by clinical trials. This editorial aims to review the evidence surrounding GCS (summarised in Table 1, Dennis et al, 2009; Mandavia et al, 2015; Shalhoub et al, 2020; Turner et al, 2024) and discuss the implications for patients and the health service for surgical inpatient VTE prevention.

The efficacy of GCS was initially called into question in mainstream scientific literature by the Clots in Legs Or sTockings after Stroke (CLOTS) 1 randomised controlled trial (RCT), which demonstrated that GCS had no additional benefit for VTE prevention in acute stroke patients (Dennis et al, 2009). Following this, a systematic review (SR) of RCTs undertaken in 2015 by Mandavia et al (2015) looked at the additional benefit of GCS to chemoprophylaxis in preventing VTE in surgical inpatients. It found no clear benefit of GCS and chemoprophylaxis vs chemoprophylaxis alone across 28 trial arms (Mandavia et al, 2015). It also identified a paucity of direct comparisons in head-to-head trials, with just one included study meeting this criterion. To further investigate this, the 2020 Graduated compression as an Adjunct to Pharmaco-thromboprophylaxis in Surgery (GAPS) RCT by Shalhoub et al (2020) assessed GCS as an adjuvant to chemoprophylaxis in elective surgical patients. Here, they demonstrated the non-inferiority of low molecular weight

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heparin (LMWH) alone vs GCS and LMWH in preventing VTE, with the authors proposing a need for an update to clinical guidelines to reflect this finding. This is compounded by new level 1A evidence from our recent meta-analysis (MA) revealing that GCS use confers no additional benefit in preventing VTE and VTE-related mortality (Turner et al, 2024).

In MA of head-to-head trials, it was shown that there was no significant difference in the risk of deep venous thrombosis (DVT) with GCS and chemoprophylaxis vs chemoprophylaxis alone (risk ratio (RR) 0.85; 95% confidence interval (CI) 0.54–1.36; 2 studies, 70 events, 2653 participants) (Turner et al, 2024). The Grading of Recommendations, Assessment, Development and Evaluations (GRADE) framework found the two trials to be well designed with good consistency, directness and precision, and a low risk of bias. This high-quality evidence for the lack of impact GCS have on VTE risk was replicated during analysis of both DVT and pulmonary embolism (PE) risk in pooled trial arms. Here, when comparing GCS and chemoprophylaxis vs chemoprophylaxis alone there was no significant difference identified in risk for DVT (RR 0.54; 95% CI 0.23–1.25; 33 trial arms, 1228 events, 14,108

Table 1. Summary data of the key papers assessing graduated compression stocking efficacy in venous thromboembolism prevention

Author	Study design	Study size	Study population	Study intervention	Study control	Key outcomes
(Dennis et al, 2009)	RCT	2518 patients from 64 centres across the UK, Italy and Australia	Patients admitted to hospital within 1 week of an acute stroke and who were immobile	Routine care and high-length GCS	Routine care with no GCS	GCS use resulted in a non-significant absolute reduction in VTE risk of 0.5% (95% CI1.9–2.9) Skin breaks, ulcers, blisters, and skin necrosis were significantly more common with GCS use (5% vs 1%; OR 4.18, 95% CI 2.40–7.27)
(Mandavia et al, 2015)	SR and MA	13,764 patients from 27 RCTs	Surgical inpatients	Prophylactic-dose pharmacologic thromboprophylaxis in conjunction with GCS	Prophylactic-dose pharmacologic thromboprophylaxis alone	10.4% of patients receiving pharmacologic thromboprophylaxis alone suffered VTE, vs 5.8% of patients receiving GCS in conjunction with pharmacologic thromboprophylaxis Heterogeneity analysis demonstrated that the results of included study arms were significantly heterogeneous, precluding a valid summation analysis
(Shalhoub et al, 2020)	RCT	1905 patients from 7 centres across the UK	Elective surgical inpatients	LMWH pharmaco-thromboprophylaxis and GCS	LMWH pharmaco-thromboprophylaxis alone	GCS use resulted in a non-significant absolute reduction in VTE risk of 0.30% (95% CI 0.65–1.26). 5.8% of patients experienced GCS-related complications

Table 1. Continued						
(Turner et al, 2024)	SR and MA	14,108 patients from 31 RCTs	Surgical inpatients	Pharmacological thromboprophylaxis and GCS	Pharmacological thromboprophylaxis alone	In head-to-head MA, GCS use did not reduce the risk of DVT (RR 0.85; 95% CI 0.54–1.36) During analysis of pooled trial arms, GCS use resulted in no significant difference in risk for DVT (RR 0.54; 95% CI 0.23–1.25) or PE development (RR 0.71; 95% CI 0.0–30.0) There were no between-group differences in VTE-related mortality

Abbreviations: CI, confidence interval; DVT, deep venous thrombosis; GCS, graduated compression stockings; LMWH, low molecular weight heparin; MA, meta-analysis; OR, odds ratio; PE, pulmonary embolism; RR, risk ratio; RCT, randomised controlled trial; SR, systematic review; UK, United Kingdom; VTE, venous thromboembolism.

participants) or PE development (RR 0.71; 95% CI 0.0–30.0; 27 trial arms, 32 events, 11,472 participants) (Turner et al, 2024). Additionally, combining GCS with chemoprophylaxis had no impact on VTE-related mortality from pooled RCT arms (27 trial arms, 3 events, 12,982 participants) (Turner et al, 2024).

Furthermore, GCS are not without complications. The CLOTS 1 trial also highlighted that GCS were associated with significantly increased rates of skin breaks, ulcers, blisters, and skin necrosis (Odds ratio (OR) 4.18, 95% CI 2.40–7.27) (Dennis et al, 2009). This was further supported by data from the GAPs trial, where 5.8% of included patients reported experiencing GCS-related complications (Shalhoub et al, 2020). As a result, patient compliance is often poor, with users reporting sweating, itching, and high costs as further reasons for therapy discontinuation (Ziaja et al, 2011). This is important, as poor compliance is likely to further reduce observed efficacy outside of a controlled trial environment, making the real terms impact of GCS on VTE incidence even smaller. Moreover, GCS use is also relevant from a health economic perspective, with a recent estimate of the annual costs of purchasing and applying GCS at £63.1 million for surgical patients in England alone (Shalhoub et al, 2017). In a climate of rising healthcare expenditure and reduced governmental investment, it is increasingly important that hospital budgets are used in the most cost-effective manner possible. The high complication rates, low compliance and lack of impact on VTE incidence make GCS a poor choice of investment in the care of most hospitalised surgical patients.

There is strong evidence to suggest that the addition of GCS to chemoprophylaxis confers no additional benefit to VTE prevention for the average surgical inpatient. However, there are still areas of uncertainty in particular patient subgroups. A recently updated Cochrane review demonstrated that combined therapy with IPC and chemoprophylaxis consistently leads to reduced rates of DVT and PE in high-risk (orthopaedic) surgical inpatient groups, compared to chemoprophylaxis alone (Kakkos et al, 2022). Conversely, limited research focuses on the effects of adding GCS to chemoprophylaxis in high-risk patient cohorts. VTE risk is heterogeneous, with VTE rates reported as high as 11.5% in the highest-risk surgical patients (Caprini VTE Risk Assessment Tool Score >8) (Obi et al, 2015). The majority of VTE studies to date fail to use validated VTE risk stratification tools to conduct their analysis, a methodological flaw which has been consistently noted in systematic appraisals of VTE literature by our research group (Turner et al, 2023; 2024). Within the scope of this MA, a subset of high-risk VTE patients in our included cohort may have experienced some benefit from the addition of GCS to chemoprophylaxis. However, this potential benefit was obscured due to the inclusion of patient groups with a lower risk of

VTE. This is being formally assessed in an ongoing National Institute for Health and Care Research (NIHR) funded trial: inpatient Graduated compression stocking use as an adjunct to Extended duration pharmacoprophylaxis for VTE prevention (GRACE multi-centre RCT) commenced in April, 2024 (Imperial College London, 2023).

Consistent, high-quality evidence has shown that GCS are expensive, poorly tolerated, and can lead to skin injury. Additionally, when used in combination with chemoprophylaxis, GCS are of no additional benefit to heparin in reducing VTE incidence or mortality in elective surgical inpatients, who have some of the highest inpatient risk of VTE. In conclusion, GCS are not clinically indicated for most surgical inpatients. Instead, elective surgical VTE prevention should consist of chemoprophylaxis alone. The authors advocate for a call-to-action change in national guidelines to reflect the most current findings from evidence appraisal.

Key points

- Surgical inpatients are at increased risk of VTE, with current guidelines recommending a combination of mechanical and pharmacological thromboprophylaxis (chemoprophylaxis) to prevent VTE occurrence.
- Most often, the mechanical prophylaxis of choice is GCS.
- A recent SR and MA has shown that GCS in combination with chemoprophylaxis confer no additional reduction in VTE development or VTE mortality when compared to chemoprophylaxis alone in surgical inpatients.
- Additionally, GCS is associated with high financial costs, discomfort and poor patient compliance.
- As a result, the authors would advocate for a change in clinical guidelines to remove the recommendation for GCS application for the average surgical inpatient.

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Availability of data and materials

All data included in this study are available upon request by contact with the corresponding author.

Author contributions

JS, BRHT, AMG and AHD all made substantial contributions to the conception and scope of the editorial, along with the acquisition and analysis of data. All authors were involved in drafting and critically revising the manuscript, before giving final approval for publication. JS, BRHT, AMG and AHD each agree that every individual is accountable for all aspects of the work, including ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval and consent to participate

Not applicable.

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Conflicts of interest

The authors declare no conflict of interest.

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