CLINICAL STUDIES SUMMARY

TOPIC:  Graduated Compression Efficacy
Reviewed: July 2009

Title:  Graduated compression stockings in the prevention of venous thromboembolism
Author:  Agu O, Hamilton G, Baker D.
Source:  British Journal of Surgery Volume 86, August 1999

Background:  Surveys still show a wide variation in routine use of deep vein thrombosis (DVT) prophylaxis despite its established place in current patient management. This article reviews the mechanism of action, efficacy and complications of stockings in preventing DVT.

Methods:  Relevant publications indexed in Medline (1966-1998) and the Cochrane database was identified. Appropriate articles identified from the reference lists of the above searches were also selected and reviewed.

Results and conclusion:  Graduated compression stockings reduce the overall cross-sectional area of the limb, increase the linear velocity of venous flow, reduce venous wall distension and improve valve function. Fifteen randomized controlled trials of graduated compression stockings alone were reviewed. Stockings reduced the relative risk of DVT by 64 percent in general surgical patients and 57 per cent following total hip replacement. The effect of stockings was enhanced by combination with pharmacological agents such as heparin; the combination is recommended in patients at moderate or high risk of DVT. Knee-length stockings are as effective and should replace above-knee stockings. Complications are rare and avoidable.

Title:  Elastic compression stockings for prevention of deep vein thrombosis
Author:  Amaragiri SV, Lees TA.
Source:  Cochrane Database Syst Rev., 2000; (3):CD001484, Northern Vascular Centre, Freeman Hospital, High Heaton, Freeman Road, Newcastle Upon Tyne, UK

Background:  One of the settings in which deep vein thrombosis (DVT) in the lower limb and pelvic veins occurs is prolonged immobilization in hospital for various surgical and medical illnesses. Use of graduated compression stockings (GCS) in these patients has been proposed to decrease the risk of DVT.

Objectives:  The objective of this review was to determine the magnitude of effectiveness of GCS in preventing DVT in various groups of hospitalized patients.

Search Strategy:  The reviewers searched the Cochrane Peripheral Vascular Disease Group trials register, MEDLINE, and EMBASE and hand searched Indexes Medicus. Various GCS manufacturing companies and the trial lists in the ongoing trials were contacted.

Selection Criteria:  Randomized controlled trials (RCT's) involving: Graduated compression stockings alone. Graduated compression stockings used on a background of any other DVT prophylactic method.

Date Collection & Analysis:  One reviewer extracted the data, assessed the quality of trials and analyzed the results (SVA) this was cross-checked and authenticated by the other reviewer (TAL).

Main Results:  A total of 16 RCTs were identified. GCS were applied on the day before surgery or on the day of surgery. GCS were worn up until discharge or until the patients were fully mobile. In the majority of the included studies, DVT was identified by radioactive I 125 uptake test. GCS alone: Nine RCTs were identified in this group. In the treatment group (GCS) of 624 patients, 81 developed DVT (13%) in comparison to the control group of 581 patients, where 154 (27%) had DVT, Peto's odds ratio 0.34 (95% confidence interval 0.25, 0.46) favoring treatment with GCS. GCS on a background of another prophylactic method. Seven RCTs were identified this group. In the treatment group (GCS + another
method) of 501 patients, 10 (2%) developed DVT whereas in the control group of 505 patients, 74 (15%) developed DVT, Peto’s odds ratio 0.24 (95% confidence interval 0.15, 0.37).

**Conclusions:** Analysis of these RCT's confirm that GCS are effective in diminishing the risk of DVT in hospitalized patients. Data examination also suggests that GCS on a background of another method of prophylaxis is even more effective than GCS alone. PMID: 10908501

**Title:** AORN Guideline for Prevention of Venous Stasis  
**Source:** AORN JOURNAL Volume 85, March 2007

**NONPHARMACOLOGIC INTERVENTIONS.**  
Low-risk patients should receive non-pharmacologic prophylaxis during the perioperative period until ambulation can be initiated.20 These measures include elastic stockings, IPC devices, and early ambulation, and are especially useful when heparin therapy is contraindicated. Compression stockings (either thigh-high length or calf-high length) frequently are used after surgery and during airplane rides to promote circulation.33 Compression stockings may be uncomfortable, but their effect on blood circulation helps to reduce the potential for DVT. Calf-length elastic stockings are effective for patients who undergo low-risk procedures and are relatively free of complications.1,2

**Title:** Venous Thromboembolism-Reducing the risk of venous thromboembolism (deep vein thrombosis and pulmonary embolism) in inpatients undergoing surgery, METHODS, EVIDENCE & GUIDANCE  
**Source:** Commissioned by the National Institute for Health and Clinical Excellence (NICE), APRIL 2007

Mechanical methods such as the use of graduated compression/anti-embolism stockings are effective and do not add the risk of bleeding. We have recommended these methods for most patients.

Reducing the risk of venous thromboembolism in all surgical specialties  
• Inpatients having surgery should be offered thigh-length graduated compression/anti embolism stockings from the time of admission to hospital unless contraindicated (for example, in patients with established peripheral arterial disease or diabetic neuropathy) . If thigh length stockings are inappropriate for a particular patient for reasons of compliance or fit, knee length stockings.

**Title:** Management of Venous Thromboembolism: A Clinical Practice Guideline from the American College of Physicians and the American Academy of Family Physicians  
**Author:** Vincenza Snow, et al.  
**Source:** Annals of Intern Medicine 2007 Volume 146

Recommendation 3: Compression stockings should be use routinely to prevent post-thrombotic syndrome, beginning within 1 month of diagnosis of proximal DVT and continuing for a minimum of 1 year after diagnosis. The evidence demonstrated a marked reduction in the incidence and severity of post-thrombotic syndrome among patients wearing compression stockings, either over-the-counter stockings or custom-fit stockings, if use was initiated within 1 month diagnosis of proximal DVT. Most diagnoses of post-thrombotic syndrome occurred early, within the first 2 years after DVT.
The compression effectiveness of the five leading brands of antiembolism stockings was compared and related to criteria previously described (pressure gradient diminishing from 18 mm Hg at the ankle to 8 mm Hg at the thigh). Tests were conducted using a standard leg form in common use within the hosiery industry, fitted with specially developed sensors. All of the stockings achieved pressures higher than recommended—some substantially. Elastic stockings from two manufacturers demonstrated tourniquet effects at the calf. Several brands ceased to preserve a continuously diminishing pressure gradient above the knee. Deviation of leg diameter from standard geometry was accompanied by a substantial increase (decrease) in pressure with increasing (decreasing) girth. Reproducibility of pressure effects produced by identical-sized stockings varied among the brands tested.
TOPIC: Proper Sizing and Fit
Reviewed: July 2009

Title: Graduated Compression Stockings in Hospitalized Postoperative Patients: Correctness of Usage and Size
Author: Elizabeth H. Winslow PhD, RN, FAAN, Debra L. Brosz MSN, RN, ONC, NEA-BC
Source: American Journal of Nursing, September 2008

Abstract: THE IMPROPER USAGE AND SIZING OF GRADUATED COMPRESSION STOCKINGS AND DEFICIENCIES IN PATIENT AND NURSE EDUCATION ARE IMPORTANT ISSUES THAT NURSES NEED TO ADDRESS.

Objective: Graduated compression stockings, when used correctly, have been shown to significantly reduce the risk of deep-vein thrombosis in surgical patients, but they can be harmful to skin and may even increase the risk of thrombosis if the wrong size is used. The authors sought to determine whether nurses correctly size and apply the stockings, whether problems were more common in knee- or thigh-length stockings, and whether nurses adequately educate patients on the usage of the stockings.

Methods: The researchers used a comparative, descriptive design to study 142 hospitalized postoperative patients; 37 had thigh-length and 105 had knee-length stockings. They assessed usage of the stockings and compared four separate leg measurements against the manufacturer's sizing chart to determine whether stockings that had been applied were the correct size. They also asked patients to rate the comfort of the stockings and to describe their purpose.

Results: The graduated compression stockings were used incorrectly (for example, they were wrinkled or the gusset was in the wrong place) in 29% of the patients and sized incorrectly in 26% of the patients. These problems were more common with the thigh-length stockings and in overweight patients. More patients who had thigh-length stockings found them uncomfortable than did those who had knee-length stockings, and 20% of patients didn't understand the stockings' purpose.

Conclusions: The authors recommend that nurses ensure that graduated compression stockings are properly sized and used, that the education of both nurses and patients regarding the stockings be improved, and that knee-length stockings be the standard length used.
**TOPIC:** Graduated Compression Stockings Knee or Thigh  
Reviewed: July 2009

**Title:** Thigh length versus knee length stockings in the prevention of deep vein thrombosis  
**Author:** M. J. Lef. Porteous, E. A. Nicholson, L. T. Morris, R. James, Mr. D. Negus  
**Source:** British Journal of Surgery, Volume 76 Issue 3

**Abstract:** Above-knee graduated compression stockings are effective in preventing postoperative deep vein thrombosis, but are more expensive and less acceptable than below-knee stockings. One hundred and fourteen patients undergoing major abdominal surgery were randomly allocated to wear above-knee or below-knee graduated compression stockings. Deep vein thromboses were diagnosed by isotope uptake in three of 56 patients (5·4 per cent) in the above-knee group and one of 58 patients (1·7 per cent) in the below-knee group. These differences are not statistically significant. Results suggest that below-knee stockings are as effective as above-knee in the prevention of postoperative deep vein thrombosis.

**Title:** Knee versus thigh length graduated compression stockings for prevention of deep venous thrombosis: a systematic review  
**Author:** Sajid MS, et al.  
**Source:** European Journal of Vascular and Endovascular Surgery, Volume 32, 2006

**Objective:** Graduated compression stockings are a valuable means of thrombo-prophylaxis but it is unclear whether knee-length (KL) or thigh length (TL) stockings are more effective. The aim of this review was to systematically analyse randomised controlled trials that have evaluated stocking length and efficacy of thromboprophylaxis.

**Method:** A systematic review of the literature was undertaken. Clinical trials on hospitalised populations and passengers on long haul flights were selected according to specific criteria and analysed to generate summated data.

**Results:** 14 randomized control trials were analysed. Thirty six of 1568 (2.3%) participants randomised to KL stockings developed a deep venous thrombosis, compared with 79 of 1696 (5%) in the TL control/thigh length group. Substantial heterogeneity was observed amongst trials. KL stockings had a significant effect to reduce the incidence of DVT in long haul flight passengers, odds ration 0.08 (95%CI 0.03–0.22). In hospitalised patients KL stockings did not appear to be far worse than TL stockings, odds ratio 1.01 (95%CI 0.35–2.90). For combined passengers and patients, there was a benefit in favour of KL stockings, weighted odds ratio 0.45 (95% CI 0.30–0.68).

**Conclusion:** KL graduated stockings can be as effective as TL stockings for the prevention of DVT, whilst offering advantages in terms of patient compliance and cost.

**Title:** Above-knee versus below-knee stockings in total knee arthroplasty  
**Author:** Williams LA, Owen TD.  
**Source:** The Royal College of Surgeons of England, Volume 88, May 2006

**Introduction:** Graduated compression stockings are frequently used following arthroplasty surgery for deep vein thrombosis (DVT) prophylaxis. There are often strongly held beliefs regarding whether below-knee or above-knee stockings should be used in total knee joint replacement. Many surgeons argue that below-knee stockings are more likely to induce wound complications because of increased swelling above the stocking and the elastic causing localised pressure on the wound.
**TOPIC:** Graduated Compression Stockings Knee or Thigh  
(CONTINUED)

**Patients and Methods:** This study is a prospective comparison of above and below-knee stockings in patients undergoing total knee joint replacement. A total of 50 patients were recruited and studied - 23 patients in the above-knee stocking group and 24 in the below-knee group. Swelling around the knee was measured over the course of an in-patient stay, together with wound complication rates and patients' preference.

**Results:** No statistical difference was found between the groups and no difference in wound complication rates was determined.

**Conclusions:** Below-knee stockings are safe following total knee replacement and are preferred by patients.

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**Title:** The use of knee-length versus thigh-length compression stockings and sequential compression devices  
**Author:** Brady D, Raingruber B, Peterson J, Varnau W, Denman J, Resuello R, De Contreas R, Mahnke J., Division of Nursing, California State University, Sacramento, California  
**Source:** Critical Care Nurs Q. 2007 Jul-Sep; Volume 30

**Background:** Nurses on an Acute Care Evidence Based Practice Committee, creating a policy to increase patient compliance with thromboembolic deterrent stockings (TEDS) and sequential compression devices (SCDs) for deep vein thrombosis prophylaxis, found limited literature on patient preference and response to this treatment.

**Study aim:** The study purpose was to determine whether knee-length or thigh-length TEDS and/or SCDs were more comfortable, correctly applied, and worn by patients, and to assess patient reasons for noncompliance. METHOD: A patient survey and observational data tool was designed. Six surveyors collected data (intrarater reliability = 93%) from 137 randomly selected patients with orders for TEDS and/or SCDs admitted to acute care medical or surgical nursing units.

**Results:** Most patients wore thigh-length SCDs and TEDS. However, only 29.2% (n = 40) had SCDs on them at the time of survey, and 62.8% (n = 86) were compliant with TEDS. The most common reasons given for noncompliance with SCDs were that the devices were not reapplied after bathing or ambulating, or were removed because they were hot or itchy. Complaints of discomfort were highest among patients wearing thigh-length SCDs and TEDS. Problems with fit were 50% higher in those who wore thigh-length TEDS, and involved stockings that created restricting bands. Most patients understood the purpose of treatment, and older patients were more compliant than younger patients.

**Implications for practice:** Knee-length TEDS and SCDs are more comfortable for patients, encourage higher levels of compliance with treatment, do not pose a risk for venous stasis to patients by creating restricting bands, and are less expensive. Patients need ongoing education to resume wearing TEDS and SCDs after activities of daily living, and knee-length stockings and devices would be easier to reapply. The policy in our institution was changed for the use of knee-length compression stockings.
Mechanical prophylaxis with foot pumps provides an interesting alternative to chemical agents in the prevention of thromboembolic disease following major orthopaedic surgical procedures. Recent studies have suggested that the simultaneous use of graduated compression stockings (GCS) may hinder the pneumatic compression effect of foot pumps. The hypothesis of this prospective study was that the use of foot pumps without GCS does not affect the efficacy of deep-vein thrombosis (DVT) prophylaxis and improves patient compliance. A total of 846 consecutive patients admitted at a single institution undergoing total hip (THR) or knee replacement (TKR) were included in the study. The A-V Impulse System foot-pump unit (Orthofix Vascular Novamedix, Andover, UK) was used in all patients. Of these 846 patients, 46 discontinued the use of foot pumps, leaving 400 patients who received foot pumps in combination with GCS and 400 patients with foot pumps alone. Eleven patients of the stocking group (2.7%) and nine patients of the no-stocking group (2.3%) developed postoperative symptomatic DVT (p=0.07). DVT was more frequent in TKR (10/364; 2.7%) than in THR (10/436; 2.3%). Non-fatal pulmonary embolism occurred in four of the 20 patients with symptomatic DVT, two patients each of the stocking and no-stocking groups. The foot-pump discontinuation rate of patients treated with stockings was 7% versus 4% of the patients treated without stockings (p<0.05). In conclusion, management of patients with foot pumps without GCS does not reduce the efficacy of DVT prophylaxis after THR and TKR and improves patient compliance. PMID: 17653546

Graduated compression stockings and intermittent pneumatic compression boots reduce the incidence of deep vein thrombosis. Recent studies suggest that the simultaneous use of these devices may have a synergistic prophylactic effect; however, conflicting reports also exist. Using duplex imaging, we analyzed the effect on peak venous velocity in the superficial femoral vein produced by the individual and simultaneous use of graduated compression stockings and intermittent pneumatic compression boots. Normal volunteers and postoperative patients were examined. The use of intermittent pneumatic compression boots significantly increased the peak venous velocity relative to rest, whereas the use of graduated compression stockings did not alter the peak venous velocity. Also, the addition of graduated compression stockings to legs already being treated with intermittent pneumatic compression boots did not produce a further augmentation of peak venous velocity. This study demonstrates that the simultaneous use of graduated compression stockings and intermittent pneumatic compression boots does not produce a synergistic augmentation of peak venous velocity in the superficial femoral vein. PMID: 1596175
Title: Prevention of deep vein thrombosis in potential neurosurgical patients. A randomized trial comparing graduated compression stockings alone or graduated compression stockings plus intermittent pneumatic compression with control

Author: Turpie AG, Hirsh J, Gent M, Julian D, Johnson J., Department of Medicine, McMaster University, Hamilton, Ontario, Canada

Source: Arch Intern Med. March 1989

In a randomized trial of neurosurgical patients, groups wearing graduated compression stockings alone (group 1) or graduated compression stockings plus intermittent pneumatic compression (IPC) (group 2) were compared with an untreated control group in the prevention of deep vein thrombosis (DVT). In both active treatment groups, the graduated compression stockings were continued for 14 days or until hospital discharge, if earlier. In group 2, IPC was continued for seven days. All patients underwent DVT surveillance with iodine 125-labeled fibrinogen leg scanning and impedance plethysmography. Venography was carried out if either test became abnormal. Deep vein thrombosis occurred in seven (8.8%) of 80 patients in group 1, in seven (9.0%) of 78 patients in group 2, and in 16 (19.8%) of 81 patients in the control group. The observed differences among these rates are statistically significant. The results of this study indicate that graduated compression stockings alone or in combination with IPC are effective methods of preventing DVT in neurosurgical patients. PMID: 2645846