The use of graduated compression stockings in Australian intensive care units: a national audit

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Abstract: Graduated compression stockings (CS) are used to prevent deep vein thrombosis (DVT); however, there is little known about the nursing practices surrounding their use in intensive care units (ICUs). This descriptive survey of adult ICUs in Australia sought to identify the nursing practices associated with the use of CS. A total of 91 (89% response rate) ICUs – 68 (75%) public and 23 (25%) private – responded.

CS were used in conjunction with anticoagulants in 88 (97%) units and with sequential compression devices (SCDs) in 48 (53%) units. Knee length CS were used most frequently (n=37, 41%); however, 31 (34%) units used both knee and thigh. Most units (n=80, 95%) allocated new CS for each patient and most (n=72, 79%) allocated one pair of CS per patient. Correct sizing was determined by the use of a tape measure in 74 (88%) of the units. CS were washed by hand in 74 (88%) units. A total of 67 (74%) of the units reported that unit protocol or tradition was a factor in determining CS use, whereas 45 (50%) reported that research evidence was also a factor. These findings suggest that while Australian ICUs are demonstrating best practices in relation to certain CS practices, Australian standards for linen and other manufacturing guidelines and are not being followed.

Limpus A & Chaboyer W. The use of graduated compression stockings in Australian intensive care units: a national audit. Australian Critical Care 2003; 16(2):53-58.

INTRODUCTION

Critically ill patients may experience complications as a result of their illness or treatment whilst in an intensive care unit (ICU)[1]. It comes as no surprise that the critically ill are the most likely or 'at risk' population to develop deep vein thrombosis (DVT)[1]. The incidence of DVT in the critically ill is reported at approximately 12-13%[2,3] with some authors suggesting this rate is as high as 30%[4]. DVT has been associated with almost 50% of all clinically significant pulmonary embolus (PE), and in the United States PE is one of the leading causes of death in hospitalised patients with DVT[5].

While routine DVT prophylaxis for the critically ill includes the use of anticoagulants, the application of compression stocking (CS) and/or sequential compression devices (SCDs)[6], the cornerstone of nurse-initiated DVT prophylaxis has been the CS. It is from this position that nurses should embrace current evidence, promote best practice and undertake further research to increase the effectiveness and clinical decision making surrounding the use of these devices.

This national survey is the first study in a programme of nursing research examining the effectiveness of CS. It identifies current practices and provides a beginning understanding of the relationship between manufacturers' recommendations and the actual use of CS in ICUs throughout Australia. Subsequent studies include a randomised controlled trial (RCT) examining the effect of CS length and body position on blood flow velocity and a study to determine the compression profiles of CS following repetitive patient use and hospital laundering.

LITERATURE REVIEW

Venous stasis, venous endothelial injury and hypercoagulability are the three major predisposing factors contributing to the formation of DVT[7]; collectively these factors are commonly known as Virchow's Triad[7]. The critically ill are at risk of having one or more of these predisposing factors as a result of their illness or treatment while in ICU[8]. Subsequently, this predisposition to venous thromboembolism places the critically ill patient in either a moderate or high risk group[9]. Without prophylaxis the incidence of DVT in the moderate risk group is 10-40% and 40-80% in the high risk group[9]. The general recommended guidelines for DVT prophylaxis in these two risk groups, unless contraindicated, includes low dose subcutaneous heparin, CS with or without intermittent pneumatic compression devices and early mobilisation[6,9].

CS alone are proven to be effective in reducing the risk of DVT in hospitalised patients[10,11]. A Cochrane review[10] of nine RCTs in the areas of general surgery (4), orthopaedics (2), neurosurgery (1), medicine (1) and obstetrics and gynaecology (1) has recently been completed. Results of these studies were pooled in a meta-analysis to demonstrate that 13% of the 624 patients in the CS group and 27% of the 581 patients in the control group developed DVT. This represents a 76% reduction in the chance of

developing DVT with CS. Additionally, a further reduction in risk was achieved when CS were used in addition to another form of prophylaxis such as dextran 70, subcutaneous heparin and SCDs [10].

Not only does this review highlight the potential role CS play in DVT reduction, it also demonstrates that researchers have primarily focused on two groups of patients, general surgery and orthopaedics, with no primary research identified in the critically ill/injured population.

While the manufacturers of CS provide recommendations for the proper use and maintenance of these devices, few studies have tested the efficacy of these guidelines to support, challenge or extend the manufacturers' recommendations. Anecdotal evidence would suggest that wide variations in practice surround the allocation, laundering and overall management of this clinical consumable between and throughout organisations.

A number of authors have examined clinical practices surrounding the use of CS. Love [12] identified that accurate initial and ongoing assessment of leg measures is vital, as it is impossible to assess the actual pressure applied by the CS. A CS that is too big or oversized will under perform. resulting in reduced efficacy. Similarly a CS that is too small will exert pressures beyond the optimal profile and lead to a reduction in subcutaneous tissue flow and may reduce venous blood flow velocity [13].

Once CS are applied, ongoing patient assessment is required. Changes to the girth of the limb due to localised swelling or oedema will cause an increase in pressure [11, 12] leading to constriction, loss of graduated pressure, possible retrograde blood flow [12], and impaired or threatened tissue oxygenation [7, 11]. Vigilance is required to ensure that CS do not roll down the leg creating a tourniquet-like effect. This action can result in a loss of graduated compression and an increase in venous stasis and potential for thrombogenesis [14, 15]. Wrinkling or bunching of the CS may also have an adverse effect on blood flow [15].

Patient positioning can also affect CS efficacy. Wilden *et al.* [16] found that leg posture can significantly increase pressure behind the popliteal fossa when wearing thigh length CS. They concluded that high 'interface' pressures behind the popliteal fossa leads to a reverse of graduated pressure with a subsequent decrease and even stagnation of venous blood flow. This rationale was offered as a possible explanation why CS failed to prevent DVT for patients who spent long periods of time in a sitting position [16].

CS remain the subject of a number of review articles as there is limited evidence comparing the two lengths of CS in the form of RCTs. The debate between the efficacy of thigh versus knee length CS is a common theme throughout [7, 12], with one later review focussing exclusively on this issue [17]. Currently there is no definitive evidence comparing the efficacy of knee and thigh length CS. The argument for the use of knee length CS is based on similar efficacy in terms of blood flow, significant cost benefit, increased patient comfort, ease of application and the avoidance of situations where the CS rolls down to form a tourniquet around the knee, which in turn may impair blood flow and have adverse outcomes for the patient [7, 12, 17].

In summary, there is a heightened awareness of the risks of DVT and the role CS play in its prophylaxis [10]; however, work examining their effectiveness has predominantly been conducted in the areas of general surgery and orthopaedics [10]. Many ICU patients fall into the medium to high risk groups for DVT and wear CS. Despite this, little is known about the relationship between manufacturers' guidelines and actual clinical practices in ICU. The ICU environment is ideal for examining practices surrounding the use of CS because of their widespread use. This audit describes current CS clinical practices in Australian ICUs.

METHOD

Sample

Using the *2001 Hospital and Services Yearbook* [18], a contact database using Microsoft ACCESS® was constructed. One hundred and seventy one hospitals were identified as offering intensive care services. The telephone number and postal address of each facility was entered into the database. Four hospitals listed as offering intensive care services failed to be contacted and were subsequently not screened. A total of 167 hospitals were contacted.

Following approval from the hospital ethics committee, telephone contact was made with each facility requesting to speak with key individuals within the ICU. In most instances this was either the nurse practice coordinator (NPC) or nurse unit manager (NUM). Eligibility was determined at this point to ensure that the facility did in fact provide general intensive care services. Facilities which were listed as providing intensive care services but transferred critically ill patients as soon as possible to higher level facilities were excluded. Other exclusion categories included high dependency units (HDUs) and cardiac-surgical ICUs. Sixty five hospitals were excluded on these criteria.

Using a set format, the invitation to participate was presented verbally to the key individual. The sequence included a personal introduction, explanation and rationale for the study. Additional factors that were highlighted included that the study had received approval from the Princess Alexandra Hospital Ethics Committee and funding from the Australian College of Critical Care Nurses (ACCCN).

Potential participants were advised that data from the survey would be kept confidential. They were also advised that each participating unit would be given an identification code to allow for mailing of results and to provide a mechanism for follow-up should clarification of data be required. At the end of the presentation, key individuals were invited to participate in the study. All 102 nurses who were contacted agreed to participate in the study.

Procedures

A 21 item survey, covering letter and postage paid returned envelope were mailed to the participant on the day of first contact. A reminder letter was sent two weeks after the date of the initial telephone contact if the survey had not been returned. No further contact was made with individuals who did not respond. A summary of results was mailed to all participants who responded to the survey. Returned survey data were initially entered into a database using Microsoft ACCESS® software. Data were transferred electronically and analysis undertaken using the Statistical Package for Social Sciences (SPSS®).

Survey development

The survey was comprised of two short sections. Dillman's [19] recommendations for the development of mailed surveys were used as a guide in the development of this survey. Additionally, DeVellis' [20] recommendations for the wording of questions and response choices also provided direction for this survey.

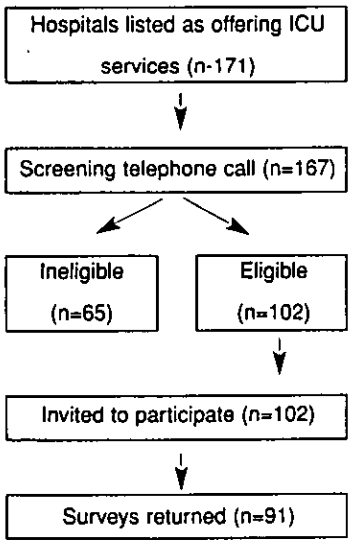
The first section of the survey contained five questions that were demographic in nature. The second section contained sixteen questions regarding the use of CS and related nursing practices. These questions were developed from a review of the literature, manufacturers' guidelines, knowledge of the nursing practices related to CS in several ICUs and from discussions with clinical experts. A draft of this survey was assessed for content validity by 10 expert nurses. These nurses were employed in a variety of ICUs. Their suggestions to improve the survey were incorporated.

Inter-rater reliability of the instrument was established by having five expert ICU nurses from the same unit independently complete the survey. A total of 14 of the 21 items in the survey were answered the same by all five clinicians. Three items – number of CS allocated per patient, the use of 'new' and the use of 'used' CS – had 80% agreement. Three items had 60% agreement – the type of CS used in the unit, the method of washing CS and the most important factor in determining how the decisions are made regarding the use of CS. One item, the frequency of measuring calf/thigh after initial measurement did not demonstrate an agreement, with the five raters choosing four different answers. With 17 out of 21 items achieving a 80% or greater level of agreement, and an additional three items achieving a 60% agreement, a decision was made to include all of these items, only deleting the one item that had less than a 60% agreement. While an 80% agreement is normally accepted for established tools, the items with 60% inter-rater reliability were retained as a lower level of reliability is expected and often accepted with newly devised instruments [21].

RESULTS

A total of 102 surveys were mailed out; 91 were returned for a 89.2% response rate. Figure 1 provides more details about the sampling process.

Figure 1. Sampling process.



A wide variety of units completed the survey with public and private hospitals and tertiary referral, metropolitan and regional centres units represented (Table 1). The average number of admissions for these units was 908 (SD 405) with a range from 250 to 2,351 and a median of 846. Managers and clinical nurse consultants were the group who most often completed the survey.

A number of questions were asked about the use of CS and other therapies for DVT prophylaxis. Most units stated that anticoagulants and CS were used routinely. Almost half of the units were using SCDs with CS, with only a few units using foot pumps and CS (Table 2). Six units (6.7%) stated that CS were not used routinely in conjunction with other methods of DVT prophylaxis.

Several questions were asked about current CS practices (Table 3). While Kendall TED® CS were most frequently used in about two thirds of the ICUs, a total of four other brands were mentioned. The second most frequently used CS was the OAPL brand with 10 units (11.1%) reporting its use. Knee length CS were most frequently used; however, many units used both thigh and knee length. Sizing of CS was most often determined by tape measurement. Most units did not use belts with thigh length CS. The majority of the units (n=82, 91.1%) responding allocated one pair of new CS per patient, with all but one unit sending CS with

Table 1. Demographic characteristics of participating units.

Variable	Response options	Frequency	
Type of hospital	Public	68	(74.7%)
	Private	23	(25.3%)
Type of unit	Tertiary referral	27	(29.7%)
	Metropolitan	26	(28.6%)
	Regional	38	(41.8%)
No. admissions	250-499	10	(11.0%)
	500-749	18	(19.8%)
	750-999	19	(20.9%)
	1,000-1,999	24	(26.4%)
	2,000 and over	2	(2.2%)
	no response	18	(19.8%)
Who completed survey	Manager/nurse practice coordinator	56	(61.5%)
	Clinical nurse consultant	16	(17.6%)
	Clinical nurse/specialist	10	(11.0%)
	Registered nurse	5	(5.5%)
	Educator	3	(3.3%)
	Research coordinator	1	(1.1%)

Table 2. Routine DVT prophylaxis.

Therapy	Frequency	
Graduated CS alone	78	(85.7%)
Anticoagulants and CS	88	(96.7%)
SCDs and CS	48	(52.7%)
Foot pumps and CS	3	(3.3%)

Table 3. Practices surrounding graduated CS use.

Question	Response option	Frequency	
Length of CS used	Knee length	37	(40.6%)
	Thigh length	15	(16.5%)
	Knee and thigh length	31	(34.1%)
	No response	8	(8.8%)
Thigh length used with a belt	No	45	(49.4%)
	Yes	8	(8.8%)
	Not applicable	30	(33.0%)
	No response	8	(8.8%)
No. pairs allocated per patient	One	72	(79.1%)
	Two	10	(11.0%)
	More than two	1	(1.1%)
	No response	8	(8.8%)
Are new CS used for each patient	No	4	(4.3%)
	Yes	80	(88.0%)
	No response	7	(7.7%)
CS size determined by	Tape measure	74	(81.3%)
	Visual estimation	8	(8.8%)
	Both tape and visual	2	(2.2%)
	No response	7	(7.7%)
No. times reused before discarding	Unknown	8	(8.8%)
	Less than 10	1	(1.1%)
	Not applicable	75	(82.4%)
	No response	7	(7.7%)
Frequency of removal for skin inspection	Once a shift	37	(40.7%)
	Daily	44	(48.4%)
	Other	3	(3.3%)
	No response	7	(7.6%)
Washing of CS	Hand wash	74	(81.3%)
	Hospital laundry	7	(7.7%)
	Other	3	(3.3%)
	No response	7	(7.7%)

Table 4. Decisions relating to graduated CS use.

Question	Response option	Frequency	
Factors influencing graduated CS use*	Unit protocol/tradition	67	
	Research evidence	45	
	Info from product rep	16	
	Finances	9	
	Trial and error	6	
	Other	14	
Most important factor in determining graduated CS decisions	Unit protocol/tradition	40	(43.9%)
	Research evidence	30	(33.0%)
	Financial	1	(1.1%)
	Other	12	(13.2 %)
	No response	8	(8.8%)

** Participants (n=84) could provide more than one response.*

patients on discharge from the unit; however, seven units did not answer this question. Approximately half of the units reported removing CS to inspect the skin on a daily basis. The vast majority of the units hand washed the CS.

Participants were asked to circle all factors that influenced decisions regarding the use of CS. The most frequently chosen response was unit protocol/tradition, followed by research evidence (Table 4). They were then asked about the most important factor that determined how decisions were made regarding the use of CS, with unit protocol/tradition being the most common response (Table 4).

DISCUSSION

The aim of this audit was to determine the current clinical use and management of CS in Australian ICUs and to identify variations between recommended use and actual use in ICU clinical practice. The audit showed that the practice of using CS in the general ICU population for routine DVT prophylaxis was well accepted throughout Australia.

There was a preference for the use of knee length CS. It is not known over what timeframe this support has been present, as this was the first audit of this nature. A significant number of units (n=31) used knee and thigh length CS. It is not clear why both lengths of CS were used concurrently in these units. Interestingly just over half (n=16) of these units also indicated that unit tradition/protocol was the most important factor in determining how decisions were made regarding the use of CS. Perhaps physician input or patient population influenced this choice. Another possible explanation for this phenomenon might be the lack of evidence comparing the efficacy of the two lengths of CS.

There is a clear preference for allocating one pair of new CS to patients who are admitted to general ICUs. Combined with this preference is the practice of hand washing CS, with the vast majority of ICUs reporting that soiled CS are washed by the nurse at the bedside. It could be argued that the nurse is at an increased risk of being exposed to bodily fluids while hand washing CS soiled by faecal matter, blood or urine. These practices also raise a number questions in relation to compromising DVT prophylaxis and placing the patient and nurse at an increased risk of infection.

For the basis of this discussion the comparisons between current clinical practice and the manufacturers recommendations will be made using the Kendall TED®, the most widely used product in Australian ICUs. Currently it is recommend that CS should be washed every 2-3 days unless soiled [22]. This manufacturer's recommendation increases the length of wear of the garment by removing acidic body secretions which degrade the elastic threads.

It is also recommended that CS should not be off the patient for more than 30 minutes [22]. While no rationale is given for this recommendation, it relates to the loss of graduated compression and subsequent increase in risk of DVT formation. While there is little work on the residual effects of graduated CS, it has been demonstrated [23] that they significantly increase blood flow velocity after only 20 minutes. With removal of the CS it is also reasonable to assume that the reverse would occur over a similar period of time.

Currently all other linen when soiled is laundered to the Australian and New Zealand standard for laundry practice [24] which ensures disinfection by either thermal or chemical means. It could be

argued that hand washing does not provide the nurse and, more importantly, the patient with the reassurance that the soiled CS have been washed adequately to ensure disinfection. While the authors acknowledge that not all CS will be soiled, it is likely that a certain proportion will be. For those that are soiled, consideration should be given to either laundering and/or allocation of another pair of CS. Additionally, the reapplication of soiled CS, which have not been adequately disinfected, may potentially place the patient at an increased risk of infection. This proposition has yet to be tested empirically.

Correct sizing has been highlighted [7, 11, 12] as one of the most important factors in the provision of adequate prophylaxis and preventing associated complications with CS use. A positive finding was that a tape measure was used to determine correct sizing by almost 90% of ICUs. The study also showed that CS were most frequently removed on a daily basis to inspect the skin, with 44% of respondents also reporting the practice of removing the CS once a shift to inspect the skin.

It is interesting to note that, when asked what factors influenced the use of CS, almost half of the respondents identified research evidence. The review of the literature identified very few studies that actually examined the clinical practices in relation to CS. That is, most of the CS research has been conducted on their effectiveness in terms of blood flow and DVT prevention, with relative little research on nursing practices surrounding their use. It may be that either the wording of the influencing factors question was not clear or the responses were affected by social desirability. That is, evidence based practice is a popular framework [24, 25] and it may be that nurses responded to this question because of this framework.

CONCLUSION

With an 89% response rate, the results of this national audit provide an accurate representation of current practices surrounding the use of CS in general ICUs throughout Australia. It appears that, beyond product information, clinical nurses have little evidence upon which to guide their practice.

These results indicate that there is a considerable variation in the length of CS used in relation to critically ill patients. There is clear evidence that practices surrounding initial measurement and regular inspection, while generally accepted, are not uniform.

This study has also highlighted allocation and laundering practices which may potentially reduce the effectiveness of these devices by delaying the time to re-application. Additionally, these practices may also place the patient at an increased risk of infection and the nurse to an increased risk of expose to bodily fluids. On the basis of these findings, there is scope for further research to enhance the clinical effectiveness of these devices and provide clinical guidelines for the use of CS in the critically ill.

ACKNOWLEDGEMENTS

The authors would like to acknowledge ACCCN for providing funding to conduct this study. Thank you also to Sean Birgan, Assistant Director of Nursing, Princess Alexandra Hospital, for his vision, support and encouragement.

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