The Use of Knee-Length Versus Thigh-Length Compression Stockings and Sequential Compression Devices

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**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 (interrater 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 and SCDs. **Key words:** compression stockings, deep vein thrombosis prophylaxis, evidence-based policy, sequential compression devices

VENOUS THROMBOEMBOLISM is a major cause of death among hospitalized adults.1 A variety of prophylactic treatment regimens to prevent deep vein thrombosis (DVT) have been recommended in the...
literature including the use of antithrombotic pharmacological agents in combination with thromboembolic deterrent stockings (TEDS) and sequential compression devices (SCDs).2,3 Benefits of TEDS and SCDs alone, as prophylaxis in patient groups with low to moderate risk of DVT and those unable to take pharmacological agents, have also been clearly demonstrated in the literature.4,5 Nurses on the Acute Care Evidence Based Practice Committee in our institution observed high levels of noncompliance with SCD therapy among patients on a variety of nursing units. SCDs were often found in the patient room but not on the patient, or applied incorrectly so that the patient was receiving no benefit from the device. Also of concern was that thigh-length TEDS were being found applied improperly or rolled down with tight constricting bands on various parts of the leg, which can actually cause venous stasis and be harmful to patients.6,7 Compression stockings and SCDs are available in thigh-length and knee-length varieties, and the policy in our institution included use of both lengths.

RATIONALE FOR STUDY

In reviewing the literature to create an evidence-based policy for our institution on TEDS and SCD use, it was evident that debate has centered on the effectiveness of both length devices in preventing venous thromboembolism, and that specific concern has been raised over appropriate application, fit, and patient compliance with thigh-length TEDS and SCDs.8,9 However, there are limited data on patient-reported comfort with thigh-length versus knee-length TEDS and SCDs and the affect this has on compliance.7 The aim of this study was to (1) gather data from patients about the comfort and fit of thigh-length versus knee-length TEDS and SCDs and (2) observe the compliance and fit of devices to facilitate evidence-based practice policy decision making for our institution that would improve patient compliance with DVT prophylaxis.

REVIEW OF THE LITERATURE

Research on the use of thigh-length and knee-length TEDS and SCDs has indicated that “compression of the thigh as well as the calf does not give extra benefit” in reducing the incidence of DVT.6(p1553) Studies have indicated that full-length devices and stockings do not provide a higher level of protection, and, in fact, the incidence of DVT is similar with the use of knee-length and thigh-length devices.10 Ingram7 notes that many studies indicate below-knee products have better patient compliance rates, and none of the published studies clearly show benefits of thigh-length over below-knee length devices.

Furthermore, if compression stockings and SCDs are used improperly, or if thigh-length stockings are rolled down, they can cause arterial thrombosis, skin necrosis, venous stasis, and reduced blood supply.6,11 Substantial cost savings have been reported from the use of knee-length stockings and/or compression devices in comparison with thigh-length ones.6 Hameed et al9 stressed that knee-length stockings are more likely to be correctly applied than thigh-length stockings. Agu et al12 argue that thigh-length stockings are more expensive, more difficult to put on, and less tolerated than knee-length stockings. In addition, researchers have reported that patients often refuse to wear stockings and compression devices they perceive to be uncomfortable or inconvenient; however, these studies do not include specific information on what aspect of the treatment is uncomfortable or details about patient knowledge of the benefit of treatment compliance.13,14

There are reports in the literature that patients and nurses preferred the use of knee-length stockings and/or compression devices. In a meta-analysis comparing thigh-length and knee-length compression stockings, Byrne summarized that “below the knee stockings are easier for both patients and nurses to use, have less associated risks and problems, and are more comfortable.”8(p285) However, Byrne did not discuss how patients were questioned.
or report on the interrater reliability of data. A study by Benko et al.\textsuperscript{15} provided a similar conclusion on patient preference for knee-length compression stockings. Researchers studied the effect of 2 brands of compression stockings on a convenience sample of 200 presurgery patients. They compared knee-length and thigh-length compression stockings of both brands for venous hemodynamics, fit, patient reports of comfort, and help required for putting on the stockings over a 1-hour period. Investigators found that both length stockings were similarly efficient in decreasing venous stasis. However, there was less wrinkling of the knee-length stockings, and patients indicated them to be more comfortable. The validity of study conclusions would have been strengthened if the method used to gather information on the fit of stockings, validity and reliability of the observational tools, and the interrater reliability for observational data were included in the study. In addition, the study period was for 1 hour and did not take into consideration patient opinion in light of the clinical reality of wearing TEDS and SCDs for hours to days while hospitalized postsurgically or with an acute illness.

A review of the literature indicates that there is limited information on studies on knee-length versus thigh-length TEDS and SCDs regarding patient comfort with these devices in the acute care setting. In addition, the literature does not fully address patient knowledge about the significance of this treatment modality, and specifics about the stockings and compression devices that lead to noncompliance.

**PURPOSE**

The Acute Care Evidence Based Practice Committee in our institution conducted a study to provide information for and on evidence-based policy on TEDS and SCDs. The primary purpose of this study was to evaluate whether knee-length or thigh-length TEDS and SCDs are more likely to be correctly applied and worn by patients so that stockings and devices with the best fit and compliance are used in our facility to provide the intended DVT prophylaxis. A secondary purpose was to determine whether patients understand why these stockings and devices were being used, and to elicit patient perspectives about their use in order to determine patient education needs.

**METHODS**

The study was conducted at a large university teaching hospital in northern California. The university institutional review board approved the study, and signed informed consent was obtained from all participants. Participant confidentiality was maintained by assigning a numerical designation to each participant, and no names or medical record numbers were recorded. Data were collected between fall 2003 and winter 2005.

A survey design method was used to collect information from patients regarding why these stockings and/or compression devices were being used, whether they found them comfortable enough to wear, and how long they wore them per day. The study also included observations on the fit of TEDS and/or SCDs. Survey content and observational descriptors on fit were determined by a review of the literature and clinical observations made by nurses in our institution. Validity of the survey was established by consulting with clinical nurse experts. The tool was piloted with data collectors for clarity, and revisions made by consensus of nurse experts. Six surveyors were used to collect data. Interrater reliability for the observational portion of the survey was established at 93%. In addition, surveyors were supplied with photoflash cards and descriptions of improper TEDS and/or SCD application that correlated with the descriptors on the survey to use as reference when making observations.

Our sample group included a random selection of patients with orders for TEDS and/or SCDs admitted to any one of the following acute care nursing units (Neuro, Transplant, Vascular/GI, ENT/Internal Medicine, Trauma,
and Orthopedics). Only those patients who had sufficient stamina and concentration to complete the 15-minute survey were asked to participate. Patients not oriented to person, place, and situation were excluded, as well as prisoners or patients who were restrained. In addition, patients with acute psychiatric illnesses or suspected brain damage as well as patients younger than 18 were excluded. Translation services were used for those who were willing and able to participate but did not speak English.

A single surveyor was assigned to collect data on a unit during a given period. Surveyors did not collect data on units in which they were employed, and more than 80% of the data were collected from another institution to mitigate any same institution bias.

RESULTS

Survey and observational data were collected on 137 individuals who agreed to participate in the study. Five patients choose not to complete the survey because of “feeling tired” and their data were not included. An additional 13 patients declined to participate when approached initially. Most study participants described themselves as “White” (n = 101), while the next most common ethnic groups represented were Hispanic (n = 14) and African American (n = 9).

Seventy-two women and 65 men participated and their age range from 18 to 92 years. No correlation was found between gender and compliance with SCDs/TEDS. However, our data indicated strong correlation (Pearson correlation = 0.247, significant at a .01 level; 2-tailed) between age and compliance, indicating that older patients were more consistent in wearing the ordered SCDs/TEDS. Data indicated that the most common SCDs ordered in our institution were the thigh-length type; of the 137 patients surveyed, 51% reported wearing thigh-length SCDs, 34% had knee-length SCDs, and 16% did not know what type they were wearing.

At the time of data collection, the surveyors found the overwhelming majority of patients (85.4%; n = 117) in bed, where one would anticipate compliance with the ordered SCD treatment, yet only 29.2% (n = 40) had SCDs on them at the time of survey. An additional 47% (n = 65) had SCDs available in their room, but did not have them on. In 19% of patients (n = 26) surveyed, no SCDs were visible in the room.

Twenty-one patients were observed wearing thigh-length SCDs, and 19 patients had knee-length SCDs. The devices were applied correctly and fit appropriately on 26 patients (14 with thigh-length and 12 with knee-length). The most common problems identified by surveyors on both lengths of SCDs were that either devices were too long or the Velcro closure had come undone.

Ninety-one patients were not wearing their SCDs at the time of the survey. Fifty-three percent of these patients indicated that they had been wearing thigh-length compression devices, and noncompliance for those who had been wearing knee-length devices was at 32%; 15% of patients did not recall the length of SCDs they had been wearing. The most common reasons patients sighted for not wearing their SCDs can be found in Table 1.

Complaints of discomfort among patients who reported having thigh-length SCDs

### Table 1. Most common responses patients gave for not wearing sequential compression devices (SCDs)*

<table>
<thead>
<tr>
<th>Reason</th>
<th>% Of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Had a good reason (just had a bath, ambulated)</td>
<td>46</td>
</tr>
<tr>
<td>2. SCDs were uncomfortable (hot, itchy)</td>
<td>39</td>
</tr>
<tr>
<td>3. Registered nurse had never initiated them or had not replaced them after transfer from another unit</td>
<td>13</td>
</tr>
<tr>
<td>4. Did not know they were off</td>
<td>2</td>
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</tbody>
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*N = 91 patients; multiple responses possible; total responses = 149.
Knee-Length Versus Thigh-Length TEDs and SCDs

ordered were more than double the complaints of patients with knee-length SCDs (39 vs 15). However, most patients (65%) indicated that the process of putting on SCDs or having the nurse put them on was “fairly easy”; hence, this was not a major deterrent in compliance with wearing either type of SCDs.

Data indicated that the most common length TEDS ordered in our institution was of the thigh-length variety. Sixty percent of patients reported wearing thigh-length stockings, 30% knee-length stockings, and 10% could not recall what stocking they were wearing. Surveyor observations on compliance with TEDS indicated that 62.8% (86 patients) were wearing compression stockings at the time of the survey; 28 patients had knee-length stockings and 58 patients were wearing thigh-length stockings. The stockings were applied correctly and fit appropriately in 35 patients. The most common problems identified with TEDS were that they were rolled down and creating a garter-like or rubber band effect on the leg or were too short. Surveyors identified 34 problems with fit on patients wearing thigh-length stockings, versus only 18 fit problems on patients wearing knee-length stockings.

Fifty-one patients were not wearing their TEDS at the time of the survey. Half of these patients reported having worn thigh-length stockings, and 26% indicated they had knee-length stockings ordered; 24% could not recall the length of stocking they had worn. The most common reasons patients sighted for not wearing their TEDS can be found in Table 2.

Complaints of discomfort with TEDS were highest among patients who reported wearing thigh-length stockings, and totaled 43, versus only 5 complaints of discomfort for patients wearing knee-length TEDS. Our data indicate that 46% of patients find the process of putting on TEDS or having them put on is fairly easy, whereas 30% report that it is difficult to put them on and that this was not related to the length of the compression stocking.

Table 2. Most common responses patients gave for not wearing thromboembolic deterrent stockings (TEDS)*

<table>
<thead>
<tr>
<th>Reason</th>
<th>% Of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TEDS were uncomfortable (hot, itchy)</td>
<td>59</td>
</tr>
<tr>
<td>2. Had a good reason (ambulated, just had a bath)</td>
<td>23</td>
</tr>
<tr>
<td>3. Registered nurse had never initiated them or had not replaced them after transfer from another unit</td>
<td>16</td>
</tr>
<tr>
<td>4. Did not know they were off</td>
<td>2</td>
</tr>
</tbody>
</table>

*N = 51 patients; multiple responses possible; total responses = 73.

DISCUSSION

Our study indicates that compliance with SCD treatment is a major issue because only 29% of patients were actually observed wearing their devices. Approximately half of the patients not wearing their SCDs indicated that they had a legitimate reason for having them off, such as recent ambulation or bathing. However, this still raises concerns about the timeliness in resuming SCD therapy and identifies an area where ongoing nursing staff education is required. This concern is supported by the fact that 13% of patients reported the devices had either never been initiated or not been put back on by the registered nurse after removal or activity or transfer from another unit. Appropriate fit was observed in most patients who were actually wearing the devices. Identified problems centered on selecting the appropriate size for the patient and ensuring that the Velcro closure were secured. The study results reiterate the need for ongoing staff and patient reinforcement education on SCD compliance to promote optimal DVT prophylaxis. Cornwell et al16 identified the same need for ongoing SCD education in a study on compliance with SCDs in patients with at-risk trauma. Our study also found a significant
correlation with age, and indicated that older patients are more compliant in wearing SCDs. This result is consistent with compliance in older patients reported by Proctor et al,\textsuperscript{10} and raises the question about the importance of selecting other forms of DVT prophylaxis for younger patients.

Moreover, noncompliance with SCD treatment was highest among patients wearing thigh-length SCDs, and thigh-length devices generated more patient complaints of discomfort. Thirty-nine complaints of discomfort were reported by patients with thigh-length SCDs, versus only 14 complaints of discomfort for patients wearing knee-length SCDs. These results are consistent with other findings in the literature that assert that knee-length SCDs would provide better patient comfort and improved patient compliance with treatment.\textsuperscript{9}

Our results also indicate that most patients wearing either knee-length or thigh-length SCDs reported they were fairly easy to have applied and were important in preventing blood clots and helping with circulation, thus implying that there is minimal resistance to initiating SCD treatment. A minority of patients reported that the devices were hot or itchy, an issue that could be addressed by using the cooling feature on the SCD machine. Our observation data indicated that the cooling feature was only being used on 20 of the 40 machines that were in operation at the time of the survey. This is another area of focus for nursing staff education.

Observations of patient compliance with TEDS were much higher (65%). This may reflect the fact that patients do not have to remove them for out-of-bed activities such as ambulation, sitting in a chair, or going to the bathroom. It may also reflect the fact that one third of the patients reported the process of putting them on was difficult, and therefore they did not remove them as readily.

Most patients had ordered thigh-length TEDS. Of concern was that surveyors found almost double the number of problems with fit in patients with thigh-length TEDS as opposed to knee-length TEDS. The most common and concerning issue was that TEDS were folded or rolled down, creating a garter-like or rubber band effect on the leg. This can actually impede circulation and increase DVT risk because of venous stasis.\textsuperscript{6} These results are consistent with the prospective study of Hameed et al\textsuperscript{9} that compared thigh-length versus knee-length compression stockings and that also identified the most common problem with fit of thigh-length stockings was the band effect when stockings were rolled down.

In addition, the data revealed that noncompliance with thigh-length TEDS was twice that of patients with knee-length stockings. This may be because our data also indicated a substantially higher number of patient complaints related to discomfort with thigh-length TEDS than complaints regarding knee-length TEDS. This supports a patient preference for knee-length TEDS that has also been reported by other authors.\textsuperscript{9} This provides additional evidence for our contention that in creating effective patient treatment protocols, issues of patient comfort must be considered in order to foster optimal compliance.

LIMITATIONS

Limitations include the fact that this is a 1-institution study, with a predominately White study sample, and this makes generalizing results to other populations more difficult. Another limitation is that the study design is a self-report survey. Patients may have reported feeling more favorable toward TEDS and SCD treatment than actually was the case, or failed to accurately report reasons for not wearing devices and stockings because they did not want to be perceived as a “bad patient” and noncompliant with treatment. There was an attempt to mitigate this by including an observational portion on the study. Portions of the survey required that patients recall information related to their ordered treatments. Multiple factors arise during hospitalization that can affect recall (pain, medications, sleep deprivation), and this may have affected on some of the patient responses. To address this issue, survey questions gave patients the
option of stating “I do not recall,” and this was reported in the study data.

IMPLICATIONS FOR PRACTICE

The study adds to the body of literature for evidence-based practice that supports the use of knee-length TEDS and SCDs for DVT prophylaxis in patients at low risk for DVT or who are unable to take pharmacological intervention. Results are consistent with other studies that found that patients preferred knee-length TEDS and SCDs and resulted in greater compliance with treatment. It also identified the fact that younger patients are less compliant with treatment, therefore consideration of another form of DVT prophylaxis may be warranted in some instances. The study reiterates conclusions by Ingram on the need to focus nursing student, staff, and patient education on the importance of resuming SCDs when the patient completes bathing or walking and returns to bed in order to optimize DVT protection. Our data indicated that most patients responded favorably to using TEDS and SCDs, could verbalize the rational for this ordered treatment, and reported legitimate reasons such as bathing or walking for having them off when surveyed, but needed consistent reminders to resume wearing the devices.

CONCLUSION

The policy in our institution was changed for the use of knee-length compression stockings and knee-length SCDs. This has a direct impact on improving patient care because knee-length compression stockings and devices are more comfortable for patients, have greater ease of application, and are more frequently applied correctly than thigh-length stockings, resulting in the intended DVT prophylaxis benefit to the patient. In addition, discontinuing the use of thigh-length stockings and devices eliminates the risk of constricting bands that can actually increase DVT risk when these stockings and devices are improperly applied. An added benefit is a decrease in cost for the institution with the use of knee-length stockings and devices.

REFERENCES

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