Venous ulcers are a common, costly occurrence. Treatment typically includes the use of short-stretch and four-layer bandages — both with demonstrated ability to increase venous return and healing rates. Which is superior is unclear. To determine whether short-stretch bandages or four-layer compression systems provide shorter healing times and fewer adverse events when used in adults with venous ulcers, a search of English-language literature was conducted using the search terms short-stretch bandages and wound care, compression bandages and wound care, compression and venous ulcers, four-layer compression and venous ulcers, and multilayer compression and venous ulcers. Data from 25 studies published between 1997 and 2006 were examined.

Short-stretch and four-layer compression bandages were found to be equally as effective in managing the edema that compromises venous ulcer healing. Time to healing was found to be shorter using four-layer or one- to two-layer compression when compared to paste compression in 24 studies. Ankle brachial index is an important factor to consider in determining compression appropriateness. Generally, use of any compression system is better than no compression at all.

In studies of patients with prior venous stasis ulcers, compression stockings and patient education have been shown to save about $60,000 per lifetime cost per quality-adjusted life year in patients with venous ulcers; also, when compression stockings are implemented, time to reoccurrence is reduced from an average of slightly greater than 18 months to 53 months.

The purpose of the current literature review was to determine if the use of short-stretch compression bandages is as effective as a four-layer compression bandage system in managing edema related to venous ulcers.
insufficiency in order to better guide treatment in adult patients.

Graham et al. offer three reasons for establishing a treatment guideline for venous insufficiency:
1. To provide more resources devoted to the treatment of venous stasis as the baby boomer population ages
2. To address regional and national variation in the treatment provided
3. To address an information gap with regard to compression.

Venous Insufficiency

Venous insufficiency is caused by valvular incompetence in the high-pressure deep venous system or low-pressure superficial system. Deep venous insufficiency can be caused by a deep vein thrombosis that damages valves and can predispose an individual to deep system reflux and increase hydrostatic venous pressure (eg, post-phlebic syndrome). Most commonly, this is seen in the superficial system in the saphenous and common femoral vein as the incompetence proceeds distally from the groin; less commonly, this failure is seen at the junction between the short saphenous and popliteal veins of the knee. Deep venous system failure and subsequent high pressure have been shown to result in edema, tissue protein disposition, perivascular fibrin cuffing, red cell extravasation, impaired arterial flow, and other local disturbances. Venous insufficiency can occur with or without the occurrence of varicose veins.

The Role of Compression

The swelling present with venous insufficiency increases the distance between the blood capillaries and the cells it supplies. Increased diffusion distance decreases the supply of needed oxygen and nutrition while increasing waste products and carbon dioxide accumulation. Accumulation of fluid

**TABLE 1**

**EXAMPLES AND MANUFACTURERS OF COMPRESSION DRESSINGS**

<table>
<thead>
<tr>
<th>Short-stretch bandages</th>
<th>Four-layer system</th>
<th>Inelastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 100% cotton, latex-free bandage that provides both compression and high resistance to stretch, increasing venous and lymphatic return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 70% elasticity, high working pressure, low resting pressure, and air permeable with woven edges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Used in multiple layers over limb padding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contains:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Layer one: padding bandage composed of a blend of synthetic materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Layer two: crepe bandage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Layer three: compression bandage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Layer four: cohesive bandage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples include: Rosidal K (Lohmann &amp; Rauscher, Rengsdorf, Germany) and Comprilan (BSN-Jobst, Rutherford College, NC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples include: Profore (Smith &amp; Nephew, Largo, Fla) and Four Press (Hartmann-Conco, Rock Hill, SC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examples include: Unna-Flex (Convatec, Greensboro, NC) and Gelocast Unna Boot (BSN-Jobst, Rutherford College, NC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY POINTS**

- Compression remains the cornerstone of venous ulcer care; various compression dressings and techniques are available.
- After reviewing the literature, the author concludes that comparative outcomes data are limited and that, all else being equal, some compression is better than no compression at all.
in the interstitium affects the microvascular and lymphatic systems, increasing capillary and venous afterload.\textsuperscript{10} Compression increases interstitial tissue pressure, reversing the fluid leak out of the capillary bed back into the blood stream, partially collapsing the superficial veins, reducing the diameter of the vessel, and increasing the return of blood through the venous system.\textsuperscript{12} Compression also has been shown to increase fibrinolytic activity; removal of excess fluid has been shown to suppress proliferation of keratinocytes, fibroblasts, and vascular endothelial cells.\textsuperscript{8,9}

**Current Approaches**

Current evidence-based practice for the treatment of venous insufficiency and venous ulcers includes compression.\textsuperscript{1,5,10–15} Studies\textsuperscript{16} of adults in home care in the US, UK, and Canada have shown the ability of short-stretch, four-layer, and long-stretch bandages to increase venous return and healing rates (see Table 1). Because not all compression options are available in a given region, practitioners may be limited in product selection. With regard to overall practicability, when applied correctly, one method has not been shown to be significantly more effective than another; this may lessen clinician concern about restricted availability.

In comparing the studies regarding compression options, it is important to consider the terminology utilized for the type and degree of compression in each study. After systematically reviewing 22 trials of venous leg ulcer compression, Cullum et al\textsuperscript{17} categorized bandages based on retention, support, compression, and performance in standardized lab tests. Classes include Class 1 (retention type), Class 2 (support type), and Class 3 (compression type), which then has four subcategories based on the amount of compression (ranging from class 3a — 14 mm Hg to 17 mm Hg — to class 3d — up to 60 mm Hg compression at the ankle). These bandages can be combined into compression systems such as short-stretch/inelastic, inelastic paste system, Unna’s boot, three-layer elastic, and four-layer elastic.\textsuperscript{15} These systems are compared in the following review of the literature.

**Literature Review**

A search of English-language literature contained in the Cumulative Index to Nurse and Allied Health Literature\textsuperscript{©} (CINAHL), Pub Med, Elton B. Stephens Company (EBSCO), UpToDate, The Cochrane Library, and the National Guideline Clearinghouse was conducted using the search terms short-stretch bandages and wound care, compression bandages and wound care, compression and venous ulcers, four-layer compression and venous ulcers, and multilayer compression and venous ulcers. Data from evidence-based research and literature reviews from 1997 to 2006 were examined and 25 publications were located and reviewed. Seven met the criteria of comparing short-stretch compression to four-layer compression for the treatment of venous ulcers — ie, studied the effects of compression using the specified bandage system with measurable results from the prospective trial(s) or meta-analysis of trials. The purpose of the literature review was to determine if current evidence supported the practice in place at the author’s lymphedema clinic of using short-stretch bandages in the treatment of venous ulcers.

**Effect on venous reflux.** Partsch et al’s\textsuperscript{18} quantitative study of inelastic bandages in 21 patients with venous ulcers and deep venous refluxes, using venous volume (VV) and venous filling index (VFI) as quantitative parameters, showed that short-stretch bandages were able to impede venous reflux more effectively than elastic material. The elastic material needs a higher compression pressure to achieve the same reduction in venous volume and improvement in venous reflux, a pressure that could not be tolerated well during ambulation and not tolerated at all in patients when they are sitting or supine.

Study results also showed four-layer bandages were similar to short-stretch bandages in the immediate decrease of edema and the reduction in venous volume; hence, a four-layer system was recommended for two reasons: 1) the technique for application would not require special training, and 2) compression pressure can be maintained for a longer period of time and require fewer follow-up visits. The specific time period for re-application of the four-layer compression was not reported; however, the short-stretch bandages required re-application every 24 hours.

**Controlled clinical studies.** In a randomized control trial (RCT) of 387 adults to compare a four-layer system and short-stretch compression bandages...
(comprised of one layer of padding and one to two layers of compression bandages), Nelson et al. found a statistically significant increase (hazard ratio 0.72, 96% confidence interval, 0.57 to 0.91) in the probability of healing with the four-layer bandage system. The median time for healing was 92 days for the four-layer bandage system compared to 126 days with the short-stretch system.

A 53-patient randomized trial of venous ulcer treatment by Scriven et al. showed short-stretch and four-layer compression bandages tested were equally efficacious but the short-stretch arm of the trial that used padding and only one short-stretch bandage required an additional retention bandage to prevent sliding of the compression bandage between dressing changes.

Franks et al.’s 24-week multicenter, prospective, randomized clinical trial (N = 159) conducted among adult outpatients with leg ulcerations caused by venous ulcers who used cohesive short-stretch versus four-layer bandaging showed no evidence that either bandage system was superior. Healing in patients with mobility issues who used short-stretch compression was not impaired compared to the four-layer arm of the study, implying that muscle pump function was not imperative to the use of short-stretch bandages.

**Literature reviews.** In their systematic review of the clinical and cost-effectiveness of compression bandage systems for the treatment of venous leg ulcerations for the Cochrane collaboration, first published in 2001, Cullum et al. evaluated 23 RCTs. The conclusion and implication for practice was that compression improves healing compared to no compression. No particular system was identified as superior to another, only that the proper application of high compression, especially in the presence of venous disease, is necessary. Four-layer and short-stretch bandages resulted in higher rates of healing when compared to paste bandages plus an outer support bandage commonly used in the US.

Davis et al.’s literature review found varied results in comparing paste bandages (Unna’s boot) to multilayered bandages, a finding that established no differences between the compared bandages. In a comprehensive literature review by Puffett et al., three RCTs and one review of trial results concluded that venous
leg ulcerations respond better when compression is initiated. A similar literature review by Lorimer et al. concluded that a high degree of compression (30 mm Hg to 40 mm Hg) was better than low compression (<20 mm Hg) with no specific bandage system recommended. Guidelines suggest that compression in the range of 30 mm Hg to 40 mm Hg is the most effective level for uncomplicated venous ulcers with adequate arterial competency.

Of note: Equally important to determining venous ulcer care plans is the measurement of the arterial brachial index (ABI) before initiating any compression protocol. Current literature suggests implementation of compression with care and caution in persons with non-venous or mixed arterial venous disease and an ABI between 0.7 and 0.9. Compression may be used safely in persons with an ABI >0.9 in the absence of arterial or other non-venous disease.

Discussion
The purpose of this overview of the literature was to determine if the use of short-stretch compression bandages is as effective as a four-layer compression bandage system in managing edema related to venous insufficiency in the treatment of adult patients with venous ulcers to better guide care. Current literature meeting the criteria for comparison, including a quantitative study, three controlled clinical studies, and four literature reviews, supports the current practice within the author's clinic of using either short-stretch or four-layer bandages at high compression in the management of venous ulcers. However, there appears to be a learning curve associated with the application of multiple layer bandages that must be considered in practice.

Conclusion
Based on the research and evidence presented from these studies, it can be concluded that compression is imperative to venous ulcer healing. Light compression is more effective than no compression at all. Patients and clinicians should be able to make an educated choice between short-stretch or four-layer systems; healing rates are similar in both. A compression system that patients and their healthcare providers can easily apply will increase the ability to carry out prescribed protocols. It is also evident that compression is only one piece of a process required in the complex treatment of venous ulcers. Each patient must be thoroughly assessed and compression guidelines, including consideration of ABI, must be followed.

Current research demonstrates that the use of short-stretch compression bandages is as effective as a four-layer compression bandage system in the treatment of adult patients with venous ulcers with only one study demonstrating appreciable differences in wound healing times. Both systems decrease healing time as compared to the Unna’s boot system. Compression should be applied by trained providers to ensure provision of appropriate evidenced-based care. Clinical and research-based evidence justifies that implementing and utilizing various modes of compression, pending ABI, is better than no compression in the treatment of venous insufficiency.

References
10. Macdonald JM, Sims N, Mayrovitz HN. Lymphedema,


