A comparison of sub-bandage pressures produced with two multi-layer bandaging systems

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Fourteen nurses with experience in the use of high-compression bandaging were asked to bandage the same limb with two different bandaging systems: the ‘Charing Cross’ four-layer regimen (System A), and a modified system incorporating two new bandages (System B). A sub-bandage pressure monitor was used to quantify the efficacy of the resulting bandaging for the two systems.

The results indicated that there was no significant difference between site sub-bandage pressures achieved using the two bandaging systems. Sub-bandage pressure profiles, however, fluctuated with patient posture, the best profiles being obtained with System B and the patient in the sitting position.

References
11. The volunteer had a 30-minute rest period after each bandage application in order to allow intercapillary pressure to return to its normal level.

Data analysis and statistical methods
All pressure measurements were stored in a dBase V relational database on a PC-compatible computer and analysed using the SPSSpc statistical package. Inter-bandaging system comparisons of site pressure values and postural bandage proficiency scores were analysed using the non-parametric Mann Whitney U-test, and intra-posture comparisons of bandage proficiency scores for each bandaging system were analysed using the Wilcoxon matched pairs sign rank test. Distribution-free or non-parametric statistics were used in preference to parametric statistics (the unpaired and paired T-test), because the conditions associated with the statistical model for the data could not be met (the data
Leg ulcers are a chronic condition, painful and debilitating for patients. They are notoriously difficult to treat and have a high recurrence rate. Treatment costs are extremely high due to the nursing time required and the products used. The care normally given in the community has proved largely ineffective in treating these patients, with low healing rates being achieved.

The Riverside project identified the efficacy of using sustained compression in the treatment of venous leg ulceration, achieving a healing rate of 74% at 12 weeks using the Charing Cross four-layer bandaging regimen (comprising Velaband wadding, crêpe, Elset and Coban bandages).

These results were emulated by Taylor et al in a prospective randomised study that compared high-compression bandaging using the Charing Cross system with conventional district nurse/GP treatment (using dressings available on FP10). The healing rates achieved at 12 weeks were 75% with the four-layer system and only 21% with conventional treatment. The study highlighted the need for expertise and skill in the application of compression bandaging.

As a consequence of this work, Salford Community Healthcare Trust introduced a team of specialist nurses to support and provide extra training for district nurses in the management of leg ulcers. Since the introduction of the specialist team approach and the use of the Charing Cross four-layer bandaging system, the 12-week healing rate has been improved to 62% of all venous ulcers.

Calculations suggest that a pressure level of 35-40mmHg is required at the ankle in order to reverse venous hypertension. The British Standard for compression hosiery requires a gradual reduction in pressure from the ankle to the knee of at least 70%. The four-layer high-compression bandaging system was introduced as the modality to achieve this therapy, securing a sub-bandage pressure of approximately 40mmHg at the ankle, graduating down to 17mmHg just below the knee, and maintaining these levels until the bandage is removed.

Three of these four layers (Velaband, Elset and Coban) were, until recently, not available on FP10, making this treatment expensive and restricting its availability to NHS patients. The cost of compression bandages to a trust such as this, supporting a population of approximately 227,000 people of whom 17% are over the age of 65 years, is in the region of £17,000 per annum (estimate based on a service with nine community leg ulcer clinics and three community healed-ulcer clinics, treating a total of 70-100 patients per week).

Two new bandages have been introduced for use in a multi-layer system (K-Lite and K-Plus). These are less expensive than the crêpe and Elset components and are also available on FP10. To date no clinical trials have been undertaken to measure the effectiveness of these two bandages within the four-layer system. The purpose of this study was to compare the sub-bandage pressures achieved using the standard Charing Cross four-layer system (System A) and the modified system using the new bandages (System B).

### Method
Fifteen district nurses (grades D to H) with proven skills and expertise (ENB 18 or specific training from specialist nurses) in applying high-compression bandaging were recruited from Salford Community Healthcare Trust for the study. They were given the opportunity to practise bandaging using the modified

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did not have a normal distribution and population variances were not the same). A probability value of < 0.05 was taken to indicate statistical significance.

**Results**

Figs 1 to 4 show the sub-bandage pressure profiles for the two bandaging systems in the four postures. The profiles obtained in the semi-recumbent position show that, although there should be a graduated decrease in pressure from the ankle to the knee, in most cases the sub-bandage pressure tends to rise from the ankle to the calf, then fall rapidly from the calf to the knee. This trend is also seen in both bandaging systems with the volunteer in the standing position, both with feet flat and with plantar flexion. It is only in the sitting position, and more so in the case of the new system, that the profiles appear to be graduated between the ankle and knee.

In view of the varying pressure levels recommended in the UK and Europe, and in order to simplify the data analysis, the pressure measurements for each posture and each bandaging system were rationalised into a bandaging proficiency score using the criteria outlined in Table 1. The proficiency score was derived from the British Standard for compression hosiery, and was applied to the data because a wide range of pressures were deemed acceptable, provided that there was a graduated pressure gradient between the ankle and the knee. Tables 2 and 3 detail the resulting bandage proficiency scores using the two systems.

Statistical analysis revealed there to be no significant differences between the two bandage types in the sub-bandage pressures achieved at each site. Bandage proficiency scores altered as a function of posture, the most desirable profiles being obtained with the volunteer sitting with a knee angle of 90°.

Considering comparisons between the two bandage types as a function of posture, System B resulted in bandaging profiles in the sitting position (12 ‘good’, one ‘adequate’, one ‘poor’) that were significantly better (p = 0.0372) than those produced by System A (six ‘good’, eight ‘adequate’). However, care should be exercised in interpreting this result in view of the number of inter-comparisons made and the moderate level of significance. The worst profiles were exhibited when the volunteer was standing with feet flat or with plantar inflexion, as when walking. Here, typically, only 64.3% of the pressure profiles were found to be ‘good’ or ‘adequate’.

**Discussion**

Graduated compression is now recognised as the single most important form of treatment for the management of venous leg ulcers. Since most people’s legs are narrower at the ankle than the knee, graduated compression should be achieved naturally by applying the bandage at the same tension all the way up the leg (Laplace’s Law). The bandage profiles recorded in Figs 1-4 generally showed an increase in pressure at the widest point of the calf; this must be due to the nurses unknowingly increasing the tension as they wrapped the bandage around the calf, a phenomenon that has already been documented.

The almost perfect sub-bandage pressure profile achieved when the patient is sitting with an angle of 90° at the knee raises interesting questions. Compared with the profile achieved in the semi-recumbent position, it is evident that the calf pressure falls when the individual changes to the sitting position. The decrease must be due to an increase in calf circumference as a result of relaxation.
and contraction of the calf muscle. The ankle and knee sub-bandage pressures seem very similar to those obtained in the semi-recumbent posture. On the basis that a higher calf pressure would be expected to increase venous hypertension at the ankle and delay healing, it would be more beneficial for a patient to remain in the sitting position while this bandage system is applied.

The recent inclusion of compression bandages on the Drug Tariff has implications for nurses working in primary care, who are under pressure to provide measurable outcomes such as improved healing rates and cost-effectiveness. The Charing Cross four-layer system has been identified as the ‘gold standard’. Prior to the introduction of compression bandages on the Drug Tariff, some trusts held budgets to purchase bandages through regional stores, where the bulk price is less expensive than the price on FP10. The experimental system used in this study is approximately 15% less expensive than the Charing Cross system when purchased both on FP10 and through regional stores.

Previous research data identified that the cost savings using four-layer bandaging can be attributed to a reduction in the number of treatments needed and more rapid healing rates. A variety of compression bandages is available on the Drug Tariff. Those that provide sustained graduated compression for at least a week are more cost-effective than bandages requiring frequent dressing change.

Accurate assessment of the underlying aetiology, together with the skills and expertise of the nurse applying the compression bandages, will have implications for successful healing and are important factors in measuring cost-effectiveness and healing rates.

The findings of this study provide evidence that there is no significant difference in sub-bandage pressures at individual sites, or in the overall bandaging pressure profiles, between the Charing Cross and the modified bandaging systems. However, in order to confirm the efficacy of the new system over time, it would be necessary to carry out a prospective randomised controlled study comparing healing rates in patients using the modified bandaging system with those treated using the standard Charing Cross regimen.

This study was undertaken with financial support and the use of bandages from Parema Limited, Loughborough.