ELSEVIER

Use of Compression Stockings in Chronic Venous Disease: Patient Compliance and Efficacy

Seshadri Raju, Kathryn Hollis, and Peter Neglen, Flowood, Mississippi

Compressive stockings are considered the centerpiece of treatment in chronic venous disease (CVD). It is known that stockings fail in some patients for varied reasons: they are ineffective despite wear in some, but more commonly patients are unable or unwilling to use them as prescribed. Detailed statistics regarding stocking compliance have not been available except in a few selected series focused on leg ulcers. This study focuses on use, compliance, and efficacy of compression stockings among a large cohort of patients referred to a tertiary venous practice. A total of 3,144 new CVD patients were seen from 1998 to 2006. As a referral practice, patients had been under the care of primary-care physicians or specialists for variable times before. A detailed history of past and present compressive regimens was part of our initial evaluation of CVD patients. These data were entered into a time-stamped electronic medical record and later analyzed. Only 21% of patients reported using the stockings on a daily basis, 12% used them most days, and 4% used them less often. The remaining 63% did not use the stockings at all or abandoned them after a trial period in the past. The primary reasons given for nonusage were as follows: unable to specify a reason, 30%; not prescribed by the primary physician, 25%; did not help, 14%; binding/"cutting off" of circulation, 13%; "too hot" to wear, 8%; limb soreness, 2%; poor cosmetic appearance, 2%; unable to apply without help, 2%; contact dermatitis or itching, 2%; and other (cost, work situation, etc), 2%. Multiple factors were cited by 8%. Surprisingly, there was no difference in compliance between men and women (39% vs. 38%) or among different decile age groups. Compliance was relatively better at 50% in patients who gave a prior history of deep vein thrombosis ($n = 675$) compared to 35% in those without such a prior history ($n = 2,437$) ($p < 0.0001$). Compliance was poor in CEAP lower (0-2) as well as higher (3-6) clinical classes ($p =$ nonsignificant). Overall compliance with stockings was low and statistically not different in several subsets with significant symptoms: compliance in pain, 39%; swelling, 37%; stasis dermatitis, 46%; and stasis ulceration, 37%. Compliance was relatively better with longer duration of symptoms: <1 year, 25%; 1-5 years, 34%; 6-10 years, 40%; >10 years, 44% ($p < 0.003$). Symptoms were still persistent in about a third (37%) of the patients despite apparent compliance with prescribed stockings. Compressive stockings are inapplicable in about a quarter of patients due to the condition of the limb or the general health of the patient. They are ineffective despite wear in about a third of patients seen. In the remainder, noncompliance with prescribed compressive stockings is an apparent major cause of treatment failure. Noncompliance is very high in patients with CVD regardless of age, sex, etiology of CVD, duration of symptoms, or disease severity. The reasons for noncompliance can be grouped into two interdependent major categories: (1) wear-comfort factors and (2) intangible sense of restriction imposed by the stockings.

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University of Mississippi Medical Center and River Oaks Hospital, Flowood, MS.

Correspondence to: Seshadri Raju, MD, 1020 River Oaks Drive, Suite 420, Flowood, MS 39232, USA, E-mail: rajumd@earthlink.net

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INTRODUCTION

Compressive stockings are often prescribed as the first choice of treatment in chronic venous disease (CVD). In many medical practices around the world it may be the only treatment offered as alternative therapies are unknown, unavailable, or not

accepted. However, some patients are unable to wear compressive stockings because of the local limb condition or their general health. Stockings fail to relieve symptoms in some others despite wear. There has been substantial research on compression failure in this group, focused on compression mechanics such as the degree and gradation of pressure applied. It is also known that a significant cause of stocking failure is simple noncompliance. It is generally assumed that such noncompliance is largely due to inadequate patient education. In some health systems, substantial health resources have been expended to motivate patients and monitor compression usage to improve outcomes.[1] However, noncompliance is a problem even under direct physician supervision, ranging from 21-67%, which suggests factors beyond patient education in nonuse.[2-4] The scope and extent of noncompliance and the underlying reasons for it have received relatively little attention in the literature. Most published reports involving compression, including many cited herein, do not provide compliance data, i.e., intent to treat results.[5,6] Furthermore, available information on the subject has largely focused on leg ulcer recurrence[4,7] to the exclusion of other CEAP clinical classes. Compliance statistics are important because there is general agreement that noncompliance is a cause of compression therapy failure.

PATIENTS AND METHODS

A total of 3,144 new CVD patients were referred during 1998-2006 to this clinic after they had been under the care of family practitioners or other specialists for variable periods of time. The case mix has varied from simple varicose veins to more complex ones involving the deep venous system.

The median age of the study cohort was 58 years (range 17-92). The male to female ratio was 1:2. The clinical class (CEAP) of the more symptomatic limb was as follows: C0-2, 67%; C3, 22%; C4, 4%; C5, 4%; C6, 3%. Etiology was primary 58% and postthrombotic 42%.

A detailed history of compressive devices used past and present was part of a comprehensive initial clinical evaluation. These data were acquired by either of the physician authors during a face-to-face interview at the initial clinical evaluation. Patients were asked if they were prescribed support stockings by the primary physician and if they were wearing them and at what frequency. Daily wear was marked as "regular use." Less consistent use was marked as "most days" if they omitted usage on some days, typically weekends or to church. Some patients used them even less frequently, wearing them "sometimes" or seasonally omitting usage during summer months, which was marked as "infrequent use." This gradation corresponded to the classification used in venous severity scoring.[8] If the patient admitted to nonusage, the reason for such was enquired and recorded. Clinical data were entered prospectively into a time-stamped electronic medical records program for retrospective analysis. The program allows the physician to choose from a customizable set of most frequently cited reasons for noncompliance, with provision to enter infrequently cited reasons in free form. The degree of compression prescribed by the primary physician was not recorded as this information could not be obtained reliably in the majority of the patients. The term "noncompliance" is used synonymously with "nonusage" (regardless of the reason) in this report.

Data Analysis

A commercially available statistical program (Graph Pad Prism for Windows, version 3.0; GraphPad Software, San Diego, CA) was used for statistical analysis. Nonparametric Wilcoxin's rank test for unpaired data and the chi-squared test were used to compare groups as appropriate. $p < 0.05$ was considered significant.

RESULTS

Statistics for compression use are shown in Figure 1. Only 37% of patients reported either full or partial compliance; 63% did not use the stockings at all or abandoned them after a trial period in the past. The primary reason given for nonusage is listed in Table I. Thirty percent of noncompliant patients could not state a specific reason they disliked using stockings. Multiple reasons were cited by 8% of patients. Overall compliance was low in subsets: surprisingly, there was no difference in compliance between men and women (39% vs. 38%) or among different decile age groups, as shown in Figure 2 (median compliance 35%, range 26-41%). Compliance was relatively better at 50% in patients who gave a prior history of deep vein thrombosis (DVT, $n = 675$) compared to 35% in those without prior history of DVT ($n = 2437$) ($p < 0.0001$). Compliance was low and similar in CEAP classes C0-2 ($n = 677$) and C3-6 ($n = 349$), 42% vs. 46% ($p =$ nonsignificant). Overall compliance with stockings was low and statistically not different in several subsets with significant symptoms of pain, swelling, stasis

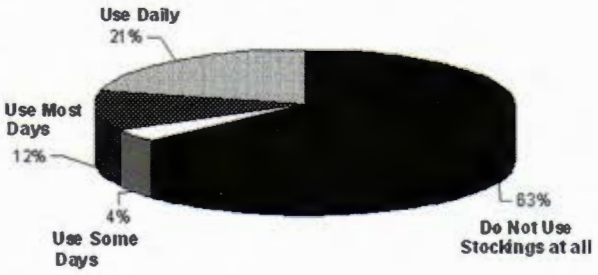

Fig. 1. Compliance with stockings among 3,144 patients with CVD. Nearly two-thirds of patients were not using stockings.

Table I. Reasons for nonuse of stocking

	%
Unable to state a specific reason	30
Not recommended by doctor	25
Ineffective, did not help	15
Binding, cutting off circulation, poor fit	13
Too hot	7
Soreness	2
Needs application assistance	2
Cosmetic, poor appearance	2
Aggravating, itching, dermatitis	2
Made symptoms worse	1
Lack of self-discipline	0.5
Cost considerations	0.4
Work-related	0.2

dermatitis, or ulceration (Fig. 3). Compliance tended to improve significantly ($p < 0.003$) with longer duration of symptoms in the context of overall low usage (Fig. 4). "Compliance" was given a generous definition in the above data analysis. Any degree of stocking use from regular to most days to infrequent use (grade 1-3 per venous severity scoring) was interpreted as compliance in data shown in Figures 1-4.

DISCUSSION

Data Validity

The data provide a regional snapshot of prescription practice, usage patterns, and compliance with compression stockings in CVD. A wide spectrum of clinical classes is covered. The patients surveyed herein are necessarily a selected group; those who were referred had symptoms, which possibly skewed against patients who may have become asymptomatic after being compliant with prescribed compression. Nevertheless, compliance data are of importance precisely in this group, which is a large one, who have persistent symptoms, i.e., the selected series covered in this study.

Efficacy of Compression Stockings: The Evidence

Compression has been used to treat CVD since antiquity. Many of the practices and concepts related to it have become ingrained due to tradition and long usage. Yet, there is much that remains unknown regarding compression therapy, and many of the established beliefs are yet to be validated by strict evidence criteria. There is general agreement that support stockings can ameliorate symptoms of pain, swelling, and stasis skin changes including ulceration in CVD in the near term.[4,9,10] Long-term efficacy, particularly in healing of stasis ulceration, remains unknown as very few studies meeting evidence criteria have been extended beyond a year.[11] In a recent randomized trial (ESCHAR), ulcer recurrence beyond a year with compression alone was significantly higher compared to compression and superficial venous surgery.[12] This is thought to be due to either recidivism of noncompliance with chronic use or inadequate pressure exerted by the stocking used.[4,13] Ulcer healing is known to require higher compression than for relief of edema or pain.[4,5,14,15] Stocking use has prophylactic benefit in the prevention of postthrombotic syndrome;[16,17] there is no information on this topic in "primary" venous disease. The precise mode of action of compression is unknown, though a variety of hemodynamic effects, some of them contradictory, have been described.[18-24] The variable hemodynamic effects may be related to variable pressure exerted by stockings in different studies. Other critical questions regarding compression therapy remain to be answered: it is not known if compression is less effective in treating postthrombotic disease than primary disease or if it is as effective in treating outflow obstruction compared to reflux pathology. Relative efficacy in superficial, perforator, or deep disease has not been explored in dedicated studies; ancillary data from the ESCHAR trial suggest that deep reflux can be controlled by compression. Control of deep reflux probably requires a higher degree of compression than afforded by class 1 stockings.[25] Higher compression will likely result in higher noncompliance however (see later). Compression results have largely focused on ulcer healing in CVD, with relatively sparse attention to relief of pain and swelling, which are important outcome measures and a possible factor in noncompliance as well. Quality-of-life metrics[26] and

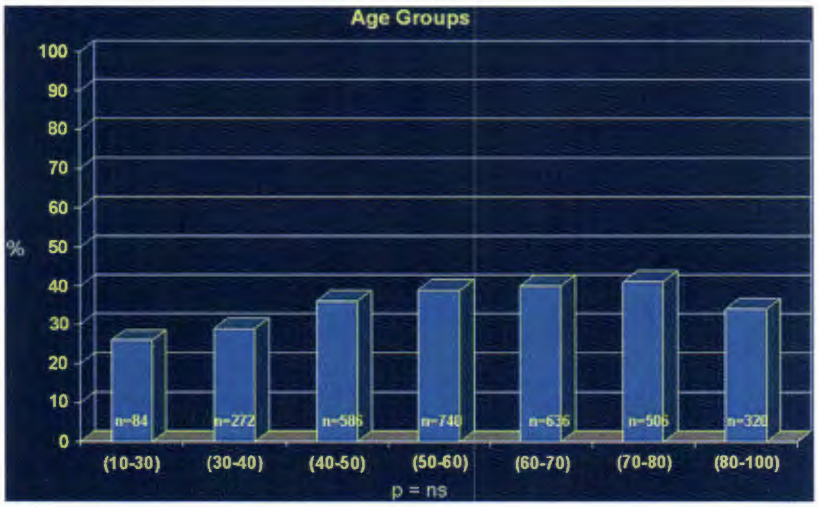

Fig. 2. Stocking use among various decile age groups. Compliance was similar in all age groups.

venous severity scoring schemes[10] are just beginning to be employed in compression studies. The current report is a clear indication that most patients consider stocking use as a quality-of-life issue in and of itself.

There are practical difficulties in mounting a well-controlled study with compression stockings. There is wide variability of compression afforded by different devices and protocols, and there is a dearth of monitoring mechanisms to ensure consistency of use. Even stockings that carry the same pressure rating vary considerably in efficacy due to differences in material, fabrication techniques, stiffness, fit, and durability in daily wear.[27-31] Efforts at standardization to reduce this bewildering variability and at measurement of the physical characteristics of the compressive devices have just begun.[13,31,32] Compression is often employed in an empiric fashion without detailed investigations,[33] resulting in a dearth of data regarding causes of compression failure particularly related to underlying pathology. Recurrence rates have been widely variable among the many reported compression studies. It is not known to what extent the variable results are due to variable underlying pathology, ineffective compression (hence the importance of standardizing compression), or simple noncompliance.

Stocking Use in Current Survey

Most patients referred to this service were symptomatic from CVD with occasional exceptions (<1%) who were asymptomatic but required reassurance regarding varices or fear of "blood clots." Symptomatic patients could be broadly classified into three overlapping categories with regard to stocking use:

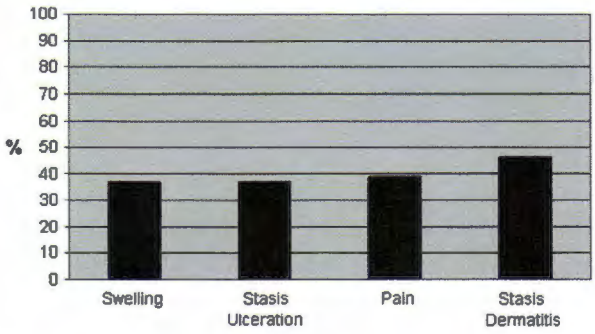

Fig. 3. Stocking compliance was poor in spite of significant symptoms. There was no difference in stocking use among the various subsets (p = nonsignificant).

(1) stocking users who continued to be symptomatic, (2) patients who were unable to use stockings, and (3) patients who were unwilling to use stockings. These categories are further amplified below.

A third of the patients in this study were compliant and still symptomatic. Another 14% of patients cited lack of efficacy as the reason for abandoning compressive stockings.

In about a quarter of the patients surveyed, the primary physician had not prescribed stockings; in most such instances, this seemed appropriate to the authors as the local condition of the limb (e.g., fragility of the skin, massive swelling, or ulceration) or the general condition of the patient (e.g., frailty of old age, arthritis, extreme obesity) would have precluded effective usage.

By far the largest group in this survey (>50%) were patients who were unwilling to use stockings for various stated and unstated reasons. Compliance was poor regardless of age, sex, duration,

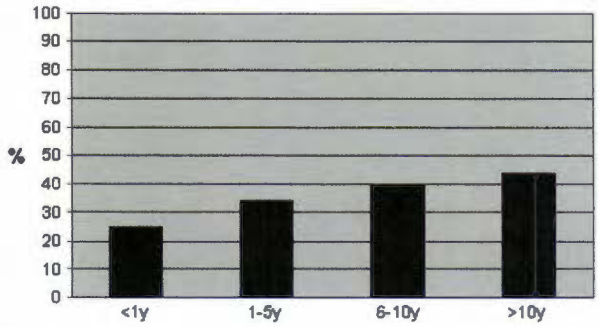

Fig. 4. Stocking use increased with longer duration of symptoms. Compliance with less than 1-year duration of symptoms was 25%. Compliance (34-44%) improved significantly after the first year of symptoms ($p < 0.003$). Compliance (44%) after 10 years of symptom duration was significantly better than stocking use (34%) in the 1-5 year group ($p < 0.015$). However, there were more nonusers than users, even after 10 years of symptoms.

and severity of disease. In the context of overall low compliance, statistically significant compliance improvement was observed in some subsets. Fear of blood clots, which is pervasive among patients with a prior history, could account for somewhat improved compliance in this subset. Repeated reinforcement of the importance of compression often by multiple physicians during multiple visits to the same or different clinic could be an explanation for marginally better compliance in patients with a long history of the disease. Paradoxically, many patients with minor symptoms more easily controlled with compression also appear to want to go without stockings, preferring to suffer the symptoms instead.

Specific reasons or excuses cited by patients for nonusage are many. The referral area served by the practice is warm and humid during summer months. Objection to stocking use for this reason was cited by 7% of patients. Objection to use can be divided into two broadly overlapping interdependent categories: (1) tangible complaints related to physical properties of the device such as fit, warmth of the fabric, and the sensation of pressure imparted on wear and (2) intangible complaints related to restriction of lifestyle imposed by the daily routine of stocking wear. Many of the 30% of patients who would not cite a specific reason for nonusage probably fall under this category. Admitted nonusage due to cosmetic considerations was quite small and was equally represented in both sexes in this study. Cost also was a minor stated factor. Similar findings have been reported in a compliance study of leg ulcer patients.[34]

Can Compliance Be Improved?

Most physicians see little harm to an initial trial of a compression device. (In a recent meeting of venous specialists, few in the audience had tried support stockings themselves.) Many private and most government insurance programs require the use of compressive stockings for 3-6 months before funding for alternative therapies could be considered. The rationale for mandating such therapy appears to be that the device is innocuous and safe and there should be little additional burden on the patient in trying what is after all a variation of the garment in daily common use. However, the current survey indicates that roughly three-fourths of the patients could not or would not use the device. Compression stockings, whether of the "approved medical grade" or "off-the-shelf" variety available without prescription in drugstores, provide significantly more compression than the daily stocking. It is this property which is at the core of its efficacy and is directly or indirectly at the root of noncompliance among patients (Table I). Future advances in fabrics and fabrication of the devices may ameliorate some or most of the tangible complaints. Stocking fabrics could be more breathable, and design innovations may yield devices that are easy to put on and apply pressure gradually or even intermittently. Solutions to intangible objections are not as readily apparent. Some compression experts have argued that poor patient education is at the root of noncompliance.[7,35] Physician involvement in patient education probably increases compliance.[34] However, the relatively high noncompliance in dedicated programs with intensive patient education and ongoing monitoring suggests that noncompliance is due to other factors and will remain high despite such efforts.[2-4]

REFERENCES

1. Moffatt CJ, Franks PJ, Oldroyd M, et al. Community clinics for leg ulcers and impact on healing. BMJ 1992;305: 1389-1392.
2. Erickson CA, Lanza DJ, Karp DL, et al. Healing of venous ulcers in an ambulatory care program: the roles of chronic venous insufficiency and patient compliance. J Vasc Surg 1995;22:629-636.
3. Mayberry JC, Moneta GL, Taylor LM, Jr, Porter JM. Fifteen-year results of ambulatory compression therapy for chronic venous ulcers. Surgery 1991;109:575-581.
4. McMullin GM. Improving the treatment of leg ulcers. Med J Aust 2001;175:375-378.
5. Cullum N, Nelson EA, Fletcher AW, Sheldon TA. Compression for venous leg ulcers. Cochrane Database Syst Rev 2001;2. CD000265.
6. Scriven JM, London NJ. Regarding "Healing of venous ulcers in an ambulatory care program: the roles of chronic

venous insufficiency and patient compliance." J Vasc Surg 1996;24:905.
7. Moffatt CJ. Factors that affect concordance with compression therapy. J Wound Care 2004;13:291-294.
8. Rutherford RB, Padberg FT, Jr, Comerota AJ, Kistner RL, Meissner MH, Moneta GL. Venous severity scoring: an adjunct to venous outcome assessment. J Vasc Surg 2000;31: 1307-1312.
9. Marston WA, Carlin RE, Passman MA, Farber MA, Keagy BA. Healing rates and cost efficacy of outpatient compression treatment for leg ulcers associated with venous insufficiency. J Vasc Surg 1999;30:491-498.
10. Motykie GD, Caprini JA, Arcelus JI, Reyna JJ, Overom E, Mokhtee D. Evaluation of therapeutic compression stockings in the treatment of chronic venous insufficiency. Dermatol Surg 1999;25:116-120.
11. Nelson EA, Bell-Syer SE, Cullum NA. Compression for preventing recurrence of venous ulcers. Cochrane Database Syst Rev 2000;4. CD002303.
12. Barwell JR, Davies CE, Deacon J, et al. Comparison of surgery and compression with compression alone in chronic venous ulceration (ESCHAR study): randomised controlled trial. Lancet 2004;363:1854-1859.
13. Veraart JC, Pronk G, Neumann HA. Pressure differences of elastic compression stockings at the ankle region. Dermatol Surg 1997;23:935-939.
14. Hirai M, Nukumizu Y, Kidokoro H, et al. Effect of elastic compression stockings on oedema prevention in healthy controls evaluated by a three-dimensional measurement system. Skin Res Technol 2006;12:32-35.
15. Partsch H, Winiger J, Lun B. Compression stockings reduce occupational leg swelling. Dermatol Surg 2004;30:737-743.
16. Prandoni P, Lensing AW, Prins MH, et al. Below-knee elastic compression stockings to prevent the post-thrombotic syndrome: a randomized, controlled trial. Ann Intern Med 2004;141:249-256.
17. Brandjes DP, Buller HR, Heijboer H, et al. Randomised trial of effect of compression stockings in patients with symptomatic proximal-vein thrombosis. Lancet 1997;349:759-762.
18. Agu O, Baker D, Seifalian AM. Effect of graduated compression stockings on limb oxygenation and venous function during exercise in patients with venous insufficiency. Vascular 2004;12:69-76.
19. Ibegbuna V, Delis KT, Nicolaides AN, Aina O. Effect of elastic compression stockings on venous hemodynamics during walking. J Vasc Surg 2003;37:420-425.
20. Zajkowski PJ, Proctor MC, Wakefield TW, Bloom J, Blessing B, Greenfield LJ. Compression stockings and venous function. Arch Surg 2002;137:1064-1068.
21. Mayberry JC, Moneta GL, DeFrang RD, Porter JM. The influence of elastic compression stockings on deep venous hemodynamics. J Vasc Surg 1991;13:91-100.
22. Sarin S, Scurr JH, Coleridge Smith PD. Mechanism of action of external compression on venous function. Br J Surg 1992;79:499-502.
23. Christopoulos DG, Nicolaides AN, Szendro G, Irvine AT, Bull ML, Eastcott HH. Air-plethysmography and the effect of elastic compression on venous hemodynamics of the leg. J Vasc Surg 1987;5:148-159.
24. Evers EJ, Wuppermann T. Effect of different compression therapies on the reflux in deep veins with a post-thrombotic syndrome. Vasa 1999;28:19-23.
25. Partsch B, Partsch H. Calf compression pressure required to achieve venous closure from supine to standing positions. J Vasc Surg 2005;42:734-738.
26. Franks PJ, Moffatt CJ, Doherty DC, Smithdale R, Martin R. Longer-term changes in quality of life in chronic leg ulceration. Wound Repair Regen 2006;14:536-541.
27. van der Wegen-Franken K, Roest W, Tank B, Neumann M. Calculating the pressure and the stiffness in three different categories of class II medical elastic compression stockings. Dermatol Surg 2006;32:216-223.
28. Liu R, Kwok YL, Li Y, Lao TT, Zhang X, Dai XQ. Objective evaluation of skin pressure distribution of graduated elastic compression stockings. Dermatol Surg 2005;31:615-624.
29. van Geest AJ, Veraart JC, Nelemans P, Neumann HA. The effect of medical elastic compression stockings with different slope values on edema. Measurements underneath three different types of stockings. Dermatol Surg 2000;26: 244-247.
30. Neumann HA. Compression therapy with medical elastic stockings for venous diseases. Dermatol Surg 1998;24: 765-770.
31. Veraart JC, Daamen E, de Vet HC, Neumann HA. Elastic compression stockings: durability of pressure in daily practice. Vasa 1997;26:282-286.
32. Partsch H, Partsch B, Braun W. Interface pressure and stiffness of ready made compression stockings: comparison of in vivo and in vitro measurements. J Vasc Surg 2006;44:809-814.
33. Cullum N, Nelson EA, Fletcher AW, Sheldon TA. Compression bandages and stockings for venous leg ulcers. Cochrane Database Syst Rev 2000;2. CD000265.
34. Jull AB, Mitchell N, Arroll J, et al. Factors influencing concordance with compression stockings after venous leg ulcer healing. J Wound Care 2004;13:90-92.
35. Moffatt CJ. Perspectives on concordance in leg ulcer management. J Wound Care 2004;13:243-248.