J Wound Ostomy Continence Nurs. 2016;43(4):1-18.
Published by Lippincott Williams & Wilkins

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Compression for Primary Prevention, Treatment, and Prevention of Recurrence of Venous Leg Ulcers

An Evidence-and Consensus-Based Algorithm for Care Across the Continuum

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ABSTRACT

Chronic venous insufficiency is a prevalent disease that frequently leads to development of venous leg ulcers. While a number of evidence-based clinical practice guidelines have been developed that provide guidance for clinicians when caring for patients with chronic venous insufficiency, they lack adequate detail concerning selection and application of compression for prevention and management of venous leg ulcers. In order to address this need, the WOCN Society appointed a task force to develop an algorithm for compression for primary prevention, treatment, and prevention of recurrent venous leg ulcers in persons with chronic venous insufficiency. The task force used findings from a scoping literature review to identify current best evidence needed to support decision points and pathways within the algorithm. In addition, the task force convened a panel of 20 clinicians and researchers with expertise in lower extremity venous disorders in order to establish consensus around pathways and decision points within the algorithm lacking robust evidence. Following initial construction of the algorithm, a second interdisciplinary group of expert clinicians established content validity and provided additional qualitative feedback used to complete final revisions of the algorithm. This article reviews the process used to create this landmark algorithm, including generation of the evidence- and consensus-based statements used in its construction, the various pathways, and rich supplemental materials embedded within the algorithm, and the process used to establish content validity.

KEY WORDS: Algorithm, Chronic venous insufficiency, Compression, Venous ulcer, Venous leg ulcer, Wound.

INTRODUCTION

Lower extremity venous disorders encompass a spectrum of functional abnormalities of the venous system including chronic venous disease and chronic venous insufficiency (CVI). Clinical manifestations of CVI include leg pain, edema, skin changes such as hyperpigmentation (hemosiderosis), venous eczema, lipodermatosclerosis, and active or healed ulcers. In the United States, it is estimated that approximately 2.5 million people (between 10% and 35% of adults) have clinical manifestations of CVI.[1,2] Venous leg ulcers (VLUs) affect 600,000 Americans or 4% of adults 65 years of age or older[1]; these ulcers account for up to 90% of all leg ulcers. The prevalence of CVI and VLU are expected to grow as the population ages.[3]

Clinical outcomes in patients with CVI and VLUs are poor. Persons with CVI frequently experience delayed healing and up to 97% experience recurrent ulcerations.[4] Half of these recurrences will occur within 10 years of development of the first VLU,[2] consuming substantial health care resources. Ma and colleagues[5] evaluated the cost of treating VLUs in 84 patients residing in the United States. The mean direct cost of treatment over a 6-month period was $15,732. Sixty percent of participants (n = 50) achieved healing with a mean time of 122 days (range, 6-379 days); the average costs were $10,563 (range, $430-$50,967). Forty-four patients (52%) were treated with compression therapy and local ulcer care; their mean cost for VLU care was $12,304. Seventeen patients (20%) with VLUs did not heal in 6 months; their mean costs were $33,907 (range, $390-$321,730). Ma's group[5] measured only direct costs; their estimates did not include loss of income, and items not covered by insurance or travel to medical offices. Rice and associates[3] estimated the incremental per-patient and overall payer burden of VLUs in the United States; they extracted data from a Medicare and private insurer's databases and matched persons with VLU to persons without VLU. Persons with VLU who were ensured by Medicare incurred $6391 more costs ($418,986 vs $12,595) than age-matched subjects without VLU. Similarly, persons with private insurance coverage incurred $7030 higher costs ($13,653 vs $6623) than subjects without VLU. In addition, privately insured persons

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The authors declare no conflict of interest.

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DOI: 10.1097/WON.0000000000000242

with VLU missed more days from work than did persons without VLU (14 vs 10 days; $P < .0001$), resulting in significantly higher work loss costs.[3]

Compression is the oldest and most widely used intervention for management of CVI. Correctly applied compression therapy is the cornerstone of treatment and has been shown to improve healing rates in patients with existing VLUs and reduce the likelihood of ulcer recurrence.[2,6-10] High-quality systematic reviews indicate that primary prevention with compression stockings improve CVI-related symptoms such as aching and itching when compared to no compression.[2,8] Compression has also been shown to improve healing of VLU when compared to no compression.[2,7-9]

Despite multiple guidelines focusing on prevention and management of CVI and venous ulcers, application of compression in daily practice remains a challenge. While the various clinical guidelines concur that compression is a cornerstone of VLU treatment and prevention, they lack adequate detail concerning which form of compression is best for each patient.[2,7-9,11,12] This decision is especially complex, given the variety of influencing factors such as the goal of therapy (primary prevention of venous ulcers in patients with CVI, prevention of ulcer recurrence, or management of a current ulcer), patient tolerance, and variable resources needed to obtain and apply compression.

CONSTRUCTION OF THE ALGORITHM

In an effort to provide clinical guidance for providing individualized care to patients with CVI across the care continuum, the WOCN Society elected to develop an evidence- and consensus-based algorithm for compression in the patient with CVI. Society leaders assembled a Task Force of 3 expert clinicians in order to (1) identify evidence supporting the use of compression for prevention and management of VLU; (2) develop evidence-based statements needed to support the algorithm; (3) develop consensus-based statements needed to support decisions and pathways not supported by higher-level evidence; and (4) establish face validity of a first draft of the VLU algorithm. Subsequently, a group of 20 key opinion leaders was convened to review the draft algorithm and evidence-based supporting statements and reach consensus on statements lacking adequate supporting evidence. Finally, an independent group of clinicians with expertise in CVI and venous ulcer care was asked to review the algorithm, establish its content validity, and suggest changes. This article summarizes each of these steps in the development of this landmark algorithm.

Scoping Literature Review

Three certified WOC nurses (C.R., S.Y., and L.M.) with clinical expertise in chronic wounds of the lower extremity were appointed by WOCN Society leadership to act as a Task Force for generation and validation of the consensus and evidence-based algorithm for use of compression in the prevention and management of CVI and VLU. Task Force members began by identifying aims and search terms required for a scoping literature review. While the criteria that define a scoping literature search continue to evolve, it can be broadly defined as a synthesis of the literature that maps key concepts, types of evidence, and gaps in research by systematically searching, retrieving, and synthesizing current best evidence.[13,14] To maximize efficiency during this process, the Task Force appointed a facilitator (M.G.) with experience in this type of literature review and algorithm construction.

The scoping literature review was completed using the basic steps recommended by Colquhoun and colleagues.[13] This review was guided by the following aim: to identify evidence concerning the use of compression for prevention and management of CVI and VLU. The review was divided into 2 phases. In the first phase, we searched the literature from 2005 to 2015 in order to identify evidence-based clinical practice guidelines for prevention and management of VLU and CVI. The search terms for this search were "venous ulcers," "venous leg ulcers," "chronic venous insufficiency," "compression," and "clinical practice guideline" along with the MESH terms "varicose ulcers," "venous insufficiency," "compression bandages," "compression stockings," "intermittent pneumatic compression devices," and "practice guidelines." We searched the MEDLINE and CINAHL electronic databases, Cochrane Library of Systematic Reviews, and United States Agency for Health Research and Quality National Guideline Clearinghouse. We limited the search to guidelines published in English and supported by an explicitly defined methodology for systematic review and generation of recommendations for clinical practice. This search identified 8 clinical practice guidelines that met inclusion criteria; all were used in construction of the algorithm (Table 1).

A second literature search was then conducted of the MEDLINE and CINAHL electronic databases from 2010 through 2015. This review more closely used techniques identified for systematic literature reviews.[17] The aim of this phase of the scoping literature review was to identify the most recent studies focusing on the use of compression for prevention and management of CVI and VLU that may not have been included in the various Clinical Practice Guidelines identified during the first phase of our search. Key terms used for this search were "venous ulcers," "venous leg ulcers," "chronic venous insufficiency," "compression," and "clinical practice guideline" along with the MESH terms "varicose ulcers," "venous insufficiency," "compression bandages," "compression stockings," and "intermittent pneumatic compression devices." We limited the review to randomized controlled trials, systematic reviews with meta-analysis, and nonrandomized comparison cohort studies that examined the efficacy of various forms of compression on prevention and management of VLU, primary prevention of VLU in persons with CVI, studies comparing the various forms of compression, and studies evaluating adherence to compression (an essential component of effectiveness). We excluded studies comparing compression products not available in the United States, studies performed in healthy volunteers, studies measuring outcomes other than VLU healing in persons with CVI, and studies measuring intermediate outcomes such as the magnitude of compression created when specific compression devices are applied to the lower extremities. The search was also limited to studies published in the English language. This review yielded 151 titles. Following elimination of foreign language articles, duplicate publications, and articles not reporting original data, the search was limited to 50 papers. Each of the 3 task force members completed title and abstract search of the remaining 50 titles for relevancy. Based on this review, 17 articles were retrieved and read in full by each task force member to determine if the study met inclusion criteria. Methodological quality was judged for each study by all 3 Task Force members; the risk of bias varied from low to high and most studies were found to have moderate to higher risk of bias. Nevertheless, no study was eliminated based on methodological weaknesses alone. Disagreements

TABLE 1.
Clinical Practice Guidelines Used as Basis for Development of the Algorithm

Clinical Practice Guidelines			
Authors	**Year Published**	**Title**	**Source**
O'Donnell TF et al[2]	2014	Management of Venous Leg Ulcers	Society of Vascular Surgery and American Venous Forum
Nelson & Bell-Sayer[11]	2014	Compression for Recurrence of Venous Ulcers	Cochrane Library of Systematic Reviews
Nelson EA, Hillman A, Thomas K[15]	2014	Intermittent Pneumatic Compression for Treating Venous Leg Ulcers	Cochrane Library of Systematic Reviews
Shingler et al[12]	2013	Compression Stockings for the Initial Treatment of Varicose Veins in Patients Without Venous Ulceration	Cochrane Library of Systematic Reviews
O'Meara S et al[7]	2012	Compression for Venous Leg Ulcers	Cochrane Library of Systematic Reviews
Scottish Intercollegiate Guidelines Network[16]	2012	Management of Chronic Venous Leg Ulcers	National Health System Quality Improvement Scotland
Kelechi TJ, Johnson JJ[8]	2011	Guideline for Management of Patients With Lower Extremity Venous Disease	Wound, Ostomy and Continence Nurses Society
Anonymous[9]	2010	Association for Advancement of Wound Care: Venous Ulcer Guideline	Association for Advancement of Wound Care

concerning study inclusion and methodological quality were resolved by discussion moderated by the Task Force facilitator. Eleven studies were selected that also provided a basis for evidence-based decision points and pathways within the algorithm (Table 2).

The Task Force also identified and retrieved 9 key references used as a background for the algorithm.[8,29-36] These references were used to provide supplemental materials for the algorithm.

Generation of Consensus- and Evidence-Based Statements and Development of the First Draft

Results from this scoping review were used to generate clinical decision points and various pathways for the algorithm. The strength of evidence from these statements was ranked using a 3-point ordinal scale adapted from the Level of Evidence Rating found in the WOCN Clinical Practice Guideline for Management of Wounds in Patients with Lower-Extremity Venous Disease[37] and the Strength of Recommendations Taxonomy (SORT) from the American Academy of Family Physicians (Table 3). Twenty-seven evidence-based statements were generated from the findings of the scoping literature review (Table 4).

Following the scoping literature review and evidence-based statement development, the Task Force constructed a first draft algorithm via a series of Web-based conference calls and face-to-face meetings. Members of the Task Force evaluated the face validity of this first draft at multiple points during its development by identifying representative patient scenarios at their facilities and creating hypothetical scenarios and following each patient through the algorithm to ensure that the processes followed (e.g., assessments, considerations, reassessments), decision points, interim, and end results (e.g., recommendations for use of compression therapy) were comprehensive, feasible, and appropriate. Based on extensive discussion, the Task Force decided that the algorithm would focus on selection and application of compression therapy for the primary prevention, treatment, and prevention of recurrence of VLU associated with CVI.

As we generated this first draft of the algorithm, Task Force members soon realized that multiple decision points and supplemental recommendations lacked adequate supporting evidence. As a result, the Task Force generated 38 statements from the draft algorithm that lacked sufficient evidence to be deemed evidence-based (ie, Level of Evidence C). Rather than rely on agreement from the 3-member core group, the Task Force sought formal input from a representative group clinical experts who provide care for these patients. A Consensus Panel was brought together that represented the variety of clinicians (nurses, physicians, physical therapists) who care for persons with VLU and CVI, and the varied settings that compression and associated management of VLU and CVI occur (acute, ambulatory, long-term, and home health care settings) (Table 5). Geographic diversity also influenced the choice of panel members. Invitations were extended to executive leaders of relevant professional organizations, authors of relevant clinical practice guidelines, and basic and applied scientists conducting research in this area of practice. Twenty persons were empaneled; 12 (60%) were advanced practice nurses, 2 (10%) were specialty practice RNs, 2 (10%) were physical therapists, 2 (10%) were researchers, 1 was a researcher with training as an engineer, and 1 was a surgeon. Eighty percent (n = 16) had national certification in wound care.

The 2-day conference began with a summary of preconference activities and a brief state-of-the-science presentation on current practice in the area of compression for CVI and VLUs. This presentation was followed by introduction of the initial draft of the algorithm and discussion of the evidence-based statements previously generated; several statements were clarified based on panel member input.

Nevertheless, the main task of the Consensus Panel was to reach formal consensus on statements guiding decision points and pathways of the algorithm that were not supported by level A or B evidence. The consensus process was facilitated by a clinician (M.G.) who does not routinely care for persons with CVI and VLU but has general knowledge of chronic wound

TABLE 2.

Individual Studies Included in Generation of Statement for Algorithm Development

Study	Subjects and Setting	Design	Outcomes of Interest to Construction of Algorithm
Sippel et al (2015)[18]	A total of 40 patients (median age 78 y) with C4-C6 CVI managed in a single ambulatory care center in Zurich, Switzerland	Randomized controlled trial: subjects allocated to 40 mmHg or 2 superimposed 20 mmHg stockings with or without donning devices, neither subjects nor care providers were blinded to group allocation, data collection period not specified	Donning devices significantly improved elderly patients' ability to correctly apply compression stockings.
Ashby et al (2014)[19]	A total of 457 subjects (mean age 69 y) with CVI and current VLU recruited from 34 ambulatory care centers in England and Ireland	Randomized controlled trial: subjects allocated to compression using 2-layer hosiery or 4-layer bandage system, groups stratified based on VLU size and duration using permuted blocks, neither subjects nor care providers were blinded to treatment group; evaluators of main study outcome measure blinded to group allocation, data collection period 12 mo	No significant differences found in median time to healing when 2-layer compression hosiery was compared to 4-layer bandage system. Subjects allocated to 2-layer hosiery were more likely to change the type of compression style than did those managed by 4-layer compression bandage.
Dolibog et al (2013)[20]	A total of 147 subjects aged 40-82 y with CVI and current VLU allocated to 5 types of compression, subjects recruited from multiple ambulatory care clinics in Poland but all were managed in a single site	Randomized controlled trial: subjects allocated to 1 of 5 types of compression: intermittent pneumatic compression, 30-40 mmHg compression stocking, multilayer short-stretch bandage, 2-layer short-stretch bandage, and rigid paste bandage/boot, patients and care providers were not blinded to treatment group; neither subjects nor care providers were blinded to treatment group, data collection period 2 wk	The rate of patients who experienced wound VLU healing or reductions in ulcer size after 8 wk was comparable in patients managed by intermittent pneumatic compression, compression stockings, and multilayer short-stretch bandages; it was significantly lower in patients managed by 2-layer bandage and rigid paste bandage/boot.
Kapp et al (2013)[21]	A total of 93 community-dwelling persons from Australia with VLU healed within 1 wk of study participation, mean age 73 y	Randomized controlled trial: subjects allocated to compression using 23-32 mmHg (moderate) knee high compression stocking vs 24-36 mmHg (high) knee high compression stocking, the study was described as double blind, data collection period 6.5 mo	The risk of VLU recurrence was 3 times greater for subjects managed with moderate vs high compression stockings.
Mauck et al (2012)[10]	Data extracted from 36 studies conducted beginning of 1990 to end of 2013; pooled sample size 4298 subjects	Meta-analysis used to compare rates of VLU healing and time to healing in patients managed by compression stockings vs bandage systems, compression stockings vs short-stretch bandages, short-stretch bandages vs long-stretch bandages, data collection period among studies varied from 2 wk to 30 mo	No differences in VLU healing were found when all compression bandage systems were compared to compression stockings. Results of a single study suggest that VLU recurrence rates are lower in patients managed by stockings vs bandage systems. VLU healing rates were not different when 4-layer bandage systems were compared to systems with <4 layers. No differences in healing rates or time to healing were found when compression applied by short-stretch vas compared to compression via long-stretch bandage systems. Healing outcomes were better when patients received any form of compression vs no compression. Multicomponent bandage systems were more likely to heal VLU within 6 mo than single-component compression systems. Four-layer bandage systems were associated with faster healing than were short-stretch bandage systems.
Finlayson et al (2012)[22]	A total of 103 patients with VLU and CVI (mean age 68 y) recruited from multiple local hospitals and 2 community nursing services, all study procedures performed in a single ambulatory care facility in Australia	Randomized controlled trial: subjects allocated to compression using 4-layer compression bandage or Class III compression stockings (delivering 25-35 mmHg compression), neither subjects nor care providers were blinded to treatment group; evaluators of main study outcome measure blinded to group allocation, data collection period 6 mo	No differences found in healing rates at 24 wk, time to healing was significantly less for patients managed with 4-layer bandage.
Lazareth et al (2012)[23]	A total of 187 patients (mean age 72 y) with VLU and CVI recruited from outpatient care centers in 3 European countries, France, Germany, and the United Kingdom	Randomized controlled trial: Subjects randomly allocated to compression using a 2-layer vs 4-layer bandaging system, no blinding procedures were described, data collection period 3 mo	The healing rates for the 2-layer bandaging system were not significantly different from rates achieved by the 4-layer system.

(*continues*)

TABLE 2.
Individual Studies Included in Generation of Statement for Algorithm Development (*Continued*)

Study	Subjects and Setting	Design	Outcomes of Interest to Construction of Algorithm
Weller et al (2012)[24]	A total of 45 patients with VLU and CVI (mean age 75 y) recruited from multiple hospital-based outpatient centers in Victoria and Queensland, Australia	Randomized controlled trials: subjects allocated to compression with 3-layer tubular bandaging system or compression with short-stretch bandage system, no blinding procedures performed, data collection period 3 mo	The healing rate for patients managed by the 3-layer bandage system was higher than the healing rate for patients managed by the short-stretch bandage system.
Wong et al (2012)[25]	A total of 331 community-dwelling patients with VLU and CVI (mean age 72 y) recruited from multiple communities in Hong Kong	Randomized controlled trial: subjects allocated to compression with short-stretch bandage system, long-stretch bandages, or topical care without compression, no blinding procedures were reported, data collection period 6 mo	Patients managed by short-stretch or long-stretch bandages had higher healing rates than those managed without compression.
Harrison et al (2011)[26]	A total of 424 persons (mean age 65 y) receiving home care services for VLU and CVI in multiple regions of Canada	Randomized controlled trial: subjects allocated to compression with 4-layer bandage system or short-stretch bandage system, neither subjects nor home health nurses were blinded to group allocation, data collection 12 mo	Healing rates did not differ between 4-layer vs short-stretch bandage systems.
Brizzio et al (2010)[27]	A total of 60 community-dwelling patients (mean age female subjects 62 years; median age male subjects 63 y) with CVI and VLU recruited from outpatient care centers in Buenos Aires	Randomized controlled trial: subjects allocated to compression with short-stretch bandage system or compression stocking placed over gauze dressing, no blinding procedures, data collection period 6 mo	No differences in healing rates were noted in patients allocated to short-stretch bandage system vs those allocated to the compression stocking.
Szewczyk et al (2010)[28]	A total of 49 community-dwelling patients managed in clinical ward of hospital in Bydgoszcz, Poland	Randomized controlled trial: subjects allocated to compression with 30-40 mmHg compression stocking, 2-layer short-stretch bandage system or 4-layer bandage system, no blinding procedures were described, data collection period 3 mo	No differences in reductions in ulcer size found when 2-layer short-stretch bandages, compared to 4-layer bandage system or 30-40 mmHg compression stocking.

Abbreviations: CVI, chronic venous insufficiency; VLU, venous leg ulcer.

care and prior experience in this type of facilitation. Consensus on each statement was obtained based on the principles outlined by Murphy and colleagues,[39] using 80% agreement as the criterion for obtaining consensus. Statements were initially read to panelists and an initial vote was taken; clinicians were asked whether they agreed or disagreed with the recommendation for care or management expressed by the statement. If consensus was not achieved on the first vote, facilitated discussion occurred and the statement was edited based on panel member input. This process was repeated for up to 3 rounds of discussion until consensus was reached by formal vote. If consensus could not be reached after 3 rounds of discussion, or the statement deemed irrelevant to algorithm development, the statement was classified as "unable to reach consensus" and removed from further discussion. An interactive software program and wireless response system (Audio Visual One, Ltd, Bedford Park, Illinois) was used for all consensus votes. An electronic system was selected because it allowed feedback concerning progress toward consensus within a matter of seconds, and because it enabled anonymous voting by participants, thus reducing the risk of bias associated with public voting. As a result of this conference, consensus was reached on all statements used to support decision points and supplemental materials within the algorithm; no statements were eliminated (Table 6).

Following the conference, the Task Force revised the algorithm to incorporate the revised consensus-based and evidence-based statements into a second draft of the algorithm. This draft also incorporated supplemental materials deemed necessary since the algorithm is intended for use by a variety of clinicians with variable knowledge of CVI and VLU prevention and management.

Content Validation and Generation of the Final Draft

The process used for content validation was based on the technique described by Waltz and Bausell[40] and subsequently modified by Lynn[41] and Grant and Davis.[42] A data collection form was developed to evaluate content validity of the algorithm and 21 experts in the field of CVI and VLU prevention and management, including use of compression, were identified (Table 7). The form contained demographic data regarding professional and educational background of respondents, and the number of years of experience in wound care and/or research. Nine sections representing various pathways in the algorithm were developed. Content experts were asked to rank individual items on a scale of 1 to 4, where 1 indicated not relevant/appropriate; 2 indicated unable to assess relevance without revision, 3 indicated relevant but needs minor alteration, and 4 indicated very relevant and appropriate. This second group of clinical experts was also given the opportunity to provide qualitative feedback (written comments and suggestions) on the comprehensiveness of the algorithm, omissions of essential content, and suggest changes to improve clarity, parsimony, and relevance.

Data were analyzed using Statistical Analysis Software version 9.4 (SAS Institute Inc., Cary, North Carolina). Data were coded and entered by a single data coordinator, analyzed by the biostatistician, and reviewed by the authors of this article. Content validity ratings were entered for 9 individual sections of the algorithm and the overall algorithm, and the content validity index was calculated for each section and the overall algorithm.[43]

The content validity index for the overall algorithm was 0.86, which is well above the suggested cut-point of 0.78 suggested by Polit and Beck[44] for establishing content validity based on feedback from 3 or more reviewers. The content

TABLE 3.
Levels of Evidence Taxonomy for Supporting Statements

Level	Supported by:
A	Consistent findings from 2 or more randomized controlled trials (RCTs) or a systematic review with meta-analysis (pooled data) of multiple clinical trials
B	Consistent findings from 1 RCT or >1 nonrandomized clinical trial or inconsistent (mixed) evidence from 2 or more RCTs or systematic reviews with meta-analysis
C	Expert opinion based on consensus among clinical experts, findings from a single nonrandomized clinical trial, case study, or a series of clinical case studies

validity indices for the 9 pathways of the algorithm varied from 0.86 to 1.0 (Table 8). These findings indicate that the majority of expert panelists found that the overall algorithm and each of its 9 pathways were "very relevant and appropriate" or "relevant and needed only minor alteration."

Content validators were also asked to provide qualitative feedback for the overall algorithm and each of its 9 pathways. Qualitative feedback focused on language used in the algorithm, options for therapies to complement the effectiveness of compression such as pharmacological agents, parameters for Ankle Brachial Index (ABI), also known as Ankle Brachial Pressure Index (ABPI) testing indicating clinically relevant arterial disease, a desire for more specific follow-up times, and suggestions for various additions to assessment of patients with CVI. The Task Force made multiple changes to the algorithm based on this qualitative feedback.

ALGORITHM FOR COMPRESSION CVI WITH AND WITHOUT VLU

The target audience for the algorithm includes nurses, specialty and advanced practice providers (wound care nurses,

TABLE 4.
Evidence-Based Statements Used in Construction of Algorithm

Primary Prevention of VLU	References/Level of Evidence
1. There is insufficient evidence to determine whether compression stockings prevent VLU in persons with CVI.	Shingler et al (2013)[12]; O'Donnell et al (2014)[2]; Kelechi and Johnson (2012)[8] LOE: A
2. Compression stockings improve CVI-related symptoms (such as aching, itching) when compared to no compression	O'Donnell et al (2014)[2]; Kelechi and Johnson (2012)[8] LOE: A
3. In patients with clinical CEAP C1-4 disease related to prior deep venous thrombosis, a high compression (30-40 mm Hg) system is recommended.	O'Donnell et al (2014)[2] LOE: B
Treatment of VLU	**References/Level of Evidence**
1. Compression improves healing of VLU when compared to no compression	O'Donnell et al (2014)[2]; O'Meara et al (2012)[7]; Mauck et al (2012)[10]; Kelechi and Johnson (2012)[8]; AAWC (2012)[9] LOE: A
2. Single component compression devices are less effective than multicomponent compression devices for VLU healing at 6 mo	O'Meara et al (2012)[7]; Mauck et al (2012)[10] LOE: B
3. A 2-component system containing an elastic bandage healed more ulcers at 1 year than one without an elastic component	Mauck et al (2014)[10]; O'Meara et al (2012)[7] LOE: B
4. A 3-component system containing an elastic component healed more ulcers than those without elastic at 3 to 4 mo, but another RCT showed no difference between groups at 6 mo	Mauck et al (2014)[10]; O'Meara et al (2012)[7]; Weller et al (2012)[24] LOE: B
5. Four-layer bandage systems heal VLU significantly faster than short-stretch bandage systems.	O'Meara et al (2012)[7]; Mauck et al (2012)[10]; Weller et al (2012)[24] LOE: A
6. High-compression stockings are associated with better healing outcomes than SSB at 2 to 4 mo	Mauck et al (2014)[10]; O'Meara et al (2012)[7] LOE: A
7. Intermittent pneumatic compression may be used when other compression options are not available, cannot be used (immobile, extremely large legs, intolerant of stockings or wraps), have failed to aid in VLU healing after prolonged compression therapy, or when higher levels of compression are needed than can be provided by stockings or wraps	O'Donnell et al (2014)[2] LOE: B
8. Two-layer compression stockings do not differ from 4-layer bandage systems in VLU healing rates.	Mauck et al (2014)[10]; O'Meara et al (2012)[7]; Lazreth et al (2012)[23] LOE: B
9. A 30-40 mmHg compression stocking is not inferior to 4LB	Ashby et al (2014)[19] LOE: B
10. Short-stretch bandages are comparable to long-stretch bandages for healing of VLU or time to VLU healing	Mauck et al (2014)[10]; O'Meara et al (2012)[7]; Harrison et al (2011)[26] LOE: A
11. Compression improves healing of VLU when compared to no compression	O'Donnell et al (2014)[2]; O'Meara et al (2012)[7]; AAWC (2012)[9]; Wong et al (2012)[25] LOE: A

(*continues*)

TABLE 4.
Evidence-Based Statements Used in Construction of Algorithm (*Continued*)

Treatment of VLU	References/Level of Evidence
12. Single-component compression devices are less effective than multicomponent compression devices for VLU healing at 6 mo	O'Meara et al (2012)[7] LOE: B
13. A 2-component system containing an elastic bandage healed more ulcers at 1 year than one without an elastic component	Mauck et al (2014)[10]; O'Meara et al (2012)[7] LOE: B
14. High-compression stockings are associated with better healing outcomes than SSB at 2 to 4 mo	O'Meara et al (2012)[7] LOE: A
Prevention Of VLU Recurrence In Patients With CVI	**References/LOE**
1. Compression stockings reduce likelihood of venous ulcers recurrence when compared with no compression	Mauck et al (2014)[10]; Kelechi and Johnson (2012)[8] LOE: B
2. Recurrence is lower in high-compression hosiery than in medium-compression hosiery at 3 y	Nelson and Bell-Syer (2014)[11]; Kapp et al (2013)[21] LOE: B
3. Adherence rates are significantly higher with moderate vs high compression hose and bandages	Nelson and Bell-Syer (2014)[11]; O'Donnell et al (2014)[2]; Weller et al (2013)[38] LOE: B
4. Nonadherence to compression indicates a higher likelihood of VLU recurrence.	Kapp et al (2013)[21]; Weller (2013)[38] LOE: B
5. Donning devices significantly improve the ability of patients aged >65 y to don compression stockings	Sippel et al (2015)[18] LOE: B
6. Short-stretch bandages are comparable to long-stretch bandages with respect to VLU recurrence	O'Donnell et al (2014)[2] LOE: A
Additional Evidence Based Statements Used For Supplemental Materials For The Algorithm	
1. There is insufficient evidence to suggest that horse chestnut seed oil (*Aesculus hippocastanum* L) prevents VLU in persons with CVI.	Pittler et al (2012)[34]
2. Evidence suggests that horse chestnut seed oil (*Aesculus hippocastanum* L) does not promote VLU healing	AAWC (2013)[9] LOE: B
3. Evidence suggests that horse chestnut seed oil (*Aesculus hippocastanum* L) does not prevent VLU recurrence	AAWC (2013)[9] LOE: B
4. In patients with VLU (C6) and incompetent superficial veins that have reflux to the ulcer bed, ablation of incompetent veins augments compression therapy	O'Donnell et al (2014)[2] LOE: B

Abbreviations: CVI, chronic venous insufficiency; LOE, level of evidence; SSB, short stretch bandage; RCT, randomized control trial; VLU, venous leg ulcer.

WOC nurses, vascular nurses, nurse practitioners, clinical nurse specialists, physician's assistants, etc), physicians (hospitalists, primary care physicians, vascular and other surgeons), physical therapists, and occupational therapists. The algorithm was designed for adult patients in acute care facilities (critical care, medical-surgical, orthopedic, rehabilitation units, and the emergency department), long-term acute care facilities, outpatient clinics, long-term care/skilled nursing homes, and home care settings.

Both the Task Force and Consensus Panel members engaged in extensive discussion concerning the importance of a classification system for CVI to enable standardization of assessment, management, and treatment of VLU, including compression. Chronic venous insufficiency can be described in terms of the well-established Clinical, Etiology, Anatomic, Pathophysiology (CEAP) classification system developed by an ad hoc committee of the American Venous Forum in 1994 and revised by an international consensus committee in 2004.[45,46] This classification system has 7 categories (0-6) defined by the presence or absence of signs or symptoms. Strategies for the prevention of the progression of CVI from "pre-ulcer stages" CEAP C1 to C5 should be implemented to avoid focusing on the treatment of the ulcer only.

Users enter the algorithm when a patient presents with complaints related to their lower extremities (see the Figure). The clinician begins with review of the medical record, followed by completion of a health history and focused physical exam. Once assessment is complete, the clinician should determine the need for appropriate diagnostic studies, which may include ABI/ABPI testing.[37,47] If access to results is delayed, the clinician may continue the differential diagnosis and refer to tools identified in the algorithm. If patient is found to have a disease or wound of other etiology (eg, lymphedema, lipedema, arterial, or neuropathic), the user should follow facility protocol or practice guideline for those conditions.[37] Periodic patient reassessment of the lower extremities should occur on a regular basis.

If the patient's lower extremity complaints and diagnostic tests are determined to be unrelated to venous disease (CEAP 0), the clinician is guided to provide education promoting leg health. These patients should be reassessed at least annually to identify any new or worsening problems with the legs; reassessment may be integrated with a general physical examination.

When assessment reveals CVI, the clinician is directed to determine the clinical CEAP level.[45,46] Patients with no current or past wound are classified as clinical CEAP 1-4. Those with healed wounds are clinical CEAP 5 and those with an active wound are classified as clinical CEAP 6.

For patients classified as clinical CEAP 1-2, treatment is based on presence and severity of symptoms. The clinician

TABLE 5.
Consensus Panel Experts (N = 20[a])

Participant	Practice Setting/Affiliation
Phyllis Bonham, RN, PhD, CWOCN	Faculty, Medical University of South Carolina, SC
Joanna Burgess, RN, BSN CWOCN	Acute Care/WakeMed Health and Hospitals, NC
Renee Cordrey, PT, MSPT	Ambulatory Care/George Washington University, Arlington, VA
Paulo DaRosa, RN, MCISC, CETN	Acute Care/London Health Sciences Centre, London, ON, Canada
Barbara Dale, RN, BSN, CWOCN	Home Care/Quality Home Health, TN
Marcus Duda, MD	Ambulatory Care/Piedmont Orthopedics, NC
Bonny Flemister, MSN, RN, A/GNP	Long-Term Care/Private Practice, TX
Dawn Franceschina, PT, DPT, CWS	Acute Care/Elmhurst Memorial Hospital, Elmhurst, IL
Arturo Gonzalez, RN, DNP, CWCN	Home Health Care/Florida International University, FL
Phyllis Gordon, RN, MSN	Acute Care/University of Texas Health Science Center, San Antonio, TX
Kathleen Lawrence, RN, MSN, CWOCN	Home Care/Rutland Area Visiting Nurse and Hospice, VT
Mary Mahoney, RN, MSN, CWON, CFCN	Home Care/Unity Point at Home, IA
Gail Parry, RN, MSN CWON	Home Care/Ochsner Westbank, Gretna, LA
Barbara Pieper, RN, PhD, CWOCN	Faculty/Wayne State University, MI
Mary Sieggreen, RN, MSN, CVN	Acute Care/Detroit Medical Center, Northville, MI
Charles Vukotich, BS	Researcher/University of Pittsburgh, PA
Julie Wellborn, RN, MN, CWON	Acute Care/Harrison Medical Center, WA

[a]Three Task Force members (C.R., L.M., and S.Y.) also participated in Consensus Panel.

must first determine the need for compression. If compression is not needed, the clinician is guided to provide education promoting leg health from an expanded list. When compression is needed, the clinician must take into consideration individual patient characteristics, such as dexterity, mobility, preference, pain level cost, caregiver resources, and size and shape of the leg, and is assisted in their decision-making process by the provision of 4 tables.

Patients with a prior history of deep vein thrombosis (DVT) should use a compression system that delivers 30 to 40 mmHg.[2] In contrast, patients with no history of DVT may use a compression system delivering 20 to 30 mmHg. Standardized methods based on the manufacturer's recommendations should be used when measuring for compression stockings or devices. Patient education regarding compression stockings/devices should be provided in addition to information about leg health. Periodic reassessment of the lower extremities should occur on a regular basis and at least twice annually.

For patient classified as clinical CEAP 3-4, treatment is based on results of ABI (ABPI) measurement. If the ABI/ABPI is <0.5 (indicating clinically relevant ischemia from arterial disease) or >1.3 (indicating possible arterial disease with noncompressible vessels) compression should not be applied.[47] Instead, the clinician should educate patient and caregiver on leg health and consider referral for evaluation and management of significant arterial disease and pharmacotherapy in selected cases. Periodic patient reassessment of the lower extremities should occur on a regular basis (at least every 6 months).

Patients with an ABI/ABPI of 0.5 to 0.8, indicating mixed venous and arterial disease, may be managed by modified light compression/support up to 30 mmHg, depending on the individual's tolerance.[2,8] If the patient's ABI/ABPI is 0.8 to 1.3, a higher level of compression is indicated. Standardized methods based on the manufacturer's recommendations should be used when measuring for compression stockings or devices. Patient education regarding compression stockings/devices should be provided in addition to information about leg health and pharmacotherapy when indicated. A previous history of DVT also influences the desired level of compression.[2] When dermatitis or eczema is observed, treatment with topical steroids is indicated, long with referral to a dermatologist if treatment is ineffective.[29] The algorithm also guides the clinician to consider referral to a specialist for further testing and intervention if indicated. Periodic patient reassessment is recommended at least every 6 months to identify any new problems with the legs and to evaluate status of ongoing compression therapy.

Clinical CEAP 5 is characterized by a patient who has experienced a VLU that has now healed. Compression continues to be a mainstay of treatment for all patients with clinical CEAP 5 CVI. As with clinical CEAP 3-4, ABI/ABPI is used to determine the level of compression. If the person's ABI/ABPI is less than 0.5 or more than 1.3, further evaluation is required before compression is considered.[47] The clinician should educate the patient and the caregiver on leg health including pharmaceuticals if applicable. An ABI/ABPI of 0.5 to 0.8 indicates mixed venous and arterial disease; these persons may require modified light compression/support up to 30 mmHg, based on patient tolerance.[2,8] For patients whose ABI (ABPI) is 0.8 to 1.3, higher compression is indicated. When selecting the type and level of compression, the same considerations must be given to individual patient characteristics as those described earlier. Standardized methods based on the manufacturer's recommendations should be used when measuring for compression stockings or devices. If dermatitis/eczema is present, treatment with topical steroids is indicated with referral to a dermatologist if treatment is ineffective. Patient education regarding compression stockings/devices should be provided in addition to information about leg health and pharmacotherapy when indicated. The clinician is guided to consider referral to the specialist for further testing

TABLE 6.
Consensus Statements Used for Algorithm Construction

Statement	Level of Agreement
Assessment Statements	
Essential components of a focused health history for chronic venous insufficiency include:	80%
• Triggers (eg, trauma, cellulitis, contact dermatitis, etc)	
• Risk factors (eg, family history, previous deep vein thrombosis, fractures to leg, etc)	
• Comorbid conditions (eg, obesity, thrombophilias, varicose veins, etc).	
Essential components of a physical assessment for chronic venous insufficiency includes examination of both lower extremities noting condition of the skin, ankle range of motion and calf muscle strength, functional mobility, extent and location of edema, superficial vascular changes, presence of any wounds, and palpation of pulses.	100%
Arterial circulation should be evaluated using appropriate diagnostic studies such as Ankle Brachial Index (ABI), Ankle Brachial Pressure Index.	85%
Comprehensive management of CVI should be based on the CEAP (Clinical Etiology, Anatomy, Physiology) classification system.	90%
If the patient's clinical CEAP score is C0, consider alternative etiologies for abnormal findings.	80%
If the patient's clinical CEAP score is C0, educate patient and family about lifestyle factors that promote leg health including:	90%
• effects of smoking, advise smoking cessation	
• follow healthy nutrition practices such as weight management	
• avoid mechanical trauma to leg	
• avoid crossing legs, prolonged sitting or standing	
• exercise and participate in physical activity often	
• avoid wearing high heels.	
Decision points based on clinical CEAP level	
If the patient's clinical CEAP score is C0-C6	80%
• Periodic reassessment is indicated.	
• Patient and family/caregiver education is recommended.	
If the patient's clinical CEAP score is CI-C4, determine type of compression based on patient dexterity, mobility, preference, pain/comfort, cost, caregiver resources, and size and shape of leg.	95%
If the patient's clinical CEAP score is C1-C4, use standardized methods based on the manufacturer's recommendations when measuring for compression stockings or devices.	95%
If the patient's clinical CEAP score is C1-C2, use compression stockings or devices at a level of 20-30 mm Hg, knee or thigh high during waking hours to prevent venous ulcers.	90%
If the patient's clinical CEAP score is C1-C2, educate patient and family/caregiver about:	100%
• effects of smoking, advise smoking cessation	
• avoid mechanical trauma to leg	
• avoid prolonged sitting or standing	
• exercise and participate in physical activity often	
• extremity elevation	
• prevention of trauma	
• appropriate footwear (eg, avoid high heels)	
• nutrition, weight management	
• use of emollients to prevent dermatitis	
• use of compression stockings/devices.	
If the patient's clinical CEAP score is C1-C2, prophylactic interventional therapies to prevent VLU are not recommended in patients with asymptomatic C1-C2 disease.	95%
If the patient's clinical CEAP score is C1-C2, apply compression therapy, at a level of 20-30 mm Hg, knee or thigh high to prevent venous ulcers.	95%
If the patient's clinical CEAP score is C3-C4, educate patient and family/caregiver about:	90%
• effects of smoking, advise smoking cessation	
• avoid mechanical trauma to leg	

(*continues*)

TABLE 6.
Consensus Statements Used for Algorithm Construction (*Continued*)

Statement	Level of Agreement
• avoid prolonged sitting or standing	
• exercise and participate in physical activity often	
• extremity elevation	
• prevention of trauma	
• appropriate footwear (eg, avoid high heels)	
• nutrition, weight management	
• use of emollients to prevent dermatitis	
• use of compression stockings/devices	
• use of pharmaceuticals (horse chestnut seed oil, pentoxifylline [Trental]), if applicable.	
If the patient's clinical CEAP score is C3-C4, consider further testing such as venous duplex ultrasound and referral to a specialist for interventional therapies if indicated.	100%
If the patient's clinical CEAP score is C3-C6, consider the use of modified light compression/support, up to 30 mm Hg, based on patient tolerance in patients with mixed venous and arterial disease (ABI = 0.5-0.8).	90%
If the patient's clinical CEAP score is C5, educate patient and family/caregiver about:	95%
• effects of smoking, advise smoking cessation	
• avoid mechanical trauma to leg	
• avoid prolonged sitting or standing	
• exercise and participate in physical activity often	
• extremity elevation	
• appropriate footwear (eg, avoid high heels)	
• nutrition, weight management	
• use of emollients to prevent dermatitis	
• use of lifelong compression stockings/devices	
• use of pharmaceuticals (horse chestnut seed oil, pentoxifylline), if applicable.	
If the patient's clinical CEAP score is C5, consider donning/doffing devices, alternative compression devices, or continuation of wraps in patients/caregivers with functional limitations affecting stocking use. Consider referral to rehabilitation services to address functional limitations.	90%
If the patient's clinical CEAP score is C5, avoid the use of paste bandage systems in nonambulatory and bedbound patients.	80%
If the patient's clinical CEAP score is C5, for patients with atypical leg size or shape, refer to a qualified fitter for measuring and selecting customized stockings, garments, and devices.	100%
If the patient's clinical CEAP score is C5, refer to a qualified fitter for measuring and selecting customized stockings, garments, and devices for patients with atypical leg size or shape.	80%
If the patient's clinical CEAP score is C5, consider further testing such as venous duplex ultrasound and referral to a specialist for interventional therapies if indicated.	95%
If the patient's clinical CEAP scores in C3-C6, consider reusable wraps, garments, or devices when selecting type of compression in patients with limited financial resources.	90%
If the patient's clinical CEAP score is C6, sustained compression is not recommended if the ankle brachial index is less than 0.5 or if absolute ankle pressure is less than 60 mm Hg.	90%
If the patient's clinical CEAP score is C6, apply topical dressing that will manage venous leg ulcer exudate.	85%
If the patient's clinical CEAP score is C6, apply emollients to intact skin underneath compression to prevent occurrence of dermatitis.	90%
If the patient's clinical CEAP score is C6, assess and monitor pain and circulatory status with use of compression.	100%
If the patient's clinical CEAP score is C6, educate patient and family about:	100%
• effects of smoking, advise smoking cessation	
• avoid mechanical trauma to leg	
• avoid prolonged sitting or standing	
• exercise and participate in physical activity often	

(*continues*)

TABLE 6.
Consensus Statements Used for Algorithm Construction (*Continued*)

Statement	Level of Agreement
• extremity elevation	
• appropriate footwear (eg, avoid high heels)	
• nutrition, weight management	
• use of emollients to prevent dermatitis	
• use of lifelong compression stockings/devices	
• wound care and compression management	
• use of pharmaceuticals (horse chestnut seed oil, pentoxifylline).	
If the patient's clinical CEAP score is C6, consider the use of elastic bandages in nonambulatory and bedbound patients, who need therapeutic levels of compression.	80%
If the patient's clinical CEAP score is C6, modify compression and consider referral to a qualified fitter for measuring and selecting customized stockings, garments, and devices for patients with atypical leg size or shape.	100%
If the patient's clinical CEAP score is C6, consider lower levels of compression to enhance adherence in patients who cannot tolerate 30-40 mmHg of compression.	95%
If the patient's clinical CEAP score is C6, wrap from metatarsal head to tibial tubercle, including the heel when applying compression wraps.	100%
If the patient's clinical CEAP score is C6, consider further testing such as venous duplex ultrasound and referral to a specialist for interventional therapies if indicated.	90%
If the patient's clinical CEAP score is C6, consider principles of wound bed preparation prior to selection of topical therapy.	95%
If the patient's clinical CEAP score is C6 and the wound fails to improve or deteriorates, evaluate for barriers to healing.	90%
If the patient's clinical CEAP score is C4-C6, identify and treat dermatitis/eczema with topical steroids for 1-2 wk; refer to a dermatologist if treatment is ineffective.	90%

Abbreviations: CVI, chronic venous insufficiency; VLU, venous leg ulcer.

and intervention if indicated. Periodic patient reassessment of the lower extremities should occur at least every 6 months.

Individuals with a current VLU are classified as clinical CEAP 6. Topical treatment of the ulcer is the primary consideration beginning with wound bed preparation. The 3 components of wound bed preparation are debridement of nonviable tissue, recognition and treatment of wound infection, and moisture balance management within the wound. Moisture balance management is critical with exudative wounds such as VLUs to promote healing and prevent periwound moisture-associated skin damage. There are a variety of dressing categories that are absorbent (eg, hydrocolloids, alginates, gelling fibers, foams, superabsorbents) which will wick the VLU exudate from the wound and periwound area.[48] However, managing periwound moisture-associated skin damage is a balancing act; avoiding both excessive dryness seen with venous stasis dermatitis, and excessive moisture in the wound and periwound skin can be challenging. In addition, a nonsensitizing emollient should be used under compression to prevent dermatitis.[29] Topical steroids may be used to treat dermatitis; referral to a dermatologist if treatment proves ineffective within a period of 2 to 4 weeks.

The algorithm directs clinicians to obtain an ABI/ABPI because it assists the clinician in determining the level of compression. An ABI/ABPI <0.5 indicates severe arterial disease and a contraindication for use of compression.[47] In this case, the clinician is guided to consider referral for evaluation and management of significant arterial disease. Patients with an ABI/ABPI of 0.5 to 0.8 are diagnosed as having mixed venous and arterial disease. This individual may require modified light compression/support up to 30 mmHg, based on tolerance. For patients whose ABI/ABPI is 0.8 to 1.3, higher compression is indicated.[2,8] When selecting the type and level of compression, the same considerations must be given to individual patient characteristics as those described earlier. Standardized methods based on the manufacturer's recommendations should be used when measuring for compression stockings or devices. Dermatitis or eczema should be treated as described previously. Patient education regarding compression stockings/devices should be provided in addition to information about leg health and pharmaceuticals. If the wound fails to improve or deteriorates, barriers to healing should be evaluated. The clinician is guided to consider referral to the specialist for advanced adjuvant therapies. Periodic patient reassessment of the success of compression therapy should occur on a regular basis, at least every 6 months and more frequent reassessment may be indicated based on wound characteristics and response to treatment. If treatment is effective, current therapy should be continued until the wound heals. Once the wound heals, the clinical CEAP level changes to clinical CEAP 5 and the clinician is guided to clinical CEAP 5 section of the algorithm.

Supplemental Materials

Multiple supplemental materials were embedded into the algorithm in order to guide clinicians with variable expertise in CVI and VLU when using compression for prevention and management of VLU in persons with CVI. Because the ABI/ABPI is critical to the diagnostic process, a quick-reference guide, including an interpretive table,[47] is provided. To further assist with diagnosis, appendices from the WOCN Society's Guideline for Management of Wounds with Lower Extremity Venous Disease have been included.[37] These assist the user in discerning among edema, lymphedema, and lipedema, and distinguishing venous eczema from cellulitis. A reference regarding wounds of other etiologies has also been provided.[49]

When clinical findings indicate CVI, a reference table with photos is available to assist the user in determining the clinical

TABLE 7.
Content Validation Experts (N = 21)

Participant	Practice Setting/Affiliation
Laura Bolton, PhD	Faculty/University of Medicine and Dentistry of New Jersey, NJ
Lisa Corbett, RN, MSN, CWOCN	Acute Care/Hartford Hospital, CT
Ellen Dillavous, MD	Faculty/Duke University Medical Center, NC
Dorothy Doughty, RN, MN, CWOCN	Acute Care/Emory University, GA
Colleen Drolshagen, RN, BSN, CWOCN	Acute Care/Cadence Health, IL
Heather Hettrick, PT, PhD, CWS	Faculty/Nova Southeastern University, FL
Jan Johnson, RN, MSN, CWOCN	Ambulatory Care/Duke University Medical Center, NC[a]
Teresa Kelechi, RN, PhD, CWCN	Faculty/Medical University of South Carolina, SC
Mary Arnold Long, RN, MSN, CWOCN-AP	Acute Care/Roper Hospital, SC
Dianne Mackey RN, MN, CWOCN	Home Care/Kaiser Permanente, CA
Peggy McCracken, RN, BSN, CWOCN	Home Care/Advanced Home Care, TN
Nancy Parslow, RN, MCISc, CETN	Acute Care/University Health Care, Ontario Canada
Marc Passman, MD	Faculty/University of Alabama Birmingham, AL
Joyce Pittman, RN, PhD, CWOCN	Faculty/Indiana University Health, IN
George Rodeheaver, PhD	Faculty/University of Virginia, VA[a]
Kazu Suzuki, DPM, CWS	Ambulatory Care/Tower Wound Care Center, CA
Nancy Tomaselli, RN, MSN, CWOCN	Ambulatory Care/Premier Health Solutions, NJ
Margaret Tracci, MD	Faculty/University of Virginia, VA
Lia van Rijswijk, RN, MSN, CWCN	Faculty/Thomas Edison State College, NJ
Dot Weir, RN, CWON, CWS	Ambulatory Care/Osceola Regional Medical Center, FL
Stephanie Woefel, PT, MPT, FACCWS	Ambulatory Care/University of Southern California, CA[b]

[a]Retired.
[b]Physical therapist.

CEAP level. Photographs are included to aid in rapid and accurate assessment.

Additional tools for selecting the type and level of compression are provided. A table entitled Compression Therapies lists the type of compression with brand-name examples and performance characteristics. A Formulary table provides detailed information about wraps, garments, and intermittent pneumatic compression pumps. Compression Stocking Classifications for the United States and the United Kingdom are included in a separate table. A key resource for those less familiar with compression therapy is the Special Considerations Table, which includes information pertinent to all patients as well as unusual patient situations. Clinical references for the use of horse chestnut seed oil and pentoxifylline have also been included in a table.

DISCUSSION

An evidence- and consensus-based algorithm for Compression in CVI with or without VLU was developed and its content validity established. Algorithm construction followed a structured pathway and combined current best evidence to support pathways and decision points within the algorithm with consensus-based decision points when supportive evidence was lacking. Face validity was assessed at multiple points as the algorithm was constructed. In addition, the initial draft of the algorithm was subjected to scrutiny by a consensus panel of 20 clinicians and researchers with expertise in CVI and VLU, resulting in substantive and meaningful changes.

Following construction of a second draft, the algorithm was subjected to review by an independent panel of 21 expert clinicians. The overall content validity index for the algorithm was robust at 0.86 and the indices for the 9 pathways of the algorithm were equally strong varying from 0.86 to 1.0 (Table 7). The algorithm was designed for adult patients in acute care facilities, long-term acute care facilities, outpatient

TABLE 8.
Content Validation Indices for the Algorithm

Algorithm Section	N	Interrater Agreement[a]	CVI
1.0	21	3.3 ± 0.71	0.86
2.0	21	3.1 ± 0.75	0.86
3.0	21	3.2 ± 0.73	0.91
4.0	21	3.3 ± 0.78	0.91
5.0	21	3.4 ± 0.49	1.0
6.0	21	3.3 ± 0.70	0.95
7.0	21	3.4 ± 0.65	0.91
8.0	21	3.2 ± 0.79	0.81
9.0	21	3.4 ± 0.49	0.95
Overall	21	3.1 ± 0.64	0.86

Abbreviation: CVI, chronic venous insufficiency.
[a]Mean ± standard deviation.

A

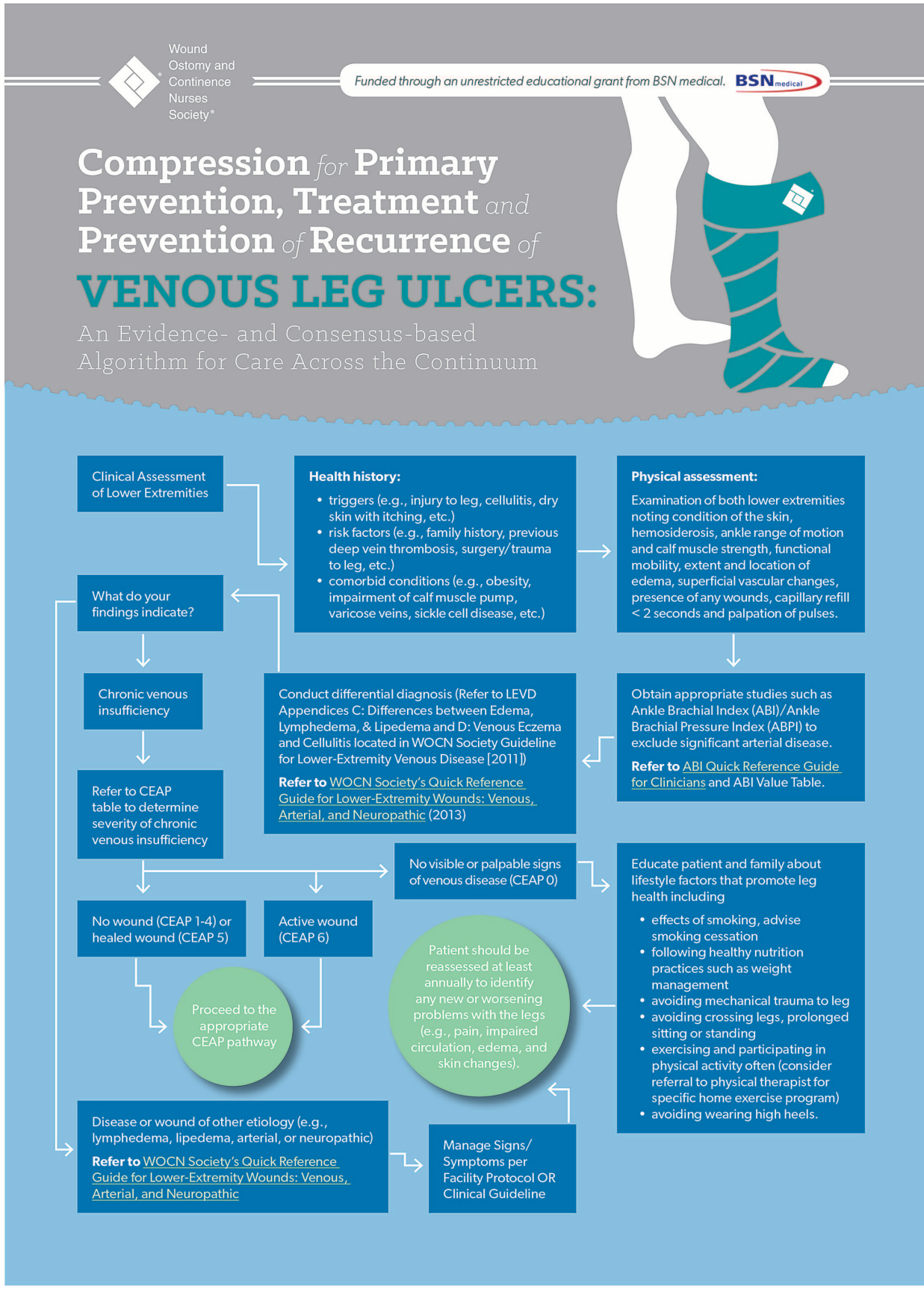
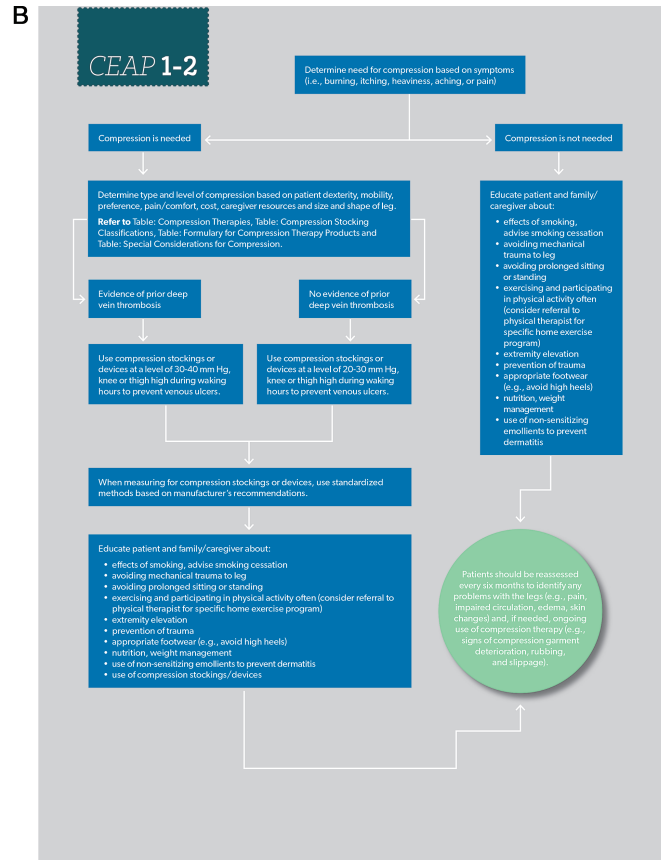


Figure. Algorithm for compression CVI with and without VLU. (*Continued*)



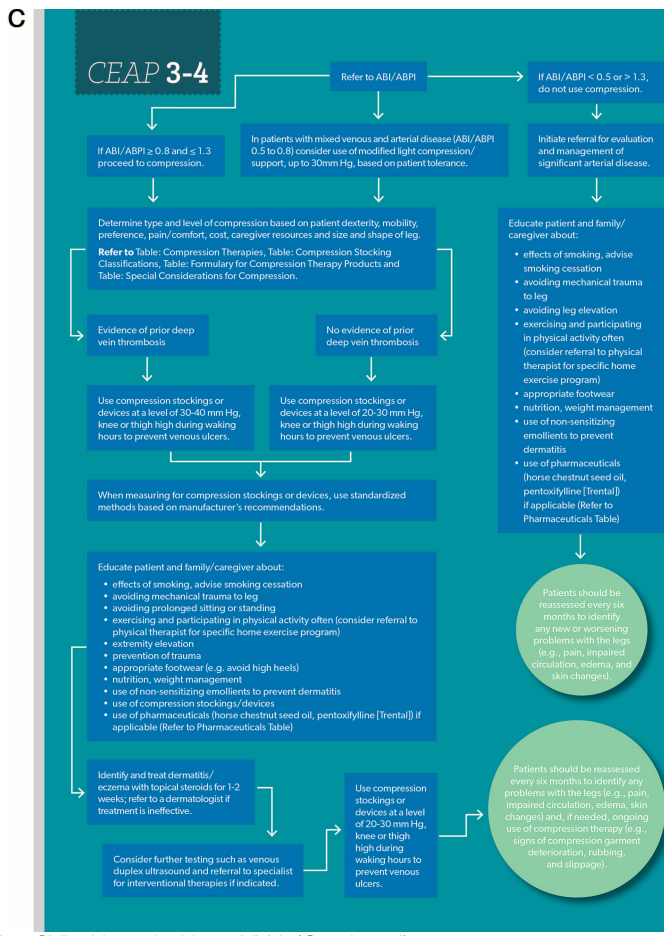


Figure. Algorithm for compression CVI with and without VLU. (*Continued*)

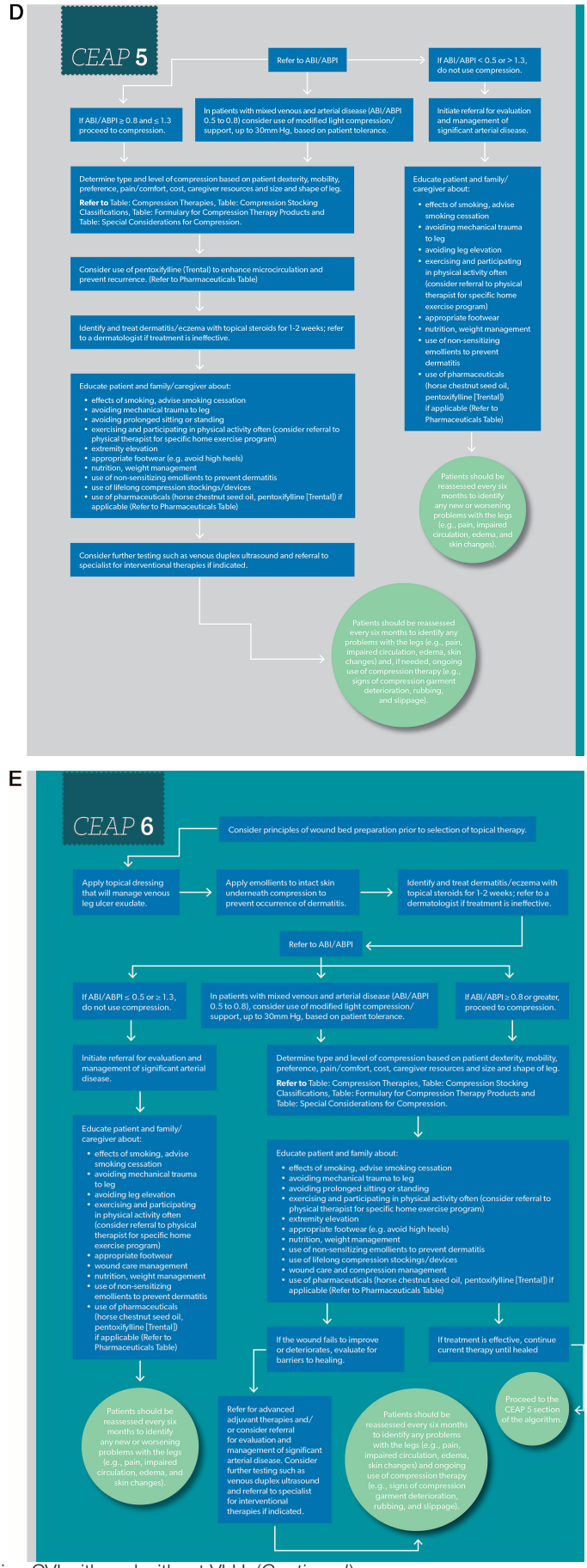


Figure. Algorithm for compression CVI with and without VLU. (*Continued*)

F

PHARMACEUTICALS TABLE

PHARMACEUTICALS	USES	DOSE	REFERENCE
HORSE CHESTNUT SEED EXTRACT	Reduce symptoms of CVI such as leg pain, fatigue/ tiredness, leg swelling	300 mg of horse chestnut seed extract containing 50 mg of the active ingredient, aescin, twice daily	Pittler MH, Ernst E. Horse chestnut seed extract for chronic venous insufficiency. Cochrane Database Syst Rev. 2012 Nov 14
PENTOXIFYLLINE (TRENTAL)	Hemorheologic agent enhances microcirculatory blood flow and may be used in CVI patients in conjunction with compression therapy	400 mg ORALLY 3 times per day with food	Jull AB, Arroll B, Parag V, Waters J. Pentoxifylline for treating venous leg ulcers. Cochrane Database of Systematic Reviews 2012, Issue 12. Art. No.: CD001733. DOI: 10.1002/14651858.CD001733.pub3.

FORMULARY OF COMPRESSION THERAPY PRODUCTS

CATEGORY	TYPE	EXAMPLES *
Wraps	Multilayer	Profore (Smith & Nephew), Comprifore (BSN Medical), Dyna-Flex (Systagenix)
	Long stretch	ACE bandage (3M)
	Short stretch	Comprilan (BSN Medical), Setopress (MölnIycke)
	Paste	Gelocast (BSN Medical), Viscopaste (Smith & Nephew), Primer (Derma Sciences)
Garments	Reusable inelastic device	CircAid (mediUSA)
	Tubular sleeve	Tubigrip (MölnIycke) Medigrip (Medline)
	Stockings	Jobst (BSN Medical) Mediven (mediUSA) Juzo (Juzo USA)
Intermittent Pneumatic Compression Pumps		Tactile Systems Technology Lympha Press Bio Compression Systems, Inc.

*Not all inclusive

Adapted with permission from Carmel, J. E. (2012). Venous ulcers. In R. A. Bryant & D. P. Nix (Eds.) Acute & chronic wounds: Current management concepts (4th ed.). St. Louis, MO: Elsevier.

ABI TABLE

ABI	PERFUSION STATUS
> 1.3	Elevated, incompressible vessels
> 1.0	Normal
≤ 0.9	LEAD
≤ 0.6 to 0.8	Borderline
≤ 0.5	Severe ischemia
≤ 0.4	Critical ischemia, limb threatened

J Wound Ostomy Continence Nurs. 2012;39(2S):S21-S29.

Manufacturers Referenced

BSN medical, Luxembourg
MölnIycke, Sweden
Medline, Mundeleine, Illinois
3M, St. Paul, Minnesota
Andover, Salisbury, Massachusetts
Hartmann, Rock Hill, South Carolina
Dynarex, Orangeburg, New York
Smith & Nephew, United Kingdom
Systagenix, Quincy, Massachusetts
Lohmann & Rauscher, Germany
Farrow Medical, Bryan, Texas
DermaSciences, Princeton, New Jersey
mediUSA, Whitsett, North Carolina
Juzo USA, Cuyahoga Falls, Ohio
Tactile Systems Technology, Minneapolis, Minnesota
Lympha Press, Manalapan Township, New Jersey
Bio Compression Systems, Inc., Moonachie, New Jersey

G

COMPRESSION STOCKING CLASSIFICATIONS

U.S. CLASS	DESCRIPTOR	ANKLE PRESSURE	INDICATION
Class 1	Light support	20-30 mmHg	Treatment of varicose veins
Class 2	Medium support	30-40 mmHg	Treatment of more severe varicosities and prevention of leg ulcers
Class 3	Strong support	40-50 mmHg	Treatment of severe chronic venous hypertension and severe varicose veins, and to prevent leg ulcers
UK CLASS	**DESCRIPTOR**	**ANKLE PRESSURE**	**INDICATION**
Class 1	Light support	14-17 mmHg	Treatment of varicose veins
Class 2	Medium support	18-24 mmHg	Treatment of severe chronic venous hypertension and severe varicose veins, and to prevent venous leg ulcers in patients with thin legs
Class 3	Strong support	25-35 mmHg	Used to treat more severe varicosities and to prevent venous leg ulcers

Adapted from: O'Meara, S., Cullum, N.A., & Nelson, E.A. (2009). Compression for venous leg ulcers. Cochrane Database Syst Rev (1), CD000265; Partsch, H., Clark, M., Mosti, G., et al. (2008). Classification of compression bandages: Practical aspects. Dermatologic Surgery, 34(5), 600-609.

COMPRESSION THERAPIES

TYPE OF COMPRESSION	EXAMPLES	PERFORMANCE CHARACTERISTICS AND MMHG PRESSURE
Light Support	Crepe, rolled gauze	Holds dressings in place No significant compression
Light Compression, support (elastic)	Elastocrepe (BSN medical), Tubigrip (MölnIycke), Medigrip (Medline)	Low pressure, light support 14-17 mmHg
Cohesive bandage	Coban (3M), Co-flex (Andover), Medi-Rip (Hartmann), Sensi-wrap (Dynarex)	Self-adherent, compression well sustained
High elastic compression	Tensopress (BSN Medical), Setopress (MölnIycke), SurePress (Medline)	Sustained compression, wash and reuse 25-40 mmHg
Multilayer high compression 3 or 4 layer	Profore (Smith & Nephew), Comprifore (BSN medical), Dynaflex (Systagenix), FourPress (Hartmann), Fourflex (Medline)	To maintain 35-40 mmHg at the ankle
Inelastic Compression	Short-stretch - Comprilan (BSN medical), Coban 2 (3M), Rosidal K (Lohmann & Rauscher), Farrow Wrap (Farrow Medical)	23-40 mmHg
	Unna's boot paste- Gelocast (BSN medical), Primer (DermaSciences) Duke boot	20-30 mmHg light; 30-40 mmHg regular Zinc oxide impregnated bandage often with calamine (plus cohesive bandage with Duke boot)
	CircAid legging (mediUSA)	Static compression device

Table compiled from information in:

O'Meara, S., Cullum, N.A., & Nelson, E.A. (2009). Compression for venous leg ulcers. *Cochrane Database Syst Rev* (1), CD000265.

H

CLINICAL CLASSIFICATION OF CVI USING THE CEAP CLASSIFICATION (CLINICAL, ETIOLOGY, ANATOMY, PATHOPHYSIOLOGY)

CLASS	CLINICAL SIGNS	
0	No visible or palpable signs of venous disease	
1	Teleangiectases, reticular veins, malleolar flare	
2	Varicose veins, distinguished from reticular veins by a diameter of 3 mm ore more	
3	Edema without skin changes	
4	Skin changes ascribed to venous disease 4a – hyperpigmentation 4c – lipodermatosclerosis 4b – venous eczema 4d – atrophie blanche	
5	Skin changes (as defined above) in conjunction with healed ulceration	
6	Skin changes (as defined above) in conjunction with active ulceration	

SPECIAL CONSIDERATIONS TABLE

All Patients	• Use standardized methods when measuring for compression stockings • Apply compression wraps from metatarsal head to tibial tubercle, including the heel • Assess and monitor pain and circulatory status while using compression
Patient/Caregiver with functional limitations	• Use donning/doffing devices • Use alternative compression device (not a stocking) • Use compression wraps ongoing • Refer to rehabilitation services to address limitations
Patient with atypical shape/size leg	• Use modified compression • Refer to a qualified fitter for custom stockings or garment • Use intermittent pneumatic compression device
Patient with limited financial resources	• Use reusable wrap products • Use reusable garments • Use intermittent pneumatic compression device
Non-ambulatory or bedbound patients	• Use elastic bandages
Patients unable to tolerate 30-40 mmHg compression	• Use lower level of compression to enhance adherence

Figure. Algorithm for compression CVI with and without VLU. (*Continued*)

clinics, long-term care/skilled nursing homes, and home care settings. It was constructed to assist clinicians in these health care settings to determine need for and correctly apply compression for persons with CVI with or without VLU.

However, the algorithm is not meant to provide comprehensive management of CVI with or without VLU. We acknowledge that adjunctive therapies, including pharmacotherapy, remain controversial. Nevertheless, their presence in the algorithm reflects their presence in the daily practice of many clinicians managing patients with CVI with or without VLU rather than an endorsement of these medications, given the paucity of evidence. The algorithm provides evidence- or consensus-based guidance toward selection of product categories when choosing compression; it intentionally avoids recommendation of any specific products. Such choices are profoundly influenced by local factors such as clinician comfort with certain products, facility considerations such as contractual arrangements, and individual patient factors such as tolerance, affordability, and access to specific products.

CONCLUSION

A consensus- and evidence-based algorithm was constructed to aid clinicians select and apply compression for primary prevention, treatment, and prevention of recurrent VLU in patients with CVI. Nurses, physicians, physical therapist, and occupational therapists practicing in all health care settings are strongly encouraged to adapt this algorithm into their practice.

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