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Limb Preservation JOURNAL

LIMB PRESERVATION ALLIANCE:
Behind A New Global Initiative

Advances And Challenges In Diabetic Foot Care: A 50-year Journey

The Influence Of Insoles In The Stability Of People With Transtibial Amputation

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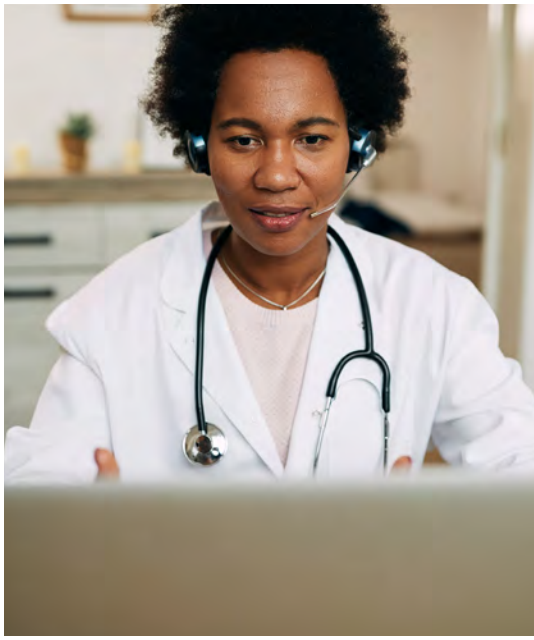

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From the Editor-in-Chief

Dear Colleagues,

Welcome to another issue of the *Limb Preservation Journal*. We are excited to share with you several thought-provoking articles about the state of amputation prevention and to announce the formation of a new Limb Preservation Alliance that brings together Wounds Canada, The American Limb Preservation Society, the Canadian Podiatric Medical Association, and D-Foot International. The focus of the Alliance will be the development of education, advocacy and awareness initiatives that improve limb preservation efforts across the world.

To provide an appreciation for the limb preservation field's rapid development, Dr. William Jeffcoate from the United Kingdom reflects on his decades of service and describes the challenges facing interdisciplinary amputation prevention work in the modern era. Dr. Jeffcoate stresses the importance of adequate documentation and data-gathering in order to better track and improve patient outcomes. This is a recurrent concern that is shared by amputation prevention experts from across the world and is one of the most important challenges to advancing our field.

I believe that part of the solution to overcoming this information barrier is to conduct high-quality mixed methods research studies that combine database and patient-centred research methodologies. In this issue, Dr. Kathleen Stevens and colleagues share an excellent example of such a study. Their practical and informative article combines quantitative and qualitative research methods to validate an education and infrared thermometer-based intervention for preventing diabetic foot complications. The outcomes of such studies are useful in communicating with other clinicians, as well as funding agencies and policy-makers.

Also in this issue are thought-provoking articles on providing individuals experiencing homelessness with adequate footwear support, the tremendous economic burden of diabetes on the health-care system, a review of the use of insoles for improving the outcomes of individuals living with a below-knee amputation and two case reports on the use of novel approaches for managing diabetic foot and venous leg ulcers.

Finally, we are excited to announce that previously published articles in the *Limb Preservation Journal* have been retroactively assigned a Digital Object Identifier (DOI) number to facilitate their tracking and sharing. We hope that you enjoy reading this issue and wish you and your team all the best of success in combating preventable lower extremity amputations.

Sincerely yours,

Ahmed Kayssi, MD MSc MPH FRCSC

In The News

Caribbean Wounds Network (CariWN) Launched

The Caribbean Wounds Network (CariWN), a non-profit initiative, was launched in early 2024. The organization is taking shape and is planning to hold its inaugural hybrid conference (online and in person) in Barbados on Saturday, June 29, 2024.

CariWN has already garnered clinical participation from Guyana, Trinidad and Tobago, Curacao, St. Maarten, Barbados, St. Kitts and Nevis, Antigua and Barbuda, Bahamas and Aruba. The organization has also engaged in a partnership with the University of the West Indies.

The initial focus will be on reducing pressure injuries and diabetic foot ulcers, as well as reducing associated amputations.

CariWN is being established as a not-for-profit organization, addressing the increasing burden of wound care throughout the Caribbean. With an estimated annual cost of $7 billion to health-care systems, there is an urgent need for proper preventative measures, education and health-care services.

The network aims to unite Caribbean nations and leverage resources from the diaspora to collectively tackle the challenges posed by various types of chronic wounds.

CariWN plans to focus on educating health-care professionals, contributing to research, advocating for policy improvements and implementing best practices in wound care. Through establishing partnerships with organizations like Wounds Canada and leveraging technology for knowledge sharing, CariWN is building capacity and competency in wound management across the Caribbean.

Canadian Podiatric Medical Association Involved In Several Initiatives

The Canadian Podiatric Medical Association (CPMA) has expanded its partnerships, becoming a founding member of the global Limb Preservation Alliance, focusing on driving awareness through media and supporting the implementation of guidelines. The association encourages members to engage on social media to amplify messages related to foot health, diabetes awareness and other campaigns throughout the year. Furthermore, the CPMA is looking to increase its profile in podiatric research and is seeking podiatrists interested in research to join or lead their research committee.

The CPMA are active participants in the Pan-Canadian Diabetic Foot Committee, in conjunction with Wounds Canada and several other organizations.

The recent *FIP Global Podiatry Summit* in March 2024 gathered over 400 participants and included keynote speeches emphasizing teamwork in health care and the role of podiatrists, as well as panels on diabetic foot management and sports medicine. The summit aims to continue advancing podiatric medicine through collaboration and innovation.

The CPMA remains committed to working inter-professionally with other professions on research, advocacy and awareness leading to limb

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preservation and the prevention of unnecessary amputations. For more information visit www.podiatrycanada.org.

D-Foot International Hosts Webinar On PAD and Diabetes

On December 9, 2023, D-Foot International welcomed renowned vascular surgeon Prof. Robert J. Hinchliffe for an engaging webinar on *Toe & Flow: PAD & Diabetes.*

Prof. Hinchliffe, who is currently a Professor of Vascular Surgery at the University of Bristol, UK brought a lot of experience to the virtual stage.

The complex association between peripheral arterial disease (PAD) and diabetes was examined in the webinar, which was particularly important considering the increased global prevalence of diabetes.

A member of the International Working Group of the Diabetic Foot, Prof. Hinchliffe contributed knowledge gleaned from his vast clinical and academic experience. During his lecture, he discussed the holistic care of diabetic feet and emphasized the significance of controlling the complicated vascular issues linked to diabetes.

For health-care professionals, the webinar offered a rare chance to learn about clinical decision- making in a practical way. The broad group in attendance received important assistance from Prof. Hinchliffe's nuanced grasp of addressing vascular problems in diabetes patients, as he discussed current research directions in vascular surgery in addition to clinical considerations.

Educational initiatives such as these encourage advancements in diabetic foot treatment and greatly advance patient treatment. For more information visit https://d-foot.org.

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UPCOMING EVENTS

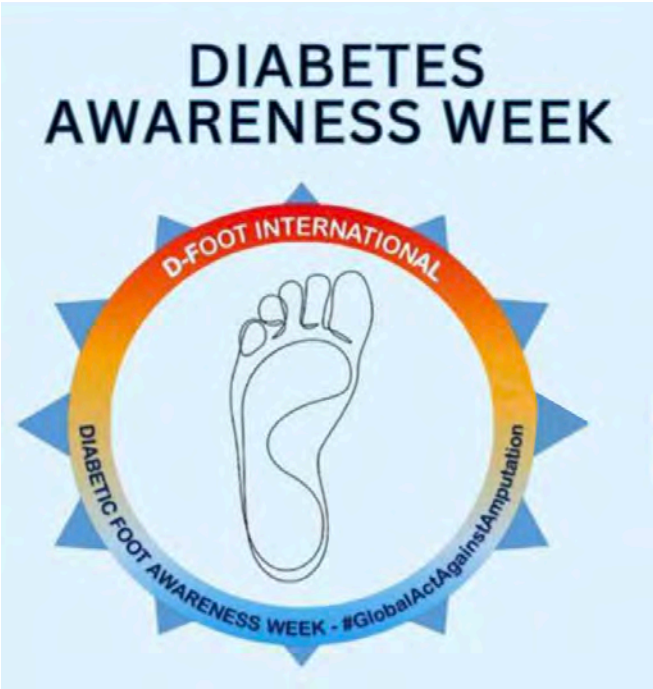
June 13-15: The Ordre des podiatres du Québec's Annual Congress.

September 27-18: The British Columbia Podiatry Association (BCPMA) annual conference, Podiatry North. To be held at the Coast Coal Harbour Hotel in Vancouver.

October 26: Canadian Podiatric Medical Association Virtual Conference.

November 15-16: The Association des podiatres du Québec (APQ) has their Annual Congress.

Diabetes Foot Awareness Week 2024 Scheduled For November



The 2024 version of D-Foot International's *Diabetes Foot Awareness Week* will run from November 7-14.

The week will be highlighted by the **Global Meet** on November 10.

Other events for the week include the following regional meetings:

African Region: November 7.

SACAR Region: November 8.

NACAR Region: November 9.

MENAR Region: November 11.

Europe Region: November 12.

SEAR Region: November 13.

WP Region: November 14.

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CASE REPORT

Successful Treatment Of A Chronic Venous Leg Ulcer Using The VenaSeal™ Closure System

Maryana Shlimun, Leslie Summers deLuca PhD **and Ahmed Kayssi** MD

Abstract: The VenaSeal™ procedure is a minimally-invasive intervention for the treatment of lower extremity superficial venous insufficiency. The VenaSeal closure system uses a medical-grade cyanoacrylate glue to seal incompetent veins. This adhesive collapses the vein walls, preventing blood flow in the treated incompetent superficial veins and forcing blood to travel in the deep venous circulation. This results in the relief of lower extremity superficial venous congestion and improvement in the side effects of venous insufficiency such as swelling, achiness, symptomatic varicosities and venous ulcers. In this report, we describe a case of a 62-year-old man who underwent successful VenaSeal therapy of the great saphenous vein (GSV) for treatment of a venous leg ulcer (VLU).

Key words: *VenaSeal closure system, lower extremity superficial venous insufficiency, cyanoacrylate glue, venous leg ulcer.*

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Introduction

Venous leg ulcers are late indicators of chronic venous insufficiency (CVI) and long-standing venous hypertension.[1] Under normal circumstances, competent intraluminal valves and calf muscle contraction promote the antegrade flow of blood and prevent retrograde flow along the veins of the leg.[2] Obstruction and retrograde venous flow will lead to eventual chronic venous hypertension that can result in the formation of venous leg ulcers (VLUs).[3] VLUs are the most common type of lower extremity chronic wounds that impact approximately 1-3% of the elderly population in the United States and Europe.[4] VLUs are not only burdensome to the patient but have a significant financial burden on the worldwide health-care system.[5] Evaluation of these patients starts with taking a thorough history and performing a physical examination with appropriate description of the wound, including its area, depth, edges, infection signs and the presence of any skin colour changes. Confirming adequate arterial blood-flow is also important in evaluating ulcer etiology, as 20% of patients with VLUs have concomitant arterial disease.[6] Colour flow duplex ultrasound of the superficial veins is another inexpensive, non-invasive and highly informative diagnostic test to assess venous valve incompetence.[7] The mainstay of care for VLUs is with compression therapy and wound management, with the ultimate goal of reducing leg edema to facilitate wound closure. Conservative treatment measures include medical compression, intermittent pneumatic compression (IPC), manual lymphatic drainage and extracorporeal shockwave therapy (REF). Compression therapy is the most practical and economical intervention for the treatment of VLUs.[8] Advanced cases that have failed standard therapy may benefit from invasive interventions that aim to obliterate or remove incompetent veins through various techniques, including vein stripping, endovenous ablation with thermal and non-thermal modalities and sclerotherapy.[2] Studies have shown improved healing time and decreased

ulcer recurrence with early endovenous intervention.[9] The VenaSeal closure system is a non-thermal endovenous therapy used in the treatment of venous insufficiency. The VenaSeal™ closure system employs medical-grade cyanoacrylate glue for the permanent closure of lower extremity superficial truncal veins by endovascular embolization with coaptation. The system consists of a single sterile patient kit that includes the VenaSeal adhesive and delivery system components. This case report describes the treatment and outcome in the use of the VenaSeal Closure system for treatment of a VLU in a single patient with chronic venous insufficiency who failed standard therapies. Written consent was obtained from the patient for sharing the details of his treatment in this report.

Patient History And Treatment Plan

A 62-year-old man with an 18-year history of recurrent bilateral lower extremity venous stasis ulcers presented with an active left leg venous ulcer. The patient had a past medical history of hypercholesterolemia, hypertension and diabetes mellitus. He had no other surgical or medical history and was not a smoker.

Despite compliance with wearing high-grade compression stockings, the ulcers recurred annually. On examination, the patient had palpable pedal pulses and no evidence of significant lower extremity peripheral arterial disease on a Doppler ultrasound. A lower extremity venous duplex scan demonstrated a valvular incompetence of > 0.5 seconds in the great saphenous veins bilaterally, with the longest durations being 2.07s and 0.77s in the right and left veins, respectively. Physical examination of the right leg revealed a medial malleolar ulcer measuring 727.82mm^2. Treatment options for venous stasis and venous ulcers were discussed with the patient, including the risks and benefits of saphenous vein stripping, as well as the VenaSeal closure system. The patient decided to proceed with the VenaSeal procedure.

Treatment

The patient underwent endovenous ablation of the right great saphenous vein (GSV) using the VenaSeal Closure System (Medtronic plc, Minneapolis, MN) in an ambulatory clinic. With the patient lying in the supine position, the right leg was prepped with chlorhexidine solution and draped. A diagnostic evaluation of his right GSV was carried out using ultrasound. After careful preparation and diagnostic examination, the skin overlying the right GSV below the knee was infused with lidocaine solution, and a small incision was made with an 11 blade. Seldinger technique was used to access the right GSV with an access needle followed by a starter wire. A 7 French (Fr) short sheath (Terumo Corporation, Tokyo, Japan) was then advanced to the vein in a retrograde direction. A J-wire was then advanced to the right saphenofemoral junction. The VenaSeal catheter was advanced 10 cm proximal to the junction and the injection catheter was advanced to 5 cm proximal to the junction within the VenaSeal catheter. An initial injection of adhesive was dispensed, and pressure was immediately applied to the vein for three minutes. Adhesive injections were then serially administered in 3 cm increments, with pressure held on each segment. Once the complete length of the target vein had been injected proximal to the access site, the catheter was removed. Pressure was then applied to the entry site for several minutes until adequate hemostasis was achieved.

To ablate the GSV below the venous ulcer, the above steps were repeated in the antegrade direction. Seldinger technique was used to access the right GSV with an access needle followed by a starter wire. A 7 Fr short sheath was advanced into the GSV and a J-wire was then advanced distally. The VenaSeal catheter was advanced into the GSV distal to the leg ulcer at the right medial maleolus. An initial injection of adhesive was dispensed and pressure was applied to the vein for three minutes. Serial injections were then applied in 3 cm increments. Once the complete length of the target vein distal to the access site had been injected, the catheter was removed and pressure was held for a further few minutes at the second entry site. Complete vein blockage was confirmed using ultrasound. A total of 2 mL of adhesive was administered to close the GSV. The procedure was

completed in 90 minutes with no complications. The skin access sites were cleaned, a dressing was applied and a compression stocking was donned onto the right leg before the patient was discharged.

Clinical Outcome

At one week follow-up post-VenaSeal treatment, the patient reported full compliance with compression stockings and no complications. A duplex ultrasound of the patient's right lower extremity confirmed full closure of the target GSV. There was no evidence of deep venous thrombosis (DVT) and the deep venous system appeared patent and compressible. The superficial venous valvular incompetency of >0.5 seconds (longest duration 2.07 seconds) noted one month prior was no longer observed.

At one month follow-up post-endovenous VenaSeal treatment, the patient reported full compliance with compression stockings and no complications. Venous duplex scans of the patient's right lower extremity confirmed persistent GSV ablation. Physical examination indicated that the ulcer was reduced to 535 mm^2 in size.

Venous duplex scans of the patient's right lower extremity at one, two and three months post-treatment confirmed persistent GSV ablation, no change in venous valvular competency and no evidence of DVT. The patient reported full compliance with compression stockings at these time points. On physical exam, ulcer healing was noted at each time point, with an ulcer size of 535 mm^2 at one month (27% healing), 306 mm^2 at 2 months (58% healing) and 105 mm^2 at three months (86% healing).

On physical examination at six months post-VenaSeal closure, the right venous ulcer had healed completely and the patient reported no skin breakdown or ulcer recurrence. A venous duplex ultrasound of the patient's right lower extremity

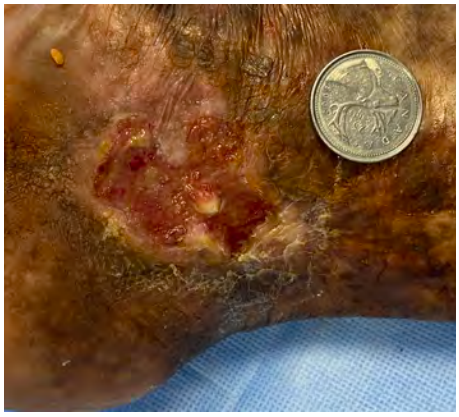

Figure 1: Baseline.

Figure 2: One month post procedure.

Figure 3: Two month post procedure.

Figure 4: Three months post procedure.

Figure 5: Six months post procedure.

Figure 6: Twelve months post procedure.

confirmed the ongoing ablation of the GSV with no change in valvular competency and no DVT. Mildly dilated subcutaneous channels were noted in the lower leg suggestive of lymphedema. The patient reported full compliance with compression stockings.

At a one year follow-up, a venous duplex ultrasound of the patient's lower leg confirmed continued GSV ablation, no change in venous valvular competency and no evidence of DVT. The patient reported continued full compliance with compression stockings and no evidence of lymphedema was noted on ultrasound. On physical examination, there was no evidence of skin breakdown or ulcerations. At a five year follow-up by phone, the patient denied any skin breakdown or recurrence of his right leg wound and reported feeling well (See Figures 1-6).

Discussion

Compression-based therapies are often used as the first line of treatment for VLUs.[7] However, when used alone, these therapies have been linked to recurrence and low healing rates.[8] In this case report, we describe a patient with an 18-year history of recurrent VLUs despite standard care treatments, including compression therapy. Thermal and non-thermal minimally invasive endovenous closure techniques provide an alternative treatment to those suffering from recurrent venous ulcers as they are linked with decreased healing times and low recurrence rates,[9] as was the case for our patient.

The VenaSeal adhesive is made from an n-butyl-2-cyanoacrylate formulation. The delivery components aid in the positioning and delivery of the cyanoacrylate adhesive within the target vein. Once the adhesive is administered into the vein, it polymerizes when in contact with body tissues through an anionic mechanism.[10] This reaction obstructs venous blood flow, resulting in long-term blockage.

A 12 month follow up of the Venaseal Sapheon Closure System Pivotal Study (VeClose) demonstrated that cyanoacrylate closure was effective and non-inferior to thermal ablation in the treatment of GSV incompetence.[9] The study involved the randomization of 222 patients with CVI to either treatment option. When compared to radiofrequency ablation (RFA), which employs thermal energy rather than an adhesive to treat CVI, patients who underwent cyanoacrylate closure had faster therapeutic success and a reduced risk of vein recanalization.[9] A five year follow-up of the VeClose study revealed long-term success and durability of the VenaSeal closure system in patients with saphenous incompetence, with lasting closure and recanalization-free survival rate.[11] Furthermore, due to the positive outcomes associated with VenaSeal treatment, 100% of patients in the study who received cyanoacrylate closure reported being satisfied with their therapy.[11]

Kolluri et al. conducted a meta-analysis of 20 randomized controlled trials that compared the efficacy of the VenaSeal closure system with other endovenous procedures for the treatment of CVI.[12] Therapies that were studied included endovenous laser therapy (EVLT), RFA, mechanochemical ablation, sclerotherapy and surgery. When compared to other treatments, VenaSeal had the highest probability of anatomic success of complete closure of the treated vein within six months of intervention.[12] In addition, the VenaSeal closure system ranked first in the reduction of postoperative pain and lowest in the incidence of adverse events. The occurrence of DVT with Venaseal was the lowest of all treatments.[12] These findings are consistent with our patient, since no adverse reactions, such as DVT, were seen after therapy.

Although studies have revealed lower adverse reactions to VenaSeal compared to other therapies, there have nonetheless been reports of allergic and inflammatory responses to the cyanoacrylate glue.[13] The VenaSeal Closure system should not be administered to individuals with hypersensitivity to adhesive and cyanoacrylates.[10]

Conclusion

This report describes a unique therapeutic approach involving treatment of a chronic venous ulcer secondary to CVI using the VenaSeal Closure System. The patient had a significant 18-year history of chronic, bilateral and recurring venous

ulcers for which he had undergone standard of care treatment with wound care and compression therapy. Using the VenaSeal Closure System, the culprit refluxing right GSV was fully ablated by the endovenous VenaSeal treatment, and the target GSV remained closed as verified by a duplex ultrasound up to one year post-treatment with no wound recurrence at a five year follow-up.

Maryana Shlimun is with the Division of Vascular Surgery, Department of Surgery, University of Toronto, Ontario, Canada.

Leslie Summers deLuca PhD is with the Division of Vascular Surgery, Department of Surgery, University of Toronto, Ontario, Canada.

Ahmed Kayssi* MD is with the Division of Vascular Surgery, Department of Surgery, University of Toronto, Ontario, Canada.

*Correspondence should be directed to: Dr. Ahmed Kayssi, 2075 Bayview Avenue H432, Toronto, ON M4N3M5. Email: ahmed.kayssi@sunnybrook.ca

References

1. Bonkemeyer Millan S, Gan R, Townsend PE. Venous ulcers: diagnosis and treatment. Am Fam Physician. 2019 Sep 1;100(5): 298-305.
2. Santler B, Goerge T. Chronic venous insufficiency: a review of pathophysiology, diagnosis, and treatment. J Dtsch Dermatol Ges. 2017 May;15(5): 538-556. DOI: 10.1111/ddg.13242
3. Nelson EA, Adderley U. Venous leg ulcers. BMJ Clin Evid. 2016 Jan 15:2016:1902.
4. Margolis DJ, Bilker W, Santanna J, Baumgarten M. Venous leg ulcer: incidence and prevalence in the elderly. J Am Acad Dermatol. 2002 Mar;46(3): 381-6. DOI: 10.1067/mjd.2002.121739
5. Phillips CJ, Humphreys I, Thayer D, Elmessary M, Collins H, Roberts C, et al. Cost of managing patients with venous leg ulcers. Int Wound J. 2020 Aug;17(4): 1074-1082. DOI: 10.1111/iwj.13366
6. Andriessen A, Apelqvist J, Mosti G, Partsch H, Gonska C, Abel M. Compression therapy for venous leg ulcers: risk factors for adverse events and complications, contraindications: A review of present guidelines. J Eur Acad Dermatol Venereol. 2017 Sep;31(9): 1562-1568. DOI: 10.1111/jdv.14390
7. Ennis WJ, Meneses P. Standard, appropriate, and advanced care and medical-legal considerations: part two-venous ulcerations. Wounds. 2003;15(4): 107-122.
8. Harlander-Locke M, Lawrence P, Jimenez JC, Rigberg D, DeRubertis B, Gelabert H. Combined treatment with compression therapy and ablation of incompetent superficial and perforating veins reduces ulcer recurrence in patients with CEAP 5 venous disease. J Vasc Surg. 2012 Feb;55(2): 446-50. DOI: 10.1016/j.jvs.2011.08.009
9. Morrison N, Gibson K, Vasquez M, Weiss R, Cher D, Madsen M, et al. VeClose trial 12-month outcomes of cyanoacrylate closure versus radiofrequency ablation for incompetent great saphenous veins. J Vasc Surg Venous Lymphat Disord. 2017 May;5(3): 321-330. DOI: 10.1016/j.jvsv.2016.12.005
10. VenaSeal closure system product code: VS-402 instructions for Use. VenaSeal, ClosureFast and Monoject are trademarks of a Covidien company. 2014 Covidien llc. PT-11348-01 Rev D, 2015-02.
11. Morrison N, Gibson K, Vasquez M, Jones A. Five-year extension study of patients from a randomised clinical trial (VeClose) comparing cyanoacrylate closure versus radiofrequency ablation for the treatment of incompetent great saphenous veins. J Vasc Surg Venous Lymphat Disord. 20 2020 Nov;8(6): 978-989. DOI: 10.1016/j.jvsv.2019.12.080
12. Kolluri R, Chung J, Kim S, Nath N, Bhalla BB, Jain T, et al. Network meta-analysis to compare VenaSeal with other superficial venous therapies for chronic venous insufficiency. J Vasc Surg Venous Lymphat Disord. 2020 May;8(3): 472-481.e3. DOI: 10.1016/j.jvsv.2019.12.061
13. Jones AD, Boyle EM, Woltjer R, Jundt JP, Williams AN. Persistent type IV hypersensitivity after cyanoacrylate closure of the great saphenous vein. J Vasc Surg Cases Innov Tech. 2019 Aug 7;5(3): 372-374. DOI: 10.1016/j.jvscit.2019.05.004

Limb Preservation Alliance: Behind A New Global Initiative In Limb Preservation Education, Advocacy and Awareness

Ian Corks and Loukia Papadopoulos MSc

Abstract: The Limb Preservation Alliance (LPA) is a new international collaboration between four founding organizations: Wounds Canada, the American Limb Preservation Society, the Canadian Podiatric Medicine Association and D-Foot International. The LPA is dedicated to advancing limb preservation education, advocacy and awareness. In this article, principals from the founding organizations answer questions on the new organization, it's objects and the way forward.

Key words: *Limb Preservation Alliance, limb preservation, education, awareness, advocacy, international cooperation.*

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In November of 2023, Wounds Canada (WC), The American Limb Preservation Society (ALPS), the Canadian Podiatric Medical Association (CPMA) and D-Foot International (D-Foot Intl.) announced an innovative global collaboration to bring change to the fight for limb preservation. The new Limb Preservation Alliance (LPA) unites regional, national and international organizations to fight against unnecessary limb amputations. This alliance combines efforts in education, advocacy and awareness.

Every 20 seconds, somewhere around the world, someone loses their leg due to the complications of diabetes.[1] Moving away from a time when amputation stood as the sole recourse, today's approach emphasizes preserving resections and undertaking intricate reconstructions, marking a significant leap forward in treating diabetic foot ulcers. In recent decades, the realm of diabetic foot ulcers and their complications has witnessed remarkable progress. Amputation is no longer the exclusive solution for managing damaged bone and soft tissue in extremities. Function-preserving alternatives for such lesions have become standard practice, offering effective local control without jeopardizing overall disease survival. This shift has not only documented improvements in the quality of life for patients, but has also rendered amputation no longer the primary approach.

Limb Preservation Journal staff asked the founding members of the LPA to comment on the objectives and role of the LPA and how it will work together on future projects and campaigns to raise awareness for limb preservation best practices.

1. How did the idea of the Limb Preservation Alliance (LPA) come about?

Zulfiqarali G Abbas: The collaboration stems from the shared common goal between the organizations in addressing the escalating challenges in limb preservation on a global scale. It is becoming more evident that a coordinated, cooperative effort

Zulfiqarali G Abbas MBBS M Med DTM&H (UK) FRCP (Glasgow) FRCP (London)

Consultant Physician,
Dar es Salaam, Tanzania

President, D-Foot International

Howard Green DPM DABPS FACFAS

President,
Canadian Podiatric Medical Association

Mariam Botros DCh DE IIWCC Med

Chief Executive Officer,
Wounds Canada

Georgia Krehbiel MBA

CEO,
American Limb Preservation Society

is necessary due to the surging prevalence of diabetic foot complication and the pressing need for comprehensive limb preservation measures.

Mariam Botros: From both a global and Canadian standpoint, the inception of the Limb Preservation Alliance was prompted by a recognition of the urgent need for action in addressing the escalating issue of traumatic amputations. Wounds Canada has long been committed to empowering health-care providers to enhance wound care practices, aiming to provide optimal care for individuals with wounds or those at risk of developing them with the ultimate goal of improving quality of life and preventing limb loss.

However, a sobering 2023 study revealed a significant rise in the number of global limb amputations indicating that, "the incidence and prevalence number of global traumatic amputation increased from 11.37 million and 370.25 million in 1990, to 13.23 million and 552.45 million in 2019."[2] This research underscored the severity of the situation we find ourselves in today.

The numbers were staggering, indicating a pressing need for intervention. Particularly concerning was the revelation that up to 85% of lower limb amputations attributed to diabetes could be prevented. According to Diabetes Canada, approximately 5,000 diabetes-related amputations are performed annually, with a potential annual growth rate of 4%, resulting in substantial health-care costs. In fact, the average cost to treat a lower limb amputation in Canada is approximately $120,000.00.[3]

Faced with these alarming statistics, it became evident that concerted efforts were imperative. Recognizing the power of raising awareness as a catalyst for change, we sought collaboration with like-minded organizations sharing our mission. This collaborative effort gave rise to the Limb Preservation Alliance, an initiative aimed at driving progress and effecting positive change in the field of limb preservation.

Howard Green: The Canadian Podiatric Medical Association has been working closely with Wounds Canada on limb preservation advocacy for a number of years. This is an area that is important for podiatrists as we work to save patients from unnecessary amputations. Research in that area is typically presented at the [Canadian] Limb Preservation Symposium and/or published in the *Limb Preservation Journal*. The goal is to work with others globally to move research and policy frameworks forward.

Georgia Krehbiel: It is believed that somewhere around the world, someone loses their leg due to

complications related to diabetes or peripheral artery disease (PAD) every 20 seconds.[1] The LPA was established to bring a multinational and multidisciplinary effort to the forefront of this global health crisis. By raising awareness and promoting early collaborative and multidisciplinary intervention, we aim to reduce the incidence of unnecessary amputations and improve patient outcomes and overall limb salvage rates on a global scale.

2. What do you hope this alliance will achieve?

Zulfiqarali G Abbas: The pathway to this alliance is characterized by the in-depth discussions, shared insights and an absolute recognition that our combined abilities will have an impactful revolutionary effect. An alliance with mutual goals, a shared set of ideologies and determined efforts will produce a positive change in the realm of limb preservation.

Mariam Botros: Through a comprehensive approach encompassing education, research, advocacy and awareness, our Alliance is committed to driving a significant reduction in preventable amputations, both in Canada and the US, as well as on a global scale. By empowering health-care professionals and caregivers with knowledge of effective wound care practices, we aim to equip individuals with the tools needed to preserve their limbs and mitigate the risk of amputation.

Furthermore, our advocacy efforts focus on influencing policy changes to foster greater awareness and education on this crucial issue. Concurrently, we are dedicated to supporting international research initiatives aimed at advancing the understanding and treatment of wounds to ultimately prevent unnecessary amputations. This holistic approach is especially vital in underserved regions where access to health care is limited, emphasizing the importance of self-care and community support in preventing amputation.

Howard Green: We hope the LPA will help raise awareness on this issue and translate into fewer amputations for patients. Locally, in Canada, our work in the LPA will hopefully aid advocacy efforts with government and policy makers to ensure that proper funding and systems are in place.

Georgia Krehbiel: I am hopeful the Alliance will advance the field of limb preservation by fostering collaboration, innovation and education among global health-care professionals in the field and will bring a unified, organized front to this health issue. In order to accomplish this, we must facilitate joint research initiatives, establish standardized protocols, enhance the understanding and treatment of limb-threatening conditions and drive policy change.

Addressing the racial and economic global health inequities in limb preservation care is also at the forefront of our mission. By driving greater awareness of these disparities and advocating for policies and measures to reduce them, the Alliance can help ensure that individuals, regardless of race, socioeconomic status or geography, have access to timely and quality limb-saving care. The Alliance's end goal and greatest achievement would be to reduce the incidence of preventable amputations and improve the quality of life for individuals dealing with limb-related health issues. While these tasks may be daunting, I believe the collective commitment, dedication and expertise of our Alliance provides hope for meaningful progress toward reducing disparities and advancing health equity in limb preservation care.

3. What has been its impact thus far?

Zulfiqarali G Abbas: Our work with LPA reflects a strong commitment to our core mission of: "ending avoidable lower-limb amputations due to diabetes worldwide". We aim to synergize our efforts to reduce the burden of limb related complications, globally. This powerful alliance positions the organization at the forefront of limb preservation innovation, advocacy and research. We envision a future where the incidence of limb complication is significantly minimized with subsequent optimized patient outcomes and an improved quality of life.

As we begin this new chapter together, the strength of our Alliance lies not just in the organizational collaboration, but unity of purpose and collective dedication of every member involved. I

am confident that this collaboration is a momentous turning point in our history and together we will script a narrative of success, achievements and dedication to limb preservation.

Mariam Botros: Our awareness campaigns conducted throughout 2023 and into early 2024 have garnered favourable reception. Collaborating closely with fellow Alliance members has amplified our reach, enabling us to disseminate our message to a broader audience. Additionally, our joint global research initiatives on policy priority setting have begun laying the groundwork for comprehensive strategies to address this pressing issue on an international scale. While we are still in the early phases, these initial outcomes signify a solid foundation for future progress.

Howard Green: We have combined efforts with our partners to reach out to the public and health-care professionals using social media. Patient education is a key issue.

Georgia Krehbiel: The impact of the LPA has been promising. So far through the Alliance, we've seen increased awareness and collaboration among a growing network of professionals dedicated to limb preservation. We have already partnered on numerous awareness campaigns for both patients and providers. We have also partnered on educational webinars led by ALPS board members and experts in the field of the diabetic foot. We will soon embark on our first collaborative research initiative, engaging global leaders and experts in the diabetic foot and gaining insights on priority and implementation timelines of the IWGDF recommendations. We are hopeful this will help policy makers better understand the complexities of the diabetic foot and identify priorities that will globally improve patient outcomes and ultimately help end preventable amputations.

4. What are your plans for the future of this alliance?

Zulfiqarali G Abbas: Our vision for the future of this alliance is revolutionary. Our goal is to become a global powerhouse in the world of limb preservation. This alliance fosters an array of collaborative research opportunities, seminars, workshops, conferences, and harbours a strong knowledge sharing and networking platform. Our plans also involve initiating dialogue on innovation, disseminating education and sharing patient care paradigms. The ultimate goal is to create a network that not only responds effectively to the current challenges but also addresses the future trends in the realm of limb preservation.

The key to our success lies in the hands of the members. Their active participation is essential to achieving our group's goal. Their knowledge, clinical expertise and dedication are crucial in establishing cutting-edge approaches to disseminate education to the health-care professionals. As I say and will always continue to say, "education is our most powerful tool", particular in low to middle-income countries. By providing valuable education, health-care professionals will directly impact our patients, increase awareness and improve approaches to limb preservation.

Mariam Botros: As more and more organizations join our efforts, we hope to see a significant change in wound-related policies, advancements, research and technology. It goes without saying that we would like to see more funds allocated to limb preservation initiatives to continue to support the many wonderful organizations doing incredible work in the field. Ultimately, we hope to see a future where wounds are treated early and efficiently removing the need for all preventable limb amputations.

In addition, the ongoing research on policy priority setting forms a robust cornerstone for our future advocacy, awareness and training strategies for the years ahead. As we progress, with the addition of more organizations to our cause, we anticipate a substantial transformation in wound-related policies, research advancements and technological innovations. It is imperative to allocate increased funding towards initiatives focused on limb preservation, thereby bolstering the efforts of numerous organizations contributing remarkable work in this field. Ultimately, our vision is to cultivate a future where wounds are promptly and effectively treated, thus eliminating all preventable limb amputations.

Howard Green: We need to still reach out to government and policy makers. We also continue to target the general public and media.

Georgia Krehbiel: Looking ahead, I am hopeful that we can expand the reach and influence of the LPA to include other global partners who are making a difference in the field. This includes forging new partnerships, engaging in strategic collaborations with research institutions and industry and continuing to advocate for the integration of limb preservation practices into mainstream health-care, as well as underserved populations. I hope to establish the Alliance as a globally recognized authority in limb preservation, with the capacity to drive policy changes, influence medical education and contribute to advancements in research and technology.

5. How can health professionals working in limb preservation help the Alliance achieve its goals?

Zulfiqarali G Abbas: D-Foot International has always worked to improve diabetic foot care globally. However, our partnership with LPA amplifies our influence. By continuing our unique missions inside this alliance, we make sure that our combined efforts transcend beyond to create a powerful force for positive change. As we embark this new journey together, let us reflect on the profound potential we at D-Foot International and LPA possess.

Mariam Botros: Health professionals specializing in limb preservation play a pivotal role in advancing the goals of our Alliance. By joining as members of their respective associations, they become integral parts of the supporting network of organizations dedicated to advancing education, advocacy and awareness. Through their expertise and resources, they can actively contribute to our mission and amplify our collective efforts. The more informed and active professionals and public members we have onboard, the greater our potential to effect tangible change and progress in the field. Together, we can elevate the significance of proper care practices, reducing health-care costs preserving limbs and saving lives.

Howard Green: All health professionals (podiatrists, nurses, vascular surgeons, endocrinologists, etc.) need to help amplify the messages and advocate for best practices and funding of such initiatives. Health professionals can work to promote and implement international guidelines, and the main reason for this is that it's all about helping patients avoid unnecessary amputations.

Georgia Krehbiel: Health professionals in limb preservation play a crucial role in the success of the Alliance. Active participation or membership of one or more of the founding organizations will help health-care professionals keep apprised of what is happening with the Alliance and get involved. Participating in events such as conferences, workshops and collaborative projects is crucial for the Alliance to reach diverse populations across the globe and promote proactive approaches to limb preservation. Furthermore, spreading awareness about the importance of limb preservation and advocating for multidisciplinary approaches within professional circles and broader health-care communities will help the Alliance achieve its overarching goals. Ultimately, the commitment of health professionals will be instrumental in making a lasting and meaningful impact. ■

Ian Corks is Editor, Major Publications, Wounds Canada, Toronto ON.

Loukia Papadopoulos MSc is Editorial Assistant, Wounds Canada, Toronto ON.

Editor's note: Responses have been edited for length and clarity.

References

1. International Working Group on the Diabetic Foot. IWGDF Guidelines. 2023 Update. Available from: https://iwgdfguidelines.org/introduction
2. Yuan B, Hu D, Gu S, Xiao S. The global burden of traumatic amputation in 204 countries and territories. Front Public Health. 2023 Oct 20:11:1258853. DOI: 10.3389/fpubh.2023.1258853
3. Diabetes Canada. Diabetes 360°: The science behind the numbers. Available from: https://www.diabetes.ca/DiabetesCanadaWebsite/media/Advocacy-and-Policy/Diabetes_CND_24HR_InfoSheets.pdf

Limb Preservation JOURNAL

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Launched in 2019 as *Limb Preservation in Canada,* the journal is the cornerstone of a limb preservation community that, in addition to clinicians, educators and researchers, includes patients, advocates, administrators and policy makers. Recognizing that the challenges associated with limb preservation are global and impact health-care professionals around the world, and identifying the lack of a dedicated clinical publication, the *Limb Preservation Journal* has expanded its scope to also invite submissions from the international limb preservation community.

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Phone: 416-485-2292 · Fax: 416-485-2291 · info@woundscanada.ca · woundscanada.ca
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The Pairing Of Patient-Oriented Research And Mixed Methods Research For Prevention Of Foot Complications Related To Diabetes: An Exemplar

Kathleen Stevens RN PhD, **Donna Moralejo** RN PhD, **Steven Ersser** RN PhD
and Cathy MacLean MD

Abstract: With increasing prevalence of diabetes and diabetic foot ulcers worldwide, practical interventions that are patient-centred are needed to prevent foot complications. In this article, we describe how we used patient-oriented and mixed methods research, using an exploratory and explanatory mixed methods sequence, to develop and test an education and infrared thermometer-based intervention to prevent foot complications for patients with diabetes. We argue that instead of employing a randomized controlled trial alone, the pairing of these methodological approaches offered more. We learned not only that, but also how the thermometer supports foot self-management. Pairing patient-oriented and mixed-methods research offers many benefits for developing and testing effective and practical interventions and can provide pertinent information to clinicians and policymakers for practice and policy.

Key words: *diabetic foot complications, prevention, thermometer-based intervention, patient-oriented research, mixed methods research.*

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Background And Purpose

The incidence and prevalence of diabetes is increasing worldwide, resulting in an increase in the number of people who are experiencing foot complications that can lead to diabetic foot ulcers (DFUs) and amputation.[1] With these increases, the global burden is high and impacts both individuals and health-care systems. Prevention of foot complications is critical, as stressed in the recently released *2023 International Working Group on the Diabetic Foot (IWGDF) Guidelines.* Research evidence is needed to develop and test practical interventions that meet patients' needs, thus guiding policy and practice regarding the most cost-effective interventions to prevent DFUs and amputation.[2] A randomized controlled trial (RCT) is an appropriate design to test how well an intervention works, and attention is paid to methodological rigour. However, more is needed because an RCT may not capture why the intervention is working or why it is not working. Therefore, researchers need to know more about patient circumstances and the local context to help explain results. In our experience, patient-oriented research (POR) and mixed methods research (MMR) are methodological approaches that will help fulfill this research mandate.

Designing patient-oriented interventions would allow researchers to identify potential issues and address these as part of the intervention to ensure research is relevant to patient needs. POR is, "a continuum of research that engages patients as partners, focusses on patient-identified priorities and improves patient outcomes."[3] The patient

is defined as a person, family member, or friend who has experience with the health issue.[3] Funding agencies in several countries promote POR, including the Canadian Institute of Health Research's Strategy for Patient Oriented Research in Canada, the Patient-Centered Outcome Research Institute in the United States and the National Institute for Health Research's INVOLVE in the United Kingdom.

MMR is an approach that can help operationalize POR and ensure that practical interventions are developed and tested. In MMR, quantitative and qualitative data are collected and integrated; the qualitative data might inform an intervention or a quantitative evaluation or might explain results obtained in the quantitative phase. Integrating both sets of data provides more comprehensive evidence and a better understanding of the research problem than could be obtained from qualitative or quantitative data alone.[4]

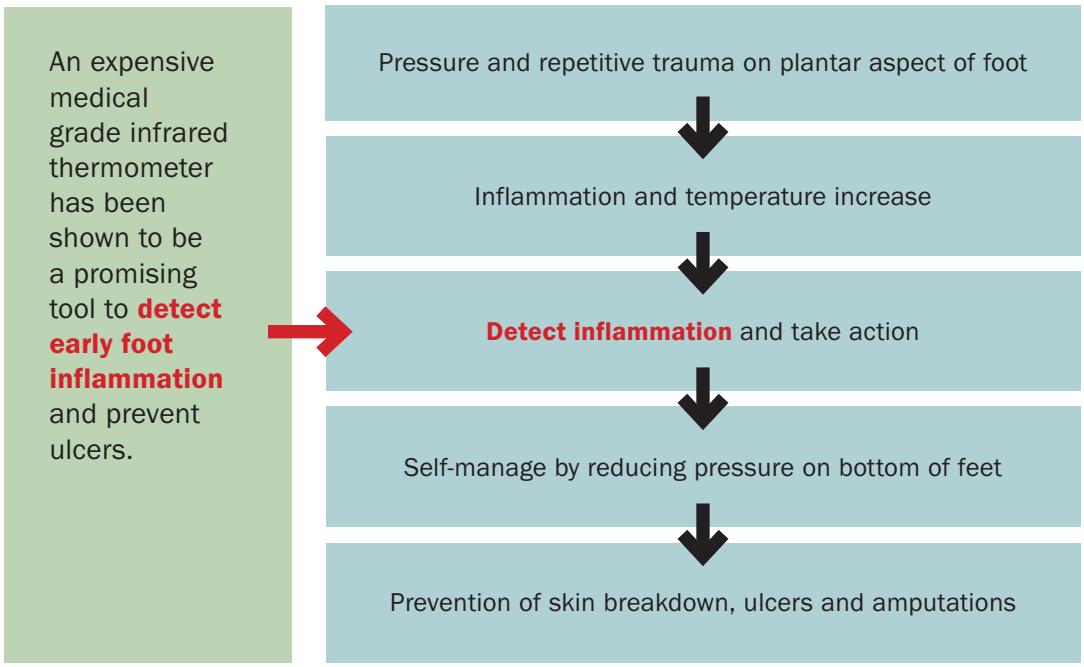
In this article, we will discuss the results of an MMR study to illustrate how using MMR and POR to develop and test an intervention provided benefits that would not have been gained through only one approach or an RCT alone. We will show how pairing these two approaches offers substantial benefits for testing practical and patient-centred interventions. First, we will provide a brief overview of the exemplar study background and method. Next, we will give specific examples showing the benefits of using MMR and POR.

Overview Of The Exemplar Study

The exemplar study is an MMR and POR study that we conducted focused on developing and testing a foot self-management intervention for patients with diabetes. Self-management is defined as, "the ability of individuals and or their caregivers to engage in the daily tasks required to maintain health and well-being or to manage the physical, psychological, behavioural and emotional sequelae of a chronic disease based on the knowledge of the condition, its consequences, and the plan of care co-developed with their health-care team."[5]

To help prevent DFUs and amputation, as health-care providers (HCPs), we need to promote self-management strategies with our patients that both prevent skin breakdown and detect early signs of skin breakdown, so actions can be taken to prevent deterioration. Skin breakdown is caused by pressure and repetitive stress on the bottom of the foot, leading to inflammation. If patients do not detect the inflammation, and thus do not take action, skin breakdown can result.[6] A temperature difference greater than 4 degrees Fahrenheit (F) or higher between the left and right foot indicates inflammation.[7] If patients know they have inflammation, they can rest or remove sources of pressure

Figure 1: Prevention of Plantar Skin Breakdown and the Infrared Thermometer. This figure illustrates the process of plantar skin breakdown and how the thermometer can detect inflammation.



until the inflammation decreases. As shown in Figure 1, using an expensive $700 infrared thermometer is a promising self-management strategy that patients can use to detect early foot inflammation and prevent ulcers.[8,9,10] A commercially-available infrared thermometer that costs between $30 and $100 was validated against the medical-grade thermometer but had yet to be widely tested in practice.[11] [*Editor's note:* all costs in CDN dollars.]

Based on the research literature available at the time of the study, it would have been appropriate for us to conduct an RCT and evaluate the commercially-available infrared thermometer in practice. An RCT would have told us about the effectiveness of the thermometer. However, we know that foot-self management is complex and impacted by many factors, such as knowledge of diabetes and foot health self-management, as well as physical abilities.[12,13] The addition of daily thermometer readings needed to be understood in the wider and local context and was best explored using POR strategies and qualitative and quantitative data that could be collected using an MMR design. Therefore, we designed and conducted an MMR and POR study and received ethics approval from the Newfoundland and Labrador Health Research Ethics Authority. Further details about the methods and results of the study are described elsewhere.[14,15,16]

The research questions we addressed were:

1. What are the issues related to self-management of feet?
2. Does a foot health intervention that utilizes a commercially-available infrared thermometer improve foot outcomes?
3. What are the participants' experiences with foot health self-management and the intervention?

To best answer these questions, we designed an MMR study to support developing and testing an intervention that attempted to address the multiple factors impacting self-management and foot health. The MMR study had three phases with exploratory and explanatory sequences. Sequential designs intend to build one stage on the other.[4] In Phase 1, self-management was explored and semi-structured interviews were completed with 12 patients, nine health-care providers and four support persons. The interviews were analyzed using Interpretive Description. The exploratory sequence involved using Phase 1 results to inform the development of a multi-modal intervention; this was the first point of integration in the study. The intervention was then tested using an RCT (Phase 2).

In the RCT, the intervention group (n = 34) received foot education and a thermometer to assess foot temperature, while the control group (n = 26) received foot education only. Participants monitored their feet and completed daily logbooks for 180 days. Phase 2 exit interviews were conducted with all participants, then, following completion of the RCT, Phase 3 semi-structured qualitative interviews were conducted with some Phase 2 participants (N = 9). The interviews focused on Phases 1 or 2 findings that we determined required further explanation. The explanatory sequence involved the integration of results from all phases (i.e., the second point of integration).

POR Methods And Value

The MMR was also patient oriented. We invited a support person for a patient with diabetes and a patient with neuropathy to join the research team. These patient representatives contributed in several important ways. They reviewed the findings of Phase 1 and provided feedback that ensured we were capturing the themes. This feedback also helped inform the intervention and both patient representatives participated in a pilot education session before the start of Phase 2. Their feedback was very valuable. For example, they provided feedback on whether the PowerPoint presentation was clear and covered all the information that would be helpful to patients. Several revisions were made to the content and slides based on their suggestions. Another meaningful way that the patient representatives contributed to the study was by providing advice regarding locations for recruitment and recruitment materials such as the poster and pamphlet used in Phase 2. Finally, the representatives reviewed a draft of the research report

and provided feedback that was incorporated into the final version.

Illustrations Of The Value Of MMR

Examples from the Exploratory Sequence

Several examples from the exploratory sequence illustrate the value of MMR. The findings from Phase 1 reinforced what we knew from the literature regarding how complex self-management and foot health are for patients. Specifically, Phase 1 findings identified the personal challenges patients experienced and the system barriers they encountered concerning foot self-management. We also learned about their educational needs and what resources patients considered to be a support. These findings and the feedback from the patient representatives helped us understand the factors impacting self-management and informed the intervention, which we tested in Phase 2. In Table 1, we summarize the results from the first point of integration, i.e., how the findings from Phase 1 impacted the intervention and RCT (Phase 2). We will explore these examples in the following paragraphs, including validation of the additions based on the Phase 2 and Phase 3 interviews.

Addition of a Comprehensive Education Component: In the initial planning of the study, we decided that an educational component would be incorporated into the intervention that focused on caring for feet with a diagnosis of diabetes. The findings from Phase 1 reinforced our decision but also highlighted that patients had a limited understanding of the prevalence of diabetes, how diabetes impacted feet, what a diabetic foot ulcer was, and how they occurred. As a result, we incorporated this content into the education component that was delivered to both groups. The education component was piloted with the patient representatives and we further refined it based on their feedback. Notably, in the Phase 2 exit interviews, most participants thought the education they received was one of the best components of the intervention.

Addition of a Mirror: Another critical Phase 1 finding that stood out was that patients had difficulty reaching and examining the bottom of their feet due to co-morbidities such as arthritis. To address this problem, we provided participants in both the intervention and control groups with an inexpensive long-handled mirror purchased at a hardware store and used for visualizing engines. The mirror could be angled to help visualize different parts of the foot and had a telescopic handle. The participants also had the option of turning on a small light built into the mirror to aid in examining their feet. In the Phase 2 exit interviews, some participants shared that the mirror was one of the best parts of the intervention. We noted during Phase 3 that this was a tool some participants continued to use.

Critical Role of Support Persons: Phase 1 results reinforced the critical role of the linked support person in supporting self-management for some patients. Based on this, we invited and encouraged support persons to attend the education session and assist the participants with their assessments and data collection. As the study progressed, we noted the important role of support persons in encouraging foot self-management and

Table 1: Exploratory Sequence: The Impact of Phase 1 Findings on the Intervention and Randomized Controlled Trial Method (Phase 2)

Findings from Phase 1	Integration of findings and impact on intervention and Randomized Controlled Trial method (Phase 2)
1. Patients had limited knowledge of diabetes and foot health and care of feet.	1. A comprehensive education component was included as part of the intervention.
2. Patients had difficulty assessing the bottoms of their feet.	2. A mirror was provided to each participant.
3. Support persons played an important role in self-management.	3. Support persons were encouraged to attend the education session.
4. Patients had varying degrees of readiness to make changes and self-manage.	4. A questionnaire was incorporated into data collection to measure readiness for change.

completing the daily foot assessments for some participants.

Measure of Readiness: Finally, the analysis of the interviews from Phase 1 showed us that, in general, patients had varying degrees of readiness to make changes related to diabetes self-management. Based on this finding, we recognized that this was a potential factor influencing self-management of foot health; therefore, we decided to add a measurement of readiness to baseline Phase 2 data collection. Although validity and reliability were not established, this tool was based on the Transtheoretical Model. It was used successfully in a research study related to diabetes education to categorize patients into a stage of change.[17] Results related to this measure are discussed in a later section.

Examples from the Explanatory Sequence

Interviews were conducted in Phase 3 to help us further understand the findings from Phases 1 and 2. Findings from all three phases were analyzed in relation to one another and the data was assessed for three possible outcomes: *confirmation, expansion* and *discordance*. *Confirmation* occurs when the findings from one phase confirm the findings from another phase. This similar conclusion provides greater credibility to the results. *Discordance* occurs if the qualitative and quantitative findings are inconsistent or disagree with each other. Finally, *expansion* occurs when the findings from the phases diverge and expand the understanding of the concepts of interest.[18] We did not identify any occurrences of discordance when considering Phase 1 and Phase 2 findings. Any instances of confirmation between Phase 1 and Phase 2 were not explored further in Phase 3. In Phase 3, we focused on expansion because several findings were identified that we wanted to know more about. Table 2 shows a selection of Phase 1 and 2 findings that we explored further in Phase 3 and the data collection results. We will discuss these findings further below.

Thermometer and Foot Assessment: Participants in Phase 1 interviews felt that the thermometer could be helpful. Analysis of the data from Phase 2 showed us that there was a significant difference between participants in the intervention and the control group regarding the completion of any foot assessment. However, we noted mismatched reporting in the logbooks, with participants in the intervention group recording completion of the temperature reading an average of 150 out of 180 days and only recording completion of the visual assessment an average of 114 out of 180 days. It was unclear to us whether participants were only completing the thermometer assessment on some days or whether the thermometer and visual assessment were completed together and this was an issue of recording. We learned in Phase 3 that the thermometer and visual assessments went 'hand in hand' and participants were looking at their feet when they completed the temperature assessment, even though they did not record it. Along with this explanation, we gained greater clarity into the participants' experience with the thermometer. We learned that using the thermometer prompted a visual assessment, provided structure to the foot assessment, made the participant feel more involved in their foot self-management and provided reassurance or increased vigilance related to their foot health, depending on if the temperature difference was greater or less than 4 degrees F.

Understanding a Foot Concern and Taking Action: It was apparent from the Phase 1 interviews that participants lacked understanding related to what a foot concern was and what the appropriate action would be. As a result, we included various foot concerns and the appropriate action in the Phase 2 teaching session. An analysis of the logbooks in Phase 2 showed that participants would record a concern but did not indicate that they took action to address the concern. As well, we noted discrepancies regarding what was considered an action. For example, some participants considered putting cream on their feet as taking action, while others used cream and did not record this as an action. Phase 3 findings showed that participants clearly understood that a break in the skin was a concern and were able to identify some other assessment findings that would constitute a concern. Concerning action, a break in the skin was a concern that would prompt them to see their HCP. However, with other concerns, such as

Table 2: Explanatory Sequence: Examples of Integration Across the Three Phases

Phase 1 findings (N=24)	Phase 2 findings (N=62)	Goal of Phase 3	Phase 3 findings (N=9)
1. Participants thought that the thermometer would be a useful tool.	Number of days with any foot assessment: intervention vs. control group **(150.98 vs. 119.84, p =.02)**. For intervention group: Temperature reading completed out of 180 days (M = **150**, SD = 43) Foot assessment completed out of 180 days (M = **114 days**, SD = 64).	To explain the connection between the thermometer and visual foot assessment.	Participants indicated the thermometer: • prompted looking at feet • provided more structure • made them feel more involved • provided reassurance when the temperature difference was < 4 ºF and heightened vigilance when it was > 4 ºF.
2. Participants were unsure about what would be considered a concern.	Mismatched reporting in relation to the foot assessment. For example, number of days with a concern often did not equal the number of days of action; discrepancy about what was viewed as an action.	To explain participants' understanding of a concern and why they did or did not take action.	Breaks in the skin were a concern that participants would have assessed right away by an HCP. Participants would wait to see if 'things settled back' for findings such as pain, tenderness, colour change, and bruising. A temperature difference > 4 ºF was considered a concern for only some participants in the intervention group.
3. There was a continuum related to patient readiness to not only manage foot health, but to self-manage diabetes in general.	Stages of change • Precontemplation: **1.67%** (1) • Contemplation: **5%** (3) • Preparation: **16.67%** (10) • Action: **36.67%** (22) • Maintenance: **40%** (24). Changes made to diabetes management during study: Intervention group: **58%** Control group: **50%**.	To explain more about readiness and foot self-management.	Participants from the preparation, action, and maintenance stages were interviewed. All were interested in finding out more about diabetes management regardless of stage of change.

pain and tenderness, they were willing to wait and see if these issues settled back to normal.

Readiness to Manage Foot Health: As discussed previously, we found in Phase 1 that there was a continuum of readiness to self-manage diabetes and we added a measurement of readiness to the Phase 2 data collection. As shown in Table 2, we found in Phase 2 that most participants were in the action and maintenance stage, and over half of the participants made changes to their dia-

What is already known about this topic?

- The number of people with diabetes is increasing and health-care providers need effective interventions that prevent diabetic foot ulcers and amputations and guide policy and practice.
- Consequently, researchers need to focus on developing and testing practical interventions that meet patients' needs.
- To ensure research is relevant to patient needs, several large research funding agencies are promoting patient-oriented research.

What does the paper add to the literature?

- We argue that researchers can use mixed methods research to operationalize patient-oriented research and develop and test patient-centred interventions to address the prevention of diabetic foot ulcers and amputation.
- To illustrate this argument, we share our experience of pairing patient-oriented and mixed methods research and how this resulted in developing and testing a patient-centred foot self-management intervention for patients with diabetes.
- The pairing of these two approaches provided benefits that would not have been gained through using only one approach or a randomized controlled trial alone.

betes management during the six-month pilot RCT. Based on this analysis, we decided that the concept of readiness to self-manage foot health required further explanation. Therefore, in Phase 3, we interviewed participants from the preparation, action and maintenance stages. The findings showed that regardless of the stage of change, participants were interested in learning about managing diabetes and were open to making changes.

Discussion

When we reflected on pairing these methodological approaches, the benefit gained from utilizing POR and MMR was clear. With the exploratory sequence, we were pleased that we added to the intervention, as data collected during the exit interviews for the RCT (Phase 2) and Phase 3 confirmed that these changes strengthened the intervention. For example, in the exit interview for Phase 2, most participants indicated that the education provided and the awareness they developed about their foot health were the best parts of the strategy, while other participants identified the mirror as one of the best parts of the intervention. Some Phase 3 participants indicated they were still using a mirror. Several spouses attended the Phase 2 education session and were involved in helping the participants throughout the study.

Overall, the pairing of MMR and POR adds to the literature in several areas and these advances would not have been achieved through employing only an RCT. We gained a new understanding of the importance, for many participants, of comprehensive education and the fact that patients may still need help to identify and take appropriate action for foot concerns even with education. We also learned how using a mirror and including a support person were important for some participants. Although these strategies may not be considered novel, these findings expand our understanding of the potential positive impact on patients when used as part of a foot self-management intervention. The clinical implications of these findings are that it is important to discuss foot health needs with patients, individualize plans of care and reinforce foot assessment education.

Completing the explanatory sequence (Phase 3) was valuable because it helped us understand and gain further clarity about the results of Phases 1 and 2. The findings also expand knowledge related to the use of the thermometer. Prior studies that used an RCT found a decrease in DFUs but did not explore patients' experiences using infrared thermometry.[8,9,10] Through exploring these experiences, we learned not only that, but also how, the thermometer supports foot self-management. However, because we conducted Phase 3, we now

better understand the extent of the value of using the commercially available infrared thermometer. Specifically, we have learned that participants felt it prompted foot assessment, provided reassurance about the assessment results and directed action. Further, POR and MMR research is needed with longer follow-up (i.e., > six months) to validate these findings and assess the optimal scheduling for taking temperature measurements and the long-term use of the thermometer.[16]

Another area these findings contribute to is readiness to self-manage foot health in patients with diabetes. A lack of research has caused readiness to change to be considered a predictor of diabetes foot self-management. The results of this study suggest that the stage of change may not indicate whether patients consider new information and explore making changes to their self-management. Regardless of the stage of readiness, participants were still interested in exploring changes to improve their diabetes management. As they do need to manage their diabetes and foot health, they need knowledge and skills to do so, even though the learning curve is steep. Further research about readiness and self-management is warranted.

We did experience some common challenges with taking an MMR approach: skills and time.[4] Researchers need knowledge and skills of patient-oriented research, quantitative methods, qualitative methods and how to integrate the findings. Individual researchers do not need all skills; instead, they should establish a research team whose members contribute the relevant skills to the collaborative whole. Also, the time it takes to conduct a study such as this can be challenging for all team members. With MMR, time is required to collect and analyze two different types of data and then integrate this data.[4] The use of POR prolongs the time required for the study to enable the involvement of the patient representatives.

Conclusion

In this paper we discussed the development and testing of an intervention informed by POR and MMR and the associated clinical and research implications. This discussion extends knowledge about the value of pairing these methodologies and contributes to knowledge related to diabetes and foot self-management. Research that is patient-oriented is vital to ensure that interventions that are real-world and practical are developed and tested. MMR provides an effective methodological structure for POR. We encourage all HCPs, when reviewing POR and MMR studies, to recognize and appreciate the value and insight gained when these two methodologies are used. Considering the benefits highlighted with our study, we also encourage researchers to consider the pairing of MMR and POR as it offers many benefits for developing and testing all types of interventions for different populations. The findings of this research can provide pertinent information to HCPs and policymakers for practice and policy. ■

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Declaration of Conflicting Interest

The authors declare that there is no conflict of interest.

Kathleen Stevens* RN PhD is an advanced foot care nurse and Assistant Professor at Memorial University Faculty of Nursing, St. John's NL, Canada.

Donna Moralejo RN PhD is a Professor at Memorial University Faculty of Nursing, St. John's NL, Canada.

Steven Ersser RN PhD is a Professor of Nursing and Dermatology at Bournemouth University, Poole, United Kingdom.

Cathy MacLean MD is a Professor and Director of Faculty Development for the College of Medicine at the University of Saskatchewan, Saskatoon SK, Canada.

*Correspondence should be directed to kathleen.stevens@mun.ca

References

1. Ong KL, Stafford LK, McLaughlin SA, Boyko EJ, Vollset SE, Smith AE et al. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. Lancet. 2023 Jul 15;402(10397):203-234. DOI: 10.1016/S0140-6736(23)01301-6
2. International Working Group on the Diabetic Foot (IWGDF). IWGDF guidelines on the prevention of foot ulcers in persons with diabetes. 2023. Available from: https://iwgdfguidelines.org/wp-content/uploads/2023/07/IWGDF-2023-02-Prevention-Guideline.pdf.
3. Canadian Institute of Health Research. Canada's strategy for patient-oriented research – patient engagement framework. 2024. Available from: http://www.cihr-irsc.gc.ca/e/48413.html.
4. Creswell, JW., Plano-Clark, VL. Designing and conducting mixed methods research. 3rd ed. Thousand Oaks, CA: Sage Publications; 2018.
5. Simmons LA, Noonan D. Self-management. In: Gidden JF, editor. Concepts of nursing practice. Amsterdam: Elsevier; 2017. p. 54-60.
6. van Schie C, Slim FJ. Biomechanics of the diabetic foot: the road to foot ulceration. In Veves A, Giurini JM, LoGerfo FW. Editor. The diabetic foot: medical and surgical management. 3rd ed. New York: Springer; 2012. p. 203-216.
7. Mufti A, Somayaji R, Coutts P, Sibbald RG. Infrared skin thermometry: validating and comparing techniques to detect periwound skin infection. Adv Skin Wound Care. 2018 Jan;31(1): 607-611. DOI: 10.1097/01.ASW.0000527352.75716.70
8. Armstrong DG, Holtz-Neiderer K, Wendel C, Mohler MJ, Kimbriel HR, Lavery LA. Skin temperature monitoring reduces the risk for diabetic foot ulceration in high-risk patients. Am J Med. 2007 Dec;120(12): 1042-6. DOI: 10.1016/j.amjmed.2007.06.028
9. Lavery LA, Higgins KR, Lanctot DR, Constantinides GP, Zamorano RG, Armstrong DG, et al. Home monitoring of foot skin temperatures to prevent ulceration. Diabetes Care. 2004 Nov;27(11): 2642-7. DOI: 10.2337/diacare.27.11.2642
10. Lavery LA, Higgins KR, Lanctot DR, Constantinides GP, Zamorano RG, Athanasiou KA, et al. Preventing diabetic foot ulcer recurrence in high-risk patients: use of temperature monitoring as a self-assessment tool. Diabetes Care. 2007 Jan;30(1):14-20. DOI: 10.2337/dc06-1600
11. Mufti A, Coutts P, Sibbald RG. Validation of commercially available infrared thermometers for measuring skin surface temperature associated with deep and surrounding wound infection. Adv Skin Wound Care. 2015 Jan;28(1): 11-6. DOI: 10.1097/01.ASW.0000459039.81701.b2
12. Coffey L, Mahon C, Gallagher P. Perceptions and experiences of diabetic foot ulceration and foot care in people with diabetes: a qualitative meta-synthesis. Int Wound J. 2019 Feb;16(1): 183-210.DOI: 10.1111/iwj.13010
13. Matricciani L, Jones S. Who cares about foot care? Barriers and enablers to foot self-care practices among non-institutionalised older adults diagnosed with diabetes. An integrative review. Diabetes Educ. 2015 Feb;41(1): 106-17. DOI: 10.1177/0145721714560441
14. Stevens LK. Effectiveness of a foot self-management intervention that utilized commercially available infrared thermometers: A patient-oriented research and mixed methods research study. 2020 (Doctoral dissertation, Memorial University of Newfoundland).
15. Stevens K, Moralejo D, Ersser S, MacLean C. Patient, support-person and healthcare provider perspectives on foot self-management for adults with type 1 and type 2 diabetes: personal challenges. Can J Diabetes. 2022 Feb;46(1): 40-46. DOI: 10.1016/j.jcjd.2021.04.011
16. Stevens K, Moralejo D, Ersser S, MacLean C. Effectiveness of a foot self-management intervention that utilized commercially available infrared thermometers: mixed methods research incorporating a pilot RCT. J Tissue Viability. 2023 Feb;32(1): 33-38. DOI: 10.1016/j.jtv.2022.12.005
17. Peterson KA, Hughes M. Readiness to change and clinical success in a diabetes educational program. J Am Board Fam Pract. 2002 Jul-Aug;15(4): 266-71.
18. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs: principles and practices. Health Serv Res. 2013 Dec;48(6 Pt 2): 2134-56. DOI: 10.1111/1475-6773.12117

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Advancements And Challenges In Diabetic Foot Care: A Comprehensive Exploration Of A 50-Year Journey

Presenter: Professor William J Jeffcoate MB MRCP

Abstract: Professor William Jeffcoate is a highly regarded authority in the realm of diabetic foot care. In this presentation from the *2023 Global Meet of Diabetes Awareness Week* symposium by D-Foot International, Prof. Jeffcoate shared profound insights derived from his extensive five-decade experience. This document seeks to distill key highlights from his presentation, providing an examination of the evolution of diabetic foot care, the encountered challenges and potential pathways for future research.

Key words: *diabetic foot care, advances, quality improvement, challenges, interdisciplinary collaboration, population-based research.*

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Professor William J Jeffcoate MB MRCP

Professor William Jeffcoate's involvement with diabetic foot complications traces back to his exposure to the consequences during medical training in 1968, where a below-knee amputation left an indelible mark. However, it was not until he was appointed a general physician and endocrinologist in 1979 that his passion for addressing diabetes-related foot diseases truly ignited.

Throughout his career, Prof. Jeffcoate observed the global progression of specialized diabetic foot services. These services, characterized by interdisciplinary collaboration involving physicians, nurses, podiatrists, radiologists, microbiologists, orthopedic surgeons and vascular surgeons, were established to meet the growing demand for focused care in managing diabetic foot complications. This presentation chronicles the evolution of these specialized services, elucidating collaborative initiatives implemented by healthcare professionals to provide targeted care, which has proven pivotal in meeting the rising need for specialized care amid the challenges posed by diabetic foot complications.

Historically, diabetic foot disease in its early stages has received insufficient research attention, as emphasized by the scarcity of publications on PubMed related to diabetic foot ulcers. This underscores the pressing need to address this research gap due to the substantial health-care burden associated with diabetic foot complications. To bridge this gap, potential avenues for future investigations were discussed, encompassing exploration of the pure science behind diabetic foot ulcers at tissue, cellular and molecular levels, formulation of clinical management strategies, examination of population-based variations and advocacy for systematic documentation of clinical practices.

Professor Jeffcoate identifies four key areas for future research in diabetic foot ulcers,

providing a comprehensive framework ranging from understanding scientific underpinnings to implementing effective clinical strategies and exploring population-level variations.

Pure Science Exploration

- Investigate the mechanisms behind the formation and failure to heal diabetic foot ulcers at the tissue, cellular and molecular levels.
- Explore underlying biological processes to gain a deeper understanding of the disease pathology.

Clinical Management Strategies

- Develop and implement strategies for the clinical management of individuals with diabetic foot ulcers.
- Focus on prevention, active disease management, effective care and prevention of recurrence.

Population-Based Research

- Conduct research on the effectiveness of care, not just in individuals but in populations.
- Analyze variations in diabetic foot ulcers across racial, social and geographic populations to identify factors influencing outcomes.

Systematic Documentation Of Clinical Practices

- Emphasize the need to record detailed information as part of routine clinical practice.
- Stress the importance of systematically documenting approaches, interventions and outcomes to facilitate continuous improvement and knowledge dissemination.

A significant initiative in addressing the research gap is the National Diabetes Footcare Audit, which systematically collects data on foot care activities across England and Wales. This audit serves as a cornerstone in ongoing efforts, offering valuable insights into patient outcomes, waiting times and the effectiveness of various interventions, significantly contributing to advancing our understanding of diabetic foot care at both national and broader levels.

Evident challenges in team collaboration within diabetic foot care were highlighted. Professor Jeffcoate underscored the historical hesitance of health-care professionals, particularly doctors, to operate effectively as team players. Addressing these challenges is crucial for fostering a collaborative health-care environment. The presentation specifically addresses these challenges, exploring Prof. Jeffcoate's observations on this observed historical reluctance to function collaboratively. It delves into potential solutions and emphasizes the importance of cultivating a collaborative health-care environment to effectively tackle the multifaceted challenges presented by diabetic foot complications.

Conclusion

In conclusion, Prof. Jeffcoate's comprehensive overview of the last 50 years in diabetic foot care stands as a profound reflection of the challenges and advancements within the field. This document encapsulates the essence of his presentation, emphasizing the multifaceted nature of the challenges posed by diabetic foot complications. His presentation underscores the need for heightened research efforts, the imperative for collaborative, team-based health-care practices and systematic documentation to propel diabetic foot care into a new era of understanding and innovation. It serves as a compelling call to action for health-care professionals, researchers and policy makers to collectively address the complexities associated with diabetic foot care and work towards enhanced patient outcomes on a global scale. ■

Professor William J Jeffcoate MB MRCP is a retired physician and endocrinologist. He was appointed as an endocrinologist in Nottingham, UK in 1979. He first established a specialist service for the care of the foot in diabetes in 1982. He has always felt strongly about the need for high quality evidence to underpin practice and has emphasized the need for systematic documentation of the outcomes of routine clinical care. He has been involved in the design and conduct of multiple randomized trials and has also been author/co-author of systematic reviews on infection, ulcer treatment, dressings and classification. He has served on the Editorial Board of *The Lancet, Diabetologia* and *The Lancet Diabetes and Endocrinology*.

Acknowledgement: Thank you to Rita Audi BHSc MMgt for summarizing Prof. Jeffcoate's video presentation.

Q&A Session

The following are highlights from the Q&A session following Prof. Jeffcote's presentation.
Editor's note: Questions and responses have been edited for length and clarity.

Q: *At the beginning of your talk, you mentioned the importance of independent studies done by health-care professionals, that are not industry-driven. How do you address the challenges of industry-driven studies pushing for the consumption of expensive materials in diabetic foot care?*

Prof. Jeffcoate: It's a difficult issue, and we need more research on clinical factors. We need standardized measures and the International Working Group on Diabetic Foot is actively looking into grading the quality of data to distinguish helpful information from potentially biased data driven by industry interests.

The real obstacle is the lack of funds and a common 'bank account' for conducting large studies.

Q: *How can we overcome this barrier and conduct more substantial research?*

Prof. Jeffcoate: Coordination and collaboration are key. We need a joint effort from multicentric individuals and wound clinics to gather a high number of cases with reliable outcomes. This would require funding and support from organizations or institutions willing to invest in comprehensive research.

Q: *You emphasized the need for more research on clinical factors. How can we ensure the standardization of data collection and assess the quality of data in the field of diabetic foot care?*

Prof. Jeffcoate: The International Working Goup on Diabetic Foot is actively involved in assessing and grading the quality of data. They meticulously examine every systematic review and it's crucial for practitioners to refer to such reports to differentiate between effective interventions and those primarily driven by industry interests.

Q: *Could you comment on the need for proper analysis of routine clinical work data to derive insights, especially in the field of prevention?*

Prof. Jeffcoate: Keeping data in databases and properly analyzing routine clinical work can indeed yield valuable results, particularly in the field of prevention. Analyzing data from preventative foot exams can provide new insights into effective strategies, making the most of the wealth of information that is already available in routine clinical practice.

Q: *Could you comment on the importance of identifying comorbidities in diabetic foot patients and the need for a holistic approach?*

Prof. Jeffcoate: We must acknowledge the importance of identifying comorbidities in diabetic foot patients, emphasizing the need for a holistic approach. This approach involves recognizing that patients with diabetic foot ulcers are not just individuals with lesions, but also individuals at high risk for various complications, and addressing their overall health is crucial.

Q: *How can we enhance communication and collaboration among medical professionals and improve the multidisciplinary approach to managing complex conditions like diabetic foot ulcers?*

Prof. Jeffcoate: Managing complex conditions requires close collaboration with various health-care professionals, including community staff and surgeons. The emphasis is on working together closely and recognizing that, as individual practitioners, it's often not possible to provide the comprehensive care that every patient needs. The key is to foster teamwork and cooperation.

Q: *What would be the priority policy focus to address the global issue of diabetic foot ulcers, especially from a government perspective?*

Prof. Jeffcoate: We must recognize the importance of systematic data collection as a priority in policy focus. I suggest strategies that incorporate simple yet comprehensive data collection methods, highlighting the need for outcomes beyond amputation rates. For instance, focusing on 12-week outcomes of being alive and ulcer-free could provide valuable insights into the effectiveness of interventions.

Q: *Considering the global efforts of organizations like the IDF and WHO, how do you see the future of addressing diabetic foot ulcers on a global scale?*

Prof. Jeffcoate: We should acknowledge the ongoing efforts of organizations like the IDF and WHO. The key lies in continued emphasis on the importance and cost-effectiveness of addressing diabetic foot ulcers. While it's a significant task, I believe that persistent efforts will eventually lead to increased awareness and action on a global scale.

This article and Q&As offer a summary of a presentation from the Global Meet of Diabetes Awareness Week symposium by D-Foot International held on Sunday, Nov. 12, 2023. A video of the full presentation is available at: https://www.youtube.com/watch?v=qXsvClQvAes&t=3342s&ab_channel=D-FootInternational

A Word On D-Foot International

Dr. Zulfiqarali G Abbas MBBS M Med DTM&H (UK) FRCP (Glasgow) FRCP (London)

D-Foot International is an organization comprised of individuals working in the field of diabetes-related complications, spanning regions such as Sub-Saharan Africa, South and Central America, the Middle East and North Africa, North America and the Caribbean, Europe, Southeast Asia and the Western Pacific. The collective mission is to provide preventive foot care for people with diabetes through awareness education and professional guidance.

The looming global diabetes epidemic is projected to rise, with the highest burden in low and middle-income countries. Diabetes research focuses on the incidence of complications, particularly foot-related issues, making it a central theme of action for D-Foot International.

The mission of D-Foot International is resolute: to prevent any avoidable limb amputations due to diabetes globally. This mandate calls for a collective effort, aiming for a 50% reduction in limb amputation rates by 2026. The organization's only weapons of choice are education and the involvement of health-care professionals.

As it strives toward its goal, education emerges as a powerful tool, especially in low and middle-income countries. D-Foot International takes pride in the success of the annual *Diabetes Awareness Week*, an integral part of its flagship program. Programs are scheduled across all regions during this week, culminating in a global event where all regions come together on one platform.

D-Foot International invites participants to envision a world where every health-care professional is equipped to offer specialized foot care, eliminating stigma and addressing the gap between affordable and accessible diabetes treatment. D-Foot International extends a hand of collaboration, urging everyone to work together to promote care for diabetes-related complications, making it financially feasible and increasing awareness.

Zulfiqarali G Abbas MBBS M Med DTM&H (UK) FRCP (Glasgow) FRCP (London) is President of D-Foot International

For more information on D-Foot International and its programs, visit: http://www.youtube.com/@d-foot

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References: 1. Smith+Nephew 2022. Summary of RENASYS EDGE pump cleaning, self-test and maintenance. Internal Report. CSD.AWM.22.068. 2. Smith and Nephew 2022. RENASYS EDGE System Human Factors Summative Report Summary. Internal Report. CSD.AWM.22.071.3. Smith+Nephew 2022. Summary of RENASYS EDGE pump mechanical and electronic reliability testing. Internal Report. CSD.AWM.22.069.

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Diabetes And Preventable Complications: Impact On The Health-care System And The Associated Economic Burden Beyond Direct Health-care Costs

Joel S Alleyne BSc (Computer Science) MISt **and Tetiana Zvorygina** BSc (Computer Science) MBSc (Computer Science)

Abstract: Diabetic foot ulcers represent a prevalent complication of diabetes mellitus, imposing a substantial clinical and economic burden on the global health-care system.[1] The enormous economic toll of diabetes continues to burden society through direct medical and indirect costs. By directing research efforts appropriately, we can make significant strides in preventing diabetic foot complications, improving patient outcomes and reducing the overall burden on health-care systems and individuals.

Key words: *diabetic foot ulcers, health systems impact, associated costs, economic burden, prevention.*

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Introduction

Diabetic foot ulcers represent a prevalent complication of diabetes mellitus, imposing a substantial clinical and economic burden on the global health-care system.[1] Diabetes-related foot infections occur in approximately 40% of diabetes-related foot ulcers and cause significant morbidity. The convergence of neuropathy and ischemia, characteristic of the diabetic foot, results in neuropathic and ischemic foot ulceration, as well as Charcot neuroarthropathy, often complicated by infections, potentially culminating in amputations and heightened mortality.[2]

About 3.0 million Canadians (8.1%) were living with diagnosed diabetes in 2013–2014.[3] In 2017, 7.3% of Canadians aged 12 and older (roughly 2.3 million people) reported being diagnosed with diabetes.[4] Among Canadians, 30% live with diabetes or prediabetes; 10% live with diagnosed diabetes, a figure that climbs to 14% when cases of undiagnosed type 2 diabetes are included.[5] Diabetes complications are associated with premature death and can reduce lifespan by five to 15 years.[5] In fact, foot problems are the leading cause of hospitalization for Canadians living with diabetes.[6] Research estimated the total estimated cost of diagnosed diabetes in the US in 2022 to be $412.9 billion USD, including $306.6 billion in direct medical costs and $106.3 billion in indirect costs attributable to diabetes. For cost categories analyzed, care for people diagnosed with diabetes accounts for one in four health-care dollars spent in the US, 61% of which are attributable to diabetes.[7] Major contributors to indirect costs in the US are reduced employment due to disability ($28.3 billion), presenteeism ($35.8 billion) and lost productivity due to 338,526 premature deaths ($32.4 billion).[7]

Reduced circulation and sensation in the feet, common in diabetes, necessitate daily foot examination and professional fitting of shoes to prevent complications. Despite preventive measures, more than one million people globally undergo lower extremity amputations (LEA) annually due to diabetes, resulting in a limb loss every 20 seconds.[8] The economic burden of limb amputation includes direct costs (hospitalization, surgery, prosthetics) and indirect costs (lost productivity, premature mortality), highlighting the substantial impact on health-care resources. The majority of foot problems diagnosed in people with diabetes could have been avoided through daily foot care and proper shoe selection. Many people with diabetes have reduced circulation or sensation in their feet (neuropathy) and are not able to feel if something may be in their shoe or if the shoe itself is irritating their foot. To avoid the development of wounds or ulcers, it is vital that people living with diabetes visually examine their feet daily[6] and, when purchasing shoes, have them professionally fitted rather than relying on how their feet 'feel'.

Every year, more than one million people undergo a lower extremity amputation (LEA) secondary to diabetes, resulting in a limb loss every 20 seconds worldwide.[8] Of all the lower extremity amputations in persons with diabetes, 85% are preceded by a foot ulcer. The mortality at five years for an individual with a diabetic foot ulcer is 2.5 times as high as the risk for an individual with diabetes who does not have a foot ulcer.[1] One possible approach to estimate the economic burden of limb amputation due to diabetes, like any other disease, is to use the following formula:

Economic Burden = Direct Costs + Indirect Costs + Intangible Costs.

Note, these cost-element (inputs or factors) vary by jurisdiction, depending on health-care costs and economic productivity.

Direct Costs

Direct costs are the expenses associated with the diagnosis, treatment and prevention of limb amputation due to diabetes, such as hospital-

Figure 1: Disability Adjusted Life Years (DALY). Source: Public Health England. Accessed at: https://www.scotpho.org.uk/comparative-health/burden-of-disease/why-burden-of-disease/.

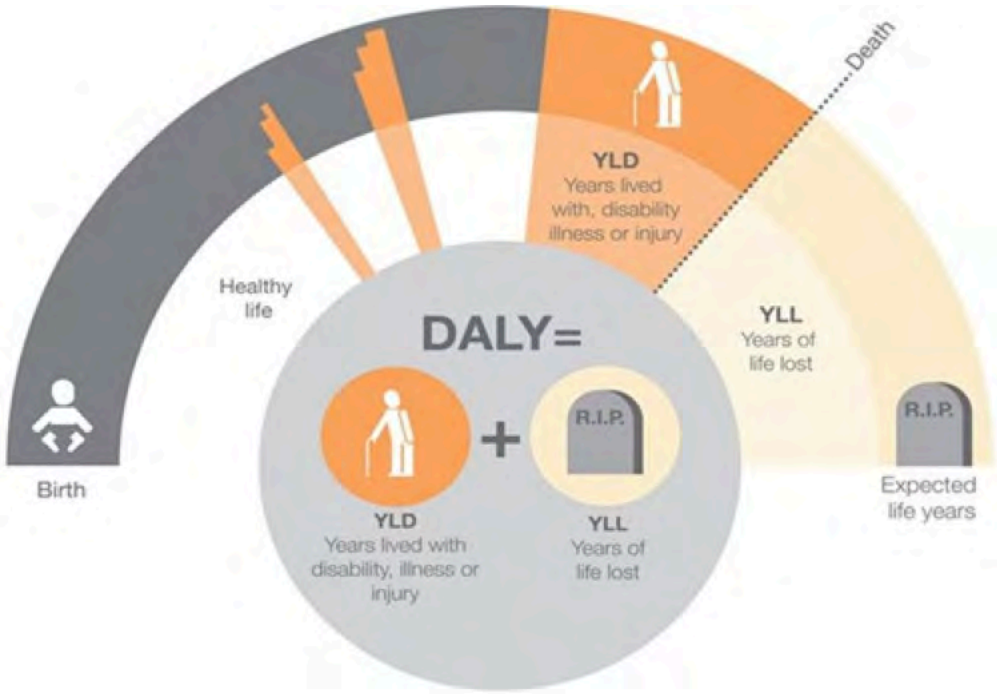

Figure 2: Disability Adjusted Life Years (DALY). Source: Wiki Commons. Accessed at: https://nccid.ca/publications/understanding-the-measurement-of-global-burden-of-disease/

ization, surgery, prosthetics, rehabilitation and medications. Indirect costs are the losses incurred by individuals and society due to reduced or lost productivity, such as absenteeism, disability, early retirement and premature mortality. Intangible costs are the non-monetary impacts of limb amputation due to diabetes on the physical and mental well-being of individuals and their families, such as pain, anxiety, depression and reduced quality of life. The diabetic foot is a significant contributor to the global burden of disability and reduces the quality of life. It remains a considerable public health problem.

Medical Costs: Direct, Indirect And Intangible

The cost-of-illness study is considered to be an essential evaluation technique in health care. By measuring and comparing the economic burdens of diseases to society, such studies can help health-care decision-makers set up and prioritize health-care policies and interventions. Using economic theories, various study methods are introduced[9] that are generally applicable to most disease cases for estimating the costs of illness associated with mortality, morbidity, disability, and other disease characteristics. It also presents concepts and scopes of costs along with different cost categories from different research perspectives in cost estimations. By discussing the economic grounds of the cost-of-illness study, the reported results represent useful information about several evaluation techniques at an advanced level, such as cost-benefit analysis, cost-effectiveness analysis and cost-utility analysis. [9]

The direct medical costs associated with foot ulcers are sustainable and encompass a range of expenses, including hospitalization, outpatient care, wound care supplies, medications, surgeries and amputation. Studies have shown that the cost of managing a single diabetic foot ulcer episode can vary widely, but it is generally higher for patients who require hospitalizations, surgical intervention or amputation. Long-term management of chronic ulcers contributes significantly to the overall economic burden.

In a multicentre study of all diabetic foot ulcer patients admitted to hospitals in the Greater Toronto Area from 2010 to 2015, diabetic foot ulcer admissions incurred the highest mean cost per patient ($22,754 CDN) when compared to non-diabetic foot ulcer diabetes ($8,350).[10] Using adjusted linear regression, diabetic foot ulcer admissions demonstrated a 49.6% greater mean cost of care than non-diabetic foot ulcer-related diabetes admissions. Direct costs of care for diabetes in general were $237 billion USD in 2017.[11] This is compared to $80 billion for cancer in 2015. As up to one-third of the direct costs of care for diabetes may be attributed to the lower extremities, these are also readily comparable.[11] The report, by Armstrong et al. (USA),[11] compared the five-year mortality and direct costs of care for people with diabetic foot complications to cancer. The report found that five-year mortality for Charcot, DFU, minor and major ampu-

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tations were 29.0%, 30.5%, 46.2% and 56.6%, respectively. This is compared to 9.0% for breast cancer and 80.0% for lung cancer. The report also estimated that the direct costs of care for diabetes in general were $237 billion USD in 2017, which is comparable to $80 billion for cancer in 2015.

Besides the direct medical expenses, the indirect costs related to diabetic foot ulcers result from reduced productivity, disability and decreased quality of life for both patients and caregivers. Indirect costs include:

- Increased absenteeism ($3.3 billion)
- Reduced productivity while at work ($26.9 billion) for the employed population
- Reduced productivity for those not in the labour force ($2.3 billion)
- Inability to work as a result of disease-related disability ($37.5 billion)
- Lost productive capacity due to early mortality ($19.9 billion).[12]

People with diabetes have a 34% lifetime risk of developing a diabetic foot ulcer. And when we look at the costs of diabetic foot ulcers, it's a significant jump in these high-risk patients. Patients without diabetic foot ulcers cost around $17,000 each year. Patients with diabetic foot ulcers — $58,000 USD. This demonstrates that there's a clear link between health-care costs and diabetic foot ulcers. A big, costly link.[13]

Diabetic foot ulcers are actually more expensive than the five most costly forms of cancer. Totaling over $100 billion USD.[13] Most are familiar with the costs of cancer and the toll that cancer has on our nations. But diabetic foot ulcers are often swept under the rug in larger conversations about health-care spending and costs, and this needs to change.

To calculate each component of the economic burden, we need data on the prevalence and incidence of limb amputations due to diabetes in a jurisdiction, the average costs and outcomes associated with different types and levels of amputation, and the valuation methods for measuring intangible costs. Some of these data may be available from existing sources such as administrative databases, surveys, studies and reports. However, some data may be missing or incomplete, requiring assumptions or extrapolations.

For example, according to a report by Diabetes Canada,[14] in 2011-12, diabetes-related foot wounds contributed to about one-third of all amputations performed in hospitals across Canada. The report also estimated that the average cost per hospitalization for a lower extremity amputation (LEA) was $21,000 CDN in 2011-12. However, this cost does not include the costs of prosthetics, rehabilitation, medications, or follow-up care. Moreover, this cost does not account for the differences in the type (LEA or upper extremity amputation [UEA]) and level (major or minor) of amputation, which may have different implications for the outcomes and costs.

A recent study by Essien et al.[15] explored the trends of LEA and UEA by level of amputation, sex and age over 14 years in Saskatchewan, Canada. The study found that LEA predominated over UEA over the study period, with minor LEA increasing and major LEA decreasing. The study also found that males were twice as likely to undergo LEA than females, and that LEA rate increased with increasing age. However, this study did not provide any information on the costs or outcomes associated with different types and levels of amputation.

Intangible Costs

Another challenge in estimating the economic burden of limb amputation due to diabetes in a jurisdiction is to measure the intangible costs. Intangible costs are difficult to quantify because they involve subjective perceptions and preferences that may vary across individuals and contexts. One possible method to measure intangible costs is to use health-related quality of life (HRQoL) instruments that capture the physical, mental and social aspects of well-being. HRQoL can be expressed as a utility score that ranges from 0 (death) to 1 (perfect health), or as a disability-adjusted life year (DALY) that combines years of life lost due to premature mortality and years lived with disability (See Figures 1 and 2).

To estimate the intangible costs of limb amputation due to diabetes, we need data on the HRQoL or DALYs associated with different types and levels of amputation, as well as the general population norms for comparison. We also need data on the willingness to pay (WTP) for a unit change in HRQoL or DALYs, which reflects the monetary value that individuals or society place on health outcomes. However, these data may not be readily available or consistent across sources.

A study by Sassi[15] compared the methods and results of calculating quality-adjusted life years (QALYs) and DALYs, which are two common measures of health outcomes that incorporate both quantity and quality of life. The study explained how to calculate QALYs and DALYs, and how they differ in terms of assumptions, perspectives, and values. The study also illustrated the relationship between QALYs gained and DALYs saved using two examples: the prevention of tuberculosis and the treatment of bipolar depression.[16]

A report by NICE[17] described the principles and methods for assessing cost-effectiveness in clinical guidelines, using QALYs as the preferred measure of health outcomes. The report also discussed the sources and methods for measuring and valuing health-related quality of life (HRQoL) and willingness to pay (WTP) for a unit change in QALYs. The report recommended using the EQ-5D as the preferred instrument for measuring HRQoL in adults, and obtaining preference data from a representative sample of the UK population for valuing changes in HRQoL.

A review by Brazier et al.[18] provided an overview of the methods and challenges of measuring and valuing health outcomes in economic evaluation. The review discussed the advantages and disadvantages of different instruments for measuring HRQoL, such as EQ-5D, SF-6D, HUI and AQoL. The review also compared different methods for eliciting preferences for health states, such as standard gamble, time trade-off, rating scale and discrete choice experiments.

A study by D. Parker et al. states that in the US diabetes is responsible for 20% of cardiovascular deaths (excluding cerebrovascular deaths), 26% of deaths with cerebrovascular disease listed as the primary cause and approximately equal to 45% of deaths with renal failure listed as the primary cause.[7]

Estimating the economic burden of limb amputation due to diabetes is a complex and challenging task that requires comprehensive and reliable data sources, rigorous analytical methods and transparent assumptions. The results may vary depending on the scope, perspective, time horizon, discount rate and sensitivity analysis used in the estimation. The results may also have limitations and uncertainties due to data gaps and quality issues. Nevertheless, estimating the economic burden of limb amputation due to diabetes in Canada can provide valuable information for policymakers, health-care providers, researchers, patients and caregivers to understand the magnitude and distribution of the problem, identify priority areas for intervention, evaluate alternative options for prevention and management and allocate resources efficiently and equitably.

Amputations And Long-term Consequences

One of the most severe consequences of diabetic foot ulcers is lower extremity amputation, significantly escalating direct, indirect and intangible costs. Amputations entail prolonged hospital stays, post-operative rehabilitation and the necessity for prosthetic devices. Furthermore, individuals undergoing amputations face heightened risks of mortality, diminished quality of life and increased health-care utilization.

In Canada, approximately 14 diabetes-related amputations are performed daily, totalling over 5000 amputations annually. The five-year mortality rate following amputation ranges from 45% to 80%. Alarmingly, 40% of diabetes patients are reported to be unaware of or unable to recognize risk factors or practice self-care behaviours to prevent diabetic foot complications. Additionally, comorbid depression affects 20-40% of individuals with diabetes.[17]

A population-based study in Ontario, Canada identified a decline in diabetes-related complications, including acute myocardial infarction, stroke, end-stage renal disease and hyperglycemia

crisis, over the last 20 years. However, it highlighted a surge in amputations over the past decade.[16] The escalating number of amputations is attributed to the increasing prevalence of diabetes, peripheral artery disease and inadequate coordination of foot and wound care. Despite discouraging statistics, the International Working Group on the Diabetic Foot (2019) emphasizes the potential for reducing amputations through well-organized diabetic foot care teams, limb preservation teams and informed self-care practices by patients.

Prevention And Treatment

Numerous studies have explored the cost-effectiveness of interventions to prevent and treat diabetic foot ulcers. These interventions encompass patient education, regular foot screening, offloading devices, wound dressings, antibiotics, revascularization procedures and advanced therapies such as growth factors and hyperbaric oxygen therapy. Despite perceived high upfront costs for preventive measures, evidence suggests substantial cost savings by reducing ulcer incidence, amputations and related complications.

Conducting a comprehensive medical history is crucial for identifying undisclosed medical conditions and potential risks to wound healing. A thorough patient history should encompass active and past medical conditions, including complications like retinopathy, nephropathy, neuropathy and vasculopathy. Smoking history is particularly relevant, given its association with peripheral arterial disease (PAD). Additionally, identifying barriers to self-managed and clinician-delivered care, such as visual or auditory impairment, is essential for effective foot assessments and instructions. Recognizing these barriers enables the implementation of appropriate care plans. The risk of foot ulceration in individuals with diabetes rises in the presence of peripheral neuropathy, previous ulceration or amputation, structural deformity, limited joint mobility, PAD, onychomycosis and elevated glycosylated hemoglobin (A1c) levels.[19] Loss of sensation, often assessed using a 10 g Semmes-Weinstein monofilament, is a significant predictor of future foot ulceration and lower-extremity amputation.

Clinicians are encouraged to use a validated foot screen in clinical practice. Foot screening tools provide a uniform approach that helps ensure that a comprehensive foot exam is completed. There are many validated diabetic foot-screening tools available, but a tool can only be effective if clinician education and organizational and system supports are in place[20] and if the tool is 'evidence-informed and relevant to the characteristics of the target population'. There are multiple tools for the clinician to consider, including the *Inlow 60-second Diabetic Foot Screen,*[21] which includes three parts: assessment, risk stratification and care recommendations.

The primary objective of diabetic foot care is to prevent diabetic foot ulcers (DFUs) and subsequent lower extremity amputations (LEAs). The involvement of an Inter-Professional Team (IPT), including a podiatrist, facilitates complementary work and synergy of skills and knowledge to achieve optimal outcomes for patients.[22]

The results of this review support the concept that IPTs with podiatrists lead to a statistically significant reduction of LEAs (total and major LEAs) compared to interventions without MDTs. After qualitative analysis, authors of the included studies examining minor LEAs as outcomes have shown that there are more minor LEAs with MDT interventions. However, upon analysis of results in relation to other severities of LEAs (major versus minor) and with total LEAs, the level of LEAs may decrease with an IPT with podiatry management. There is a 31% relative risk reduction in undergoing a LEA, either major or minor, with MDT management with podiatry for people at risk for diabetic foot. Considering only major LEAs, the relative risk reduction was of 55%. These results are clinically meaningful in favour of the intervention, considering the high five-year mortality rate and the low quality of life of patients with diabetes who undergo LEAs.[11,22]

Diabetic foot ulcers often become chronic wounds, requiring prolonged and costly care. The management involves a multidisciplinary approach, including wound care specialists, dia-

betologists, vascular surgeons and podiatrists. The need for continuous monitoring and treatment can significantly impact health-care resources.

Despite advancements, there is an ongoing need for health services research and research programs into the specific causes of amputation, including vascular, neuropathic factors, and preventive foot care practices.[12] Clinicians must also renew their efforts to organize clinical processes for identifying at-risk feet and applying preventive measures.[23]

Early identification of high-risk feet is imperative to decrease rates of mortality and morbidity. An interprofessional approach involving physicians, nurses and foot care specialists is often necessary to address the diverse needs of patients.[24]

Future Direction

The enormous economic toll of diabetes continues to burden society through direct medical and indirect costs.

Using the formulas provided, jurisdictional estimates can be calculated.

Given the significant clinical and economic burden, emphasis should be placed on preventive strategies. This includes patient education on foot care, regular foot examinations, glycemic control and lifestyle modifications. Early detection of foot issues and timely intervention can prevent the progression to severe complications.

Future research should focus on refining methodologies for assessing the economic burden of diabetic foot ulcers, considering standardized approaches to cost estimation, data collection and outcome measurement. Additionally, investigating innovative interventions and technologies that can further reduce the incidence of foot ulcers and associated complications is crucial for improving patient outcomes and mitigating the economic impact.

Other Opportunities

On a related note, future research to prevent diabetic foot problems should focus on several key areas to enhance our understanding and develop more effective preventive strategies. Here are some directions for future research. While not directly related to the topic of 'Economic Burden', these opportunities should be explored by the larger field:

Early Biomarkers and Predictive Models: Explore and identify early biomarkers that can predict the risk of diabetic foot complications. This can aid in the early identification of individuals at higher risk, allowing for timely intervention.

Develop predictive models that take into account multiple factors such as glycemic control, neuropathy, vascular status and patient-specific variables to estimate the risk of developing diabetic foot complications.

Advanced Imaging Technologies: Investigate and develop advanced imaging technologies for early detection of structural and functional changes in the foot. This includes techniques such as advanced ultrasound, MRI, and infrared imaging to identify early signs of neuropathy, vascular compromise, or inflammation.

Personalized Medicine Approaches: Explore personalized medicine approaches to diabetic foot prevention. This involves tailoring interventions based on an individual's unique characteristics, genetic predispositions and response to treatments.

Wearable Technologies: Investigate the use of wearable devices and sensor technologies to continuously monitor foot temperature, pressure distribution, and gait patterns. These technologies can provide real-time data for early detection of potential issues and enable timely interventions.

Patient Education and Behavioural Interventions: Conduct research on increasing the effectiveness of methods of patient education and behavioural interventions to promote foot self-care and adherence to preventive measures. Understanding the psychological and social factors that influence patient behaviour is crucial for designing targeted interventions.

Telehealth and Remote Monitoring: Explore how to improve the effectiveness of telehealth and remote monitoring in diabetic foot care. Investigate how technologies such as telemedicine, mobile applications and remote monitoring devices can facilitate regular follow-ups, early

detection of problems and timely communication between health-care providers and patients.

Interventions Addressing Peripheral Neuropathy: Investigate novel interventions for preventing and managing peripheral neuropathy, a significant contributor to diabetic foot complications. This may include pharmacological agents, neuroprotective strategies and regenerative medicine approaches.

Community-based Interventions: Conduct research on community-based interventions to promote foot health. Engage community health workers, educators and local health-care facilities to deliver preventive education and early screening in at-risk populations. Develop early warning sentinels in the family and circle of care.

Healthcare System Integration: Explore ways to integrate diabetic foot care into broader health-care systems. This includes optimizing communication and collaboration between primary care providers, endocrinologists, podiatrists, vascular specialists, and other relevant health-care professionals.

Long-term Outcomes and Cost-effectiveness: Assess the long-term outcomes and cost-effectiveness of various preventive strategies. Evaluate the impact of preventive measures on reducing the incidence of diabetic foot complications, amputations and associated health-care costs.

By directing research efforts toward these areas, we can make significant strides in preventing diabetic foot complications, improving patient outcomes and reducing the overall burden on health-care systems and individuals. ■

Joel Alleyne BSc (Computer Science) MISt is Executive Director, Canadian Podiatric Medical Association and President, Alleyne Inc., and is Adjunct Faculty, Faculty of Information, University of Toronto.

Tetiana Zvorygina BSc (Computer Science) MBSc (Computer Science) is Research Associate, Alleyne Inc.

References

1. Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. N Engl J Med. 2017 Jun 15;376(24): 2367-2375. DOI: 10.1056/NEJMra1615439
2. ESSR 2023. Accessed 2023 Sep 13. Available from: https://www.essr2023.org/formulario-comunicaciones/posters/5ab91aa5632764463022b15fb5d539d1.pdf
3. Government of Canada. Diabetes in Canada. Public Health Agency of Canada; 2017. Available from https://www.canada.ca/en/public-health/services/publications/diseases-conditions/diabetes-canada-highlights-chronic-disease-surveillance-system.html
4. Statistics Canada. Diabetes, 2017. Published November 14, 2018. Accessed February 7, 2024. https://www150.statcan.gc.ca/n1/en/pub/82-625-x/2018001/article/54982-eng.pdf?st=xCJ_Bhbf
5. Diabetes Canada. Diabetes in Canada: 2022 backgrounder. 2022. Available from: https://www.diabetes.ca/DiabetesCanadaWebsite/media/Advocacy-and-Policy/Backgrounder/2022_Backgrounder_Canada_English_1.pdf
6. Pedorthic Association of Canada. Diabetic Foot Care. 2013 Oct 8. Available from: https://pedorthic.ca/foot-health/diabetes/
7. Parker ED, Lin J, Mahoney T, Ume N, Yang G, Gabbay RA, et al. Economic costs of diabetes in the U.S. in 2022. Diabetes Care. 2024 Jan 1;47(1): 26-43. DOI: 10.2337/dci23-0085
8. Liu R, Petersen BJ, Rothenberg GM, Armstrong DG. Lower extremity reamputation in people with diabetes: a systematic review and meta-analysis. BMJ Open Diabetes Res Care. 2021 Jun;9(1):e002325. DOI: 10.1136/bmjdrc-2021-002325
9. Jo C. Cost-of-illness studies: concepts, scopes, and methods. Clin Mol Hepatol. 2014 Dec;20(4): 327-37. DOI: 10.3350/cmh.2014.20.4.327
10. Syed MH, Salata K, Hussain MA, Zamzam A, de Mestral C, Wheatcroft M, et al. The economic burden of inpatient diabetic foot ulcers in Toronto, Canada. Vascular. 2020 Oct;28(5): 520-529. DOI: 10.1177/1708538120923420
11. Armstrong DG, Swerdlow MA, Armstrong AA, Conte MS, Padula WV, Bus SA. Five year mortality and direct costs of care for people with diabetic foot complications are comparable to cancer. J Foot Ankle Res. 2020 Mar 24;13(1):16. DOI: 10.1186/s13047-020-00383-2
12. American Diabetes Association. New American Diabetes Association report finds annual costs of diabetes to be $412.9 Billion. Arlington, Virginia; 2023 Nov 1. Available from: https://diabetes.org/about-us/statistics/cost-diabetes
13. Podimetrics. Diabetic Foot Complications: The True Cost. 2022. Available from: https://podimetrics.com/the-true-cost-of-diabetic-foot-complications/
14. Statistics Canada. Diabetes, 2011. 2022 Oct 24. Available from: https://www150.statcan.gc.ca/n1/pub/82-625-x/2012001/article/11659-eng.htm
15. Essien SK, Kopriva D, Linassi AG, Zucker-Levin A. Trends of limb amputation considering type, level, sex and age in Saskatchewan, Canada 2006-2019: an in-depth assessment. Arch Public Health. 2022 Jan 4;80(1):10. DOI: 10.1186/s13690-021-00759-1

16. de Mestral C, Gomez D, Wilton AS, Lee DS, Albalawi Z, Austin PC, et al. A population-based analysis of diabetes-related care measures, foot complications, and amputation during the COVID-19 pandemic in Ontario, Canada. JAMA Netw Open. 2022 Jan 4;5(1):e2142354. DOI: 10.1001/jamanetworkopen.2021.42354
17. Diabetes Canada. Amputation prevention. Available from: https://www.diabetes.ca/advocacy---policies/our-policy-positions/amputation-prevention
18. Diabetes Canada. Chapter 32: foot care. Available from: https://www.diabetes.ca/health-care-providers/clinical-practice-guidelines/chapter-32
19. Pourkazemi A, Ghanbari A, Khojamli M, Balo H, Hemmati H, Jafaryparvar Z, et al. Diabetic foot care: knowledge and practice. BMC Endocr Disord. 2020 Mar 20;20(1):40. DOI: 10.1186/s12902-020-0512-y
20. Wounds Canada. Foot Screen. Available from: https://www.woundscanada.ca/future-students/19-healthcare-professional/resources-health-care-professionals/25-foot-screen
21. Wounds Canada. Inlow's 60 second diabetic foot screen. 2018. Available from: https://www.diabetes.ca/DiabetesCanadaWebsite/media/Health-care-providers/2018%20Clinical%20Practice%20Guidelines/Inlows-60-second-diabetic-foot-screen-Wounds-Canada.pdf?ext=.pdf
22. Blanchette V, Brousseau-Foley M, Cloutier L. Effect of contact with podiatry in a team approach context on diabetic foot ulcer and lower extremity amputation: systematic review and meta-analysis. Foot Ankle Res. 2020 Mar 20;13(1):15. DOI: 10.1186/s13047-020-0380-8
23. Perkins BA. Sounding the alarm on rising diabetes-related amputations. CMAJ. 2019 Sep 3;191(35): E953-E954. DOI: 10.1503/cmaj.191064
24. Alavi A, Sibbald RG, Mayer D, Goodman L, Botros M, Armstrong DG, et al. Diabetic foot ulcers: part I. Pathophysiology and prevention. J Am Acad Dermatol. 2014 Jan;70(1):1.e1-18; quiz 19-20. DOI: 10.1016/j.jaad.2013.06.055

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Foot Health And Footwear For Persons Experiencing Homelessness: A Resource

Janet L Kuhnke RN BA BScN MS NSWOC FCN DrPsych, **Erin Telegdi** RN (Hon) BA BScN **and Kirsten Hansen** LPN

Abstract: For individuals experiencing homelessness (IEH) good foot health is of special importance as their feet generally experience harsher conditions. Building trust and providing equitable access are foundational to the success of any foot health service. In this paper we discuss the links between IEH in Canada and their foot health. Given the multiple and complex barriers faced by IEH when attempting to access health care, it is imperative that health-care providers engage in creative, collaborative and intersectoral care planning to prioritize and improve the foot health of this population.

Key words: *homelessness, foot health, footwear, equitable access, barriers to foot care.*

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Good foot health plays an important role in the health and well-being of individuals in the general population. Yet, for individuals experiencing homelessness (IEH) foot health is of greater importance as their feet experience harsher conditions. Building trust, respect, solidarity and equitable access are foundational to the success of any foot health service. Therefore, to understand foot health and skin care issues for IEH, we first present links between social determinants of health and the state of homelessness in Canada.

Homelessness In Canada

Homelessness is on the rise in Canada. Statistics Canada (2023) recently stated that more than one in ten (11.2%) Canadians (1,690,000 people) report to have experienced some form of homelessness in their lifetime.[1] The reported numbers of IEH in Canada varies from 150,000 to 300,000 and the actual numbers may be higher.[2]

Homelessness includes the intersection of an individual's physical needs, mental health and well-being, housing, social marginalization and access to health-care services.[3] Today, IEH are diverse and over-represented by women (27.3%), youth (18.7%) and Indigenous people (28% to 34%). Moreover, statistics show that older adults (50-64 years), seniors (65 years) and veterans (2.5%) make up 24.4% of persons accessing services at shelters.[4]

Situations leading to homelessness are complex, both at a systemic and individual level, and vary over time. Factors contributing to homelessness include: trauma and violence, poverty, unemployment and changes in employment (full/part-time to casual), lack of accessible and affordable housing, mental health and substance use disorders, violence by intimate partners, acute and chronic illnesses, divorce, involvement of the justice system, development of disability and death of a family or support person.[5]

Homelessness is described as:

> "The situation of an individual, family or community without stable, safe, permanent, appropriate housing or the immediate prospect, means and ability of acquiring it. It is the result of systemic or societal barriers, a lack of affordable and appropriate housing, the individual/household's financial, mental,

cognitive, behavioural or physical challenges and/or racism and discrimination. Most people do not choose to be homeless, and the experience is generally negative, unpleasant, unhealthy, unsafe, stressful and distressing."[6]

For First Nation, Métis and Inuit individuals, families or communities, Thistle (2017) defines homelessness as:

> "Lacking stable, permanent, appropriate housing or the immediate prospect, means or ability to acquire such housing. Unlike the common colonialist definition of homelessness, Indigenous homelessness is not defined as lacking a structure of habitation; rather, it is more fully described and understood through a composite lens of Indigenous worldviews. These include: individuals, families and communities isolated from their relationships to land, water, place, family, kin, each other, animals, cultures, languages and identities. Importantly, Indigenous people experiencing these kinds of homelessness cannot culturally, spiritually, emotionally or physically reconnect with their Indigeneity or lost relationships." *Aboriginal Standing Committee on Housing and Homelessness, 2012.*[7]

For IEH, there are four physical living situations described by the Canadian Homelessness Research Network (2012). These include the following:

- **Living unsheltered**, in places or spaces not intended for humans (e.g., streets, under bridges, alongside train tracks, sheds, barns, tents);
- Living in an **emergency shelter** overnight that may be related to family violence (e.g., families and children);
- **Provisionally accommodated** or existing in a temporary place that is not permanent; and finally,
- Being **at risk of homelessness** when a person is not homeless, but at risk due to social and economic issues related to income; and/or housing is precarious and does not meet safety and health standards (e.g., leaking roofs, poor water and plumbing, taxes owing, structural damage).[4]

Researchers also state the coronavirus (COVID-19) pandemic created additional challenges for IEH. According to Maretszki et al., during the pandemic access to supportive health care (testing, vaccinations, foot care, showers/bathing), social resources and services were reduced. Furthermore, as a result of the pandemic, changes in the health and social service sectors led to many IEH experiencing (multiple) displacements, fragmentation in their existing health care and formal/informal social care networks.[8]

Therefore, in this paper we discuss the links between IEH and their foot health. We also explore difficult conversations such as, who in society, or if the health-care system, is responsible for the provision of funded foot care and footwear? We ask this as we know that IEH have or develop worsening foot conditions. We also ask, why is provision of funded foot care not part of standardized health care in Canada?

Foot Health Issues For Persons Experiencing Homelessness

Persons living homeless require comprehensive health assessments, including acute and chronic illness. Assessment should include foot health (e.g., gait, foot exam and sensation, footwear, socks).[9] This can be challenging if persons are not able to sit, stand or fully engage in the health assessment or if persons need to focus on meeting their daily needs. Therefore, the health assessment may need to be completed over several interactions/visits.

Assessing the health of IEH is complex, with multi-factorial health and social factors and co-occurring issues such as diabetes mellitus, hypertension, mental health issues, substance use and infections (local, systemic).[10] Specifically, in relation to lower limb and feet, the person may have pre-existing foot conditions related to employment, surgery or childhood foot deformity. They also may have experienced physical violence and accidental traumatic injuries, which can have implications for pre-existing limb and foot conditions and thereby increase their risk for foot-related complications.[11,12]

To address this issue, The Queen's Nursing Institute in the United Kingdom (2020) explored

social and health issues that contribute to foot health problems. They discuss a broad range of issues related to social determinants of health and how they lead to cause or exacerbate foot health for IEH (See Table 1).

Prevalence Of Foot Conditions In Persons Experiencing Homelessness

The importance of assessing and caring for people's feet and the effect this can have on one's overall health and well-being cannot be underestimated.[14] Yet the care of feet for IEH is often disregarded and not fully funded by social or health-care systems. Foot care services are often offered and managed by health-care professionals volunteering time and services (e.g., physicians, foot care nurses, podiatrists, chiropodists, health professional students).[15,16,17] As well, it often takes the media to draw attention to the crisis of poor foot health, lack of foot care, and access to appropriate footwear and socks for IEH.[18,19,20]

Adding to the burden is the reality of pre-planning foot care clinics when organized by volunteers. As a result, clinics may not always be available, times and weather may vary. Therefore, foot care services may be viewed by patients as intermittent and less consistent, with many patients seeking care when it becomes most urgent or wanting immediate or same day appointments. Wainwright and colleagues explored the importance of 'place of service' and adherence by patients to self-care. The team reported that team members at shelters were to offer routine diabetes care (blood pressure, monitoring hemaglobin A1C, foot checks) and related foot exams. Yet, when foot health services and clinics were stable there was increased patient participation in diabetes care.[21]

This is of concern as IEH are at greater risk of trauma to their lower limbs and feet/hands. In a

Table 1: Social and Health Issues Contributing to Foot Health Problems[13]

Mental health issues	• Mental health issues can contribute to decreased ability to complete personal care and may lead to difficulty engaging with health-care providers and other support workers. • People who are experiencing homelessness may have experienced traumatic events in their lives (e.g., Adverse Childhood Events – ACEs). This in turn can lead to poor mental well-being, decreased self-care and/or diagnosed or undiagnosed mental health conditions.
Asylum seekers, refugees and vulnerable migrants	• Asylum seekers, refugees and vulnerable migrants can present with foot conditions rarely seen. For instance, a history of polio, TB, leprosy, rickets, polydactyly (extra toes), untreated talipes (club foot) and industrial/agricultural accidents can all cause foot issues, as can torture (specifically, 'fallaca' where the soles of the feet are beaten).
Increased risk of diabetes and diabetic foot complications	• The incidence of diabetes is higher in socially disadvantaged groups, which causes a higher risk of foot pathology. • Foot deformity (Charcot Foot), diabetes-related foot ulcers with loss of protective sensation, peripheral vascular disease and pressure.
Walking long distances	• Walking long distances (on pavement, gravel, uneven surfaces), often carrying heavy bags can lead to foot blisters, biomechanical problems such as forefoot, heel pain (including plantar fasciitis – inflammation of the fascia), ankle and arch pain.
Sleeping on buses/trains/ benches	• Sleeping in an upright, sitting position may cause peripheral dependent oedema. Sleeping on sidewalk grates can cause burns.
Exposure to the elements	• Exposure to cold, wet and/or heat increases the risk of fungal infections (onychomycosis), frostbite, chilblains (itchy, painful, swollen patches on skin, hands and feet), severe maceration (too much moisture in the stratum corneum), immersion (trench) foot and development of blisters (blood or fluid filled).

Table 1: Social and Health Issues Contributing to Foot Health Problems[13]

Poor nutrition and smoking	• Poor nutrition and/or smoking can cause problems with wound healing, skin integrity and reduced immunity. • Smoking increases the risk of peripheral artery disease. • Lack of access to nutritional food and fluids or a registered dietitian for consultation. • Food provided in shelters and drop-in programs is often nutrient-poor and inappropriate for those requiring special diet considerations (e.g., diabetes, Crohns' disease, lactose intolerance).
Difficulty in maintaining good hygiene	• Good hygiene may be difficult to maintain due to lack of accessibility of shower facilities or increased risk of physical or sexual violence in shower facilities. • Scabies (human skin mite infestation), infections (fungal, bacterial, and viral) can result. Sharing showers increases the risk of contracting verrucae (plantar wart, *tinea pedis*).
Not removing shoes (footwear) and socks at night	• This may happen due to fear of theft or the need to move quickly and being constantly 'on the go'. This results in immersion (trench) foot, fungal infections (onychomycosis) and blisters (blood or fluid filled).
Poor footwear (shoes, running shoes, slippers, sandals, boots, rubber boots)	• Lack of funds for well-fitting, good quality shoes, clean socks and appropriate nail clippers, files and/or scissors causes foot problems. • Poor quality shoes made of synthetic materials can cause fungal infections (onychomycosis) as moisture is absorbed and saturated into materials. Sometimes, moisture and tight shoes can contribute to blisters, corns (heloma, soft, hard or seed corns) and ingrown toenails (leading to pain, infection).
Self-treating	• Due to lack of podiatry and foot care nurses the person may resort to trimming nails with knives, other improvised blades and acid-based corn plasters, or picking and pulling off finger and toenails; this results in trauma, ulceration, infection and scarring. • Sharing of nail clippers/files is a common contributor to poor nail health.
Difficulty accessing health care and podiatry/foot care nurses	• Access issues can include: perceived or actual insensitive treatment by health-care staff, embarrassment, language barriers, literacy, vision and hearing challenges, no internet access, missing appointments due to lack of calendar or phone or need to attend to other needs of daily living and thus not being able to wait long periods of time to be seen by a health-care professional, being restricted from services and/or the need to be chaperoned if assessed as being high risk for lone working. • Missed texts and calls are often a result of lost or stolen phones, lack of funds to pay for a phone, inability to charge a phone, poor internet access. • Not having a permanent address for appointment letters to be sent.
Substance use	• Alcohol use can result in alcohol-related peripheral neuropathy, an increased risk of diabetes mellitus and osteoporosis, poor immunity and foot injuries due to accidents and potential decrease in self-care.

Adapted with permission from: The Queen's Nursing Institute. The Foot Health of People Experiencing Homelessness. 2020. https://www.qni.org.uk/wp-content/uploads/2016/09/The-Foot-Health-of-People-Experiencing-Homelessness-2020-1.pdf

recent review (29 studies), researchers explored the rates of musculoskeletal injuries and conditions and issues among IEH. They reported that persons are at risk of significant injury related to musculoskeletal and soft-tissue injuries (SSTIs), fractures and traumatic injuries, chronic pain and pain related to the foot and ankle region.[22]

Persons experiencing homelessness have limited access to appropriate foot care and appropriate well-fitted footwear. To et al., in a review (17 studies, n-6,371 participants, majority were male),

reported the prevalence of foot conditions in IEH ranged from 9% to 65%. They stated two-thirds of IEH reported a foot issue such as, "corns and calluses, nail pathologies and infections. Foot pathologies related to chronic diseases such as diabetes were identified."[23] As well, they identified conditions related to diabetes mellitus and foot problems such as, "tinea pedis, foot pain, functional limitations with walking and improperly-fitting shoes."[23] They further stated that up to one-fifth of IEH needed to have health-care follow-up for foot conditions/issues.

Though foot conditions may be identified, persons may struggle to access basic foot care and footwear, or to obtain orthotics or specialized footwear. Muirhead and colleagues screened 65 males and 30 females with a history of diabetes mellitus, high blood pressure and or peripheral vascular disease. Persons were described as being too shy or embarrassed to show the health-care provider their feet and nails. Some described not having a sense that a trust-filled relationship existed in order to share their foot concerns.[24] Bourque and colleagues studied the health conditions of Canadian veterans experiencing homelessness in Canada. In the 99 persons involved, common conditions reported included dental problems, head injuries, musculoskeletal injuries and foot problems.[25]

Major deterrents to engaging in foot care include the present state or poor condition of one's feet, nails, socks and shoes, along with foot odour. Moes explored the role of properly fitted shoes to reduce knee, back, ankle/feet pain, increase activity and improve patient's foot health. In their study, when participants wore proper fitting shoes over six weeks, they experienced less pain and enjoyed increased walking speed.[26] Wallace et al. facilitated a free foot clinic at a homeless shelter in Colorado. They remind health-care professionals and students that basic foot care, trimming and filing nails, managing callous, applying athlete's foot powder and assessing for footwear and socks is only part of the goal. The broader goal includes listening to the persons' stories, talking about their health, feet, shoes and, in the end, providing empathetic foot care services.[15]

In British Columbia, Canada, D'souza et al. explored the experiences of 65 IEH.[27] Using *Inlow's 60-second Foot Screen* to screen for risk, they reported that individuals require foot care assessments as part of overall health assessments. They further state that IEH will experience increased foot complications when their feet are not assessed as part of holistic assessment (e.g., hospitalizations, foot and limb amputation and disability).[28] They advocate for foot care to be a priority and that foot care services should be fully funded by the health-care system. Foot health services need to be framed in principles of trust and equity of access. Mullins et al. explored the role of publicly funded community-based podiatry services. In their study they identified that persons (n=295) often presented with one or more co-occurring foot issues such as, "skin and nail pathologies (68.1%), inadequate footwear (51.9%) and biomechanical issues (44.1%)".[29] As well, for persons sleeping unsheltered, they were more likely to present with, "foot biomechanical issues (50.8%), acute wound care needs (17.4%) or with a traumatic injury (10.6%)".[29] They also recommend provision of publicly funded foot health services focused on prevention and identification of foot and ankle conditions in order to support development of trust and to build sustainable client-team connections to prevent foot complications.[29]

Promoting Foot Health: What Can We Do?

As health-care providers we can advocate for change in foot health services for IEH. There are several advocacy theories and frameworks on which teams can base their energies.[30] Tips for becoming an effective advocate for foot health can be found at: https://www.woundscanada.ca/docman/public/wound-care-canada-magazine/wcc-2022-v20-n2/2659-wcc-fall-2022-v20n2-final-pg-20-27-how-to-become-a-skin-wound-care-advocate/file

Leaders And Decision Makers

- Advocate for policy and decision makers to include funded foot health services for persons living homeless.[28,30]

- Support leaders to plan funded foot care clinics, mobile outreach foot health and establish foot health provider roles.
- Build collaborative partnerships with foot health and footwear providers to support development of a responsive, relevant foot care clinic.[23]
- Adopt a 'Foot Care Model' that supports prevention, promotion and assessment and treatment of foot health.[28]
- Co-create solutions for unfunded foot care services including travel, transportation and accessibility (e.g., taxi chits).

Researchers

- Partner with social and health-care organizations providing foot health services for persons living homeless.[31]
- Co-create research projects focused on fully understanding the needs of the population, health-care foot providers and the larger organization.
- Support teams to develop evidence-based foot health resources with client input.[32]
- Utilize community-based research approaches with client involvement with lived experience to promote self-determination and autonomy.[33,34]
- Offer cash versus gift cards for participation in research studies; this eases some of the daily burden of meeting one's needs.[35]

Foot Health Providers

- Plan foot health appointments to ensure feet and footwear are being routinely assessed as part of an overall health assessment.[9,13]
- Be knowledgeable on referral services in your area (podiatry, chiropody, foot care nurses, etc.).
- Partner with leaders and researchers to collect relevant foot health data to fully understand the population and foot health issues identified.
- Screen for risk of amputation using validated assessment tools in the holistic assessment. For example: *Inlow's 60-second Diabetic Foot Screen* (2022). Available from: https://www.woundscanada.ca/news/618-inlow-s-60-second-diabetic-foot-screen-update-2022
- Support persons with foot issues to attend planned consult appointments. For example, this may include having a friend or community worker attend the appointment with the person. Plan transportation and funds to support transportation.[13]
- Advocate for client access to basic nail clippers and files to self-manage.[13]
- Partner with diabetes and foot health teams providing care in your community; include opportunities for knowledge exchange, where IEH and workers working with IEH have the opportunity to increase cultural-responsiveness for workers who don't have experience working with IEH. This provides providers working with IEH the opportunity to learn from diabetes and foot health teams about foot health and its complications.
- Support knowledge exchange to promote health equity by centring and valuing the lived experience of IEH while providing collaborative opportunities for IEH to learn about foot health and share their learnings with others.[33]

Educators

- Co-create with client-centred foot health resources relevant to the population served.[13]
  - Include times to access and location of foot care clinics.
  - Outline times to access footwear, socks and other items for foot care first aid.[13]
  - Include location of bathing and cleansing wipes, dry towels, foot powders and moisturizing lotions.
- Develop foot health resources with a range of foot health information including mild complications (broken finger and toe nails) to critical issues such as frostbite, gangrene, critical limb ischemia and risk of sepsis.[13] Sample resources include:
  - Wounds Canada, Care at Home Series, Caring for Your Wounds at Home. Available at: https://www.woundscanada.ca/patient-or-caregiver/resources/care-at-home-series
  - CATIE (Canadian AIDS Treatment Information Exchange), How do I know it's serious? When to seek medical care for wounds? Available at: http://librarypdf.catie.ca/ATI-80000s/80007.pdf

- Promote client self-care and engagement in daily foot and footwear checks.[13]
  - This may include a friend daily checking another's feet or footwear.
  - Resources include: Wounds Canada. Steps for Healthy Feet Checklist. Available at: https://www.woundscanada.ca/docman/public/diabetes-healthy-feet-and-you/2181-checklist-formjan2017-update-2021/file
- Increase community awareness and provide opportunities for foot health providers, workers and IEH to network and engage in knowledge exchange around experiences of foot health issues.[13]
- Build trust-filled relationships through 'warm-referrals', where workers working with IEH refer IEH to known and trusted specialized foot care providers.
- Share foot health education materials with shelters in your community to heighten awareness within your region.[13] This builds communities of practice, collaboration and co-creation of services to meet the local needs.

Engaging Persons[30]

- Advocate for and encourage persons to attend foot health clinics.
- Focus on trust, respect and kindness - remember people may be shy, reserved and not want to show their feet and nails to a foot health provider.[13]
- Build relationships and partnerships to provide transportation. Consider a cash (financial) incentive to attend the foot health appointment and to help offset some of the unaddressed costs of coming to appointment (less time to work, or make money for daily needs or finding nightly sleeping quarters, shelter).[13,34]
- Be creative in scheduling appointments as time-specific appointments can create barriers to accessibility and persons do not always have regular access to clocks, or a smartphone for appointment reminders.
- Plan drop-in foot health clinics with appointment times that can accommodate individuals and provide flexibility.
- If resources allow, support health-care workers to provide reminders and a person to co-attend appointments; this can help facilitate accessibility and increase comfort levels for individuals especially if they are visiting the clinic for the first time and potentially meeting a new foot health provider.

Common Foot And Skin Conditions

Table 2 identifies some of the common foot and surrounding skin conditions identified in foot care clinics for IEH. Ideal prevention strategies may not always be possible given circumstances, health-care provider and support available, access to and funding of podiatry, foot care nurses, new footwear and/or orthotics, travel costs and the transient nature of IEH. For each condition, seeking the underlying cause is important.

Focus on prevention including daily skin care, wound care for nails and feet, access to bathing and showering facilities, daily foot checks, access to footwear and dry socks. Treatments will depend

Figure 1: Community members at the Moss Park Consumption and Treatment Service in Toronto, Ontario engaging in foot care related art in response to the site's first visit by a chiropodist. With permission from Erin Telegdi

on the IEH engagement, ability to do care and comfort with the care plan (e.g., access to treatment powders and topical or oral medications).

Treatments and referrals considered may depend on the foot care services offered in each geographic area and may include antibiotics (topical, oral or intravenous), laboratory, x-ray and scans, wound care, lab work and pain management. Referrals to physicians, nurse practitioners, infection control, pharmacy, podiatry/chiropody, foot care nurses, dermatologists, support workers trained in care of IEH and the IEH's informal support teams all contribute to treatment success.

Resources For Foot Conditions For Persons Living Homeless

For health-care providers providing services for IEH it is important to acknowledge the assessment and care of persons' feet. Providers need to be knowledgeable about foot conditions and care options. Providers need the tools to educate IEH and support care of their feet. The list below is not all inclusive. Please reach out to and refer to your foot health provider.

Athlete's Foot (Tinea Pedis)

- Athletes foot, "is an infection of the skin and feet that can be caused by a variety of different fungi. Although *tinea pedis* can affect any portion of the foot, the infection most often affects the space between the toes. Athlete's Foot is typically characterized by skin fissures or scales that can be red and itchy. *Tinea pedis* is spread through contact with infected skin scales or contact with fungi in damp areas (for example, showers, locker rooms, swimming pools). *Tinea pedis* can be a chronic infection that recurs frequently. Treatment may include topical creams (applied to the surface of the skin) or oral medications." (Hygiene-related diseases. Centers for Disease Prevention and Control. 2017; para. 1.) Available from: https://www.cdc.gov/healthywater/hygiene/disease/athletes_foot.html
- "Athlete's foot is caused by the same type of fungi (dermatophytes) that cause ringworm and jock itch." (Mayo Clinic, 2024.) Available from: https://www.mayoclinic.org/diseases-conditions/athletes-foot/symptoms-causes/syc-20353841
- Onychomycosis develops when the fungi moves to the nails - also called nail fungus.

Cutaneous Porphyria

Porphyria cutanea tarda (PCT) is a subtype of a complex group of diseases. Porphyria cutanea tarda results from a deficiency of the enzyme urophorphyrinogen decarboxylase. Clients who drink alcohol on a daily basis and spend a large amount of time outdoors may present with an increase in the blistering of hands and face due to his condition. Provide the clients with education around skin health and encourage reduction of sun exposure all year round. (Kuhnke, et al., 2015.) Available from: https://www.woundscanada.ca/docman/public/wound-care-canada-magazine/2015-vol-13-no-2/547-wcc-fall-2015-v13n2-calgary-drop-in/file

Chillblains

"Chilblains (perniosis, also known as pernio) is a reaction to cold, non-freezing temperatures. It is seen most often in people who are exposed to damp, cold weather. Symptoms develop 12 to 24 hours after exposure to cold. Chilblains usually affect the fingers and toes, but the ears, nose and heels can also be affected. Symptoms include: local redness and swelling, small areas of skin that look purplish, skin bumps, changes in sensation, such as itching or burning, tender blue bumps that develop after rewarming and blisters and ulcers (in severe cases). Treatment includes rewarming the affected areas, caring for any blisters that form and avoiding re-exposure to cold." (HealthLink BC. March 2023; para. 1.) Available from: https://www.healthlinkbc.ca/health-topics/chilblains-perniosis

Diabetes Mellitus

Caring for your feet: Safe foot care if you have diabetes. (Wounds Canada. 2021.) Available from: https://www.woundscanada.ca/docman/public/patient-or-caregiver/1728-home-safe-df-care-1942e/file

Table 2: Common Foot and Surrounding Skin Conditions Identified in Foot Care Clinics for IEH

Condition	Example	Condition	Example
Cellulitis		Frostbite	
Deformity (bone) bunions; claw/ hammer/ mallet toes; over- lapping digits; dropped metatarsal heads		Lipo-dermato-sclerosis	
Skin Abscess		Ulcers (leg and foot)	
Fissures		Heloma (corn) (3 types): • Heloma durum (hard); • Heloma molle (soft); • Heloma milliare (seed)	
Edema, Swelling		Hyper-keratosis	
Immersion (trench) foot		Onycho-mycosis (fungal infection of the nail unit)	

Condition	Example	Condition	Example
Lesions, scratches, bites (insect, animal)		*Tinea Pedis* (Athlete's foot) fungal infection of the skin	
Maceration of skin breakdown between or under toes		Tyloma (callus, hyper-keratosis)	
Onycho-gryphosis (Ram's horn nail)			

Images with permission from Kristen Hansen

Frostbite

"Frostbite is a thermal injury occurring when tissues are exposed to temperatures below their freezing point for a prolonged period. The severity of frostbite injury is directly related to absolute exposure, including external temperature, wind chill, conditions and quality of clothing/tissue protection". (Klammer et al. 2023 ; pp. 427-428.) Available from: https://www.wemjournal.org/article/S1080-6032(23)00107-2/pdf

Immersion Foot (Trench Foot, Street Foot)

Immersion foot, "is a cold injury that occurs gradually over several days of exposure to cold, but not freezing, temperatures. The name comes from World War I troops who developed symptoms after standing in cold, wet trenches. Signs and symptoms of trench foot include: red skin that turns pale and swollen, numbness or burning pain, leg cramps, no actual freezing of the skin, a slow or absent pulse in the foot and development of blisters or ulcers after two to seven days. First aid for trench foot includes rewarming the affected areas, relieving pain and preventing problems such as infection or dead skin (gangrene)". (BC HealthLink BC. November, 2022, para 1.) Available from: https://www.healthlinkbc.ca/trench-foot

Windburn And Hypothermia

Government of Canada. It's Your Health: Extreme Cold. 2013. Available from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/hl-vs/alt_formats/pdf/iyh-vsv/environ/cold-extreme-froid-eng.pdf

First Nations Health Authority. (n.d.). Staying Warm and Safe this Winter. Available from: https://www.fnha.ca/Documents/FNHA-Staying-Warm-and-Safe-this-Winter.pdf

Greater Vancouver Housing Society. (n.d.). Hypothermia Checklist for Seniors. Available from: https://hsa-bc.ca/_Library/Resource_Library/Tools-and-Checklist-141125.pdf#page=24

Janet L Kuhnke RN BA BScN MS NSWOC FCN, Doctorate in Psychology is Associate Professor, School of Nursing, Cape Breton University and Nova Scotia Health Affiliate Scientist; MSSU-SPOR Researcher.

Erin Telegdi RN (Hon) BA BScN is with Moss Park Consumption and Treatment Service, South Riverdale Community Health Centre, Casey House and Wound Healing Clinic, Women's College Hospital, Toronto ON.

Kristen Hansen LPN is an Advanced Foot Care Nurse & Foot Care Educator in association with Foot Canada Training; Kirsten's Foot Care; and North End Community Health Centre, Halifax NS.

Summary

Provision of funded foot health for persons experiencing homelessness includes access to skin and nail care (feet and hands), appropriate footwear (based on the season), orthotics and dry socks, as well as readily accessible referrals to foot care specialists as needed. These basic care elements can improve the health and wellbeing of IEH. Given the multiple and complex barriers faced by IEH when attempting to access health care, it is imperative that health-care providers engage in creative, collaborative and intersectoral care planning to prioritize and improve the foot health of IEH.

Central to this work will be collaboration with IEH themselves and their formal and informal support networks. People with lived experience hold tremendous expertise into the challenges they experience as well as the solutions needed to improve their health. Interventions to this end will range from the individual to the systemic level. ■

References

1. Statistics Canada. Homelessness: How does it happen? 2023 Dec. Available from: https://www.statcan.gc.ca/o1/en/plus/5170-homelessness-how-does-it-happen
2. Homeless Hub. About homelessness. Canadian observatory of homelessness; 2021. Available from: https://www.homelesshub.ca/about-homelessness/homelessness-101/what-homelessness
3. Liu M, Hwang SW. Health care for homeless people. Nat Rev Dis Primers. 2021 Jan 14;7(1):5. DOI: 10.1038/s41572-020-00241-2
4. Gaetz S, Barr C, Friesen A, Harris B, Hill C, Kovacs-Burns K, et al. Canadian definition of homelessness. Canadian Observatory on Homelessness Press. 2012. Available from: https://www.homelesshub.ca/sites/default/files/COHhomelessdefinition.pdf
5. MedlinePlus. Homelessness and health. Bethesda, MD: National Library of Medicine; 2023 Apr 20. Available from: https://medlineplus.gov/homelessnessandhealth.html
6. Canadian Observatory on Homelessness. We're a global thought leader on homelessness prevention. 2023. Available from: https://preventhomelessness.ca/about/
7. Thistle J. Indigenous definition of homelessness in Canada. Toronto: Canadian Observatory on Homelessness Press; 2017. Available from: https://homelesshub.ca/sites/default/files/COHIndigenousHomelessnessDefinition.pdf
8. Maretzki M, Geiger R, Buxton JA. How COVID-19 has impacted access to healthcare and social resources among individuals experiencing homelessness in Canada: a scoping review. BMJ Open. 2022 Aug 1;12(8):e058233. DOI: 10.1136/bmjopen-2021-058233
9. Gordon SJ, Baker N, Steffens M. Appropriate and acceptable health assessments for people experiencing homelessness. BMC Public Health. 2022 Jul 4;22(1):1289. DOI: 10.1186/s12889-022-13723-7
10. National HealthCare for the Homeless Council. Homelessness and health: what's the connection? Fact Sheet. 2019 Feb. Available from: https://nhchc.org/wp-content/uploads/2019/08/homelessness-and-health.pdf
11. Kushel M. Violence against people who are homeless: the hidden epidemic. San Francisco, CA: University of California San Francisco; 2022 Jul. Available from: https://homelessness.ucsf.edu/blog/violence-against-people-homeless-hidden-epidemic
12. Canadian Human Rights Commission. Ending violence against people experiencing homelessness starts with upholding their human rights. 2022 Aug 3. Available from: https://www.chrc-ccdp.gc.ca/en/resources/ending-violence-against-people-experiencing-homelessness-starts-upholding-their-human

13. The Queen's Nursing Institute. The foot health of people experiencing homelessness: guidance for community nurses. London, UK: 2020. Available from: https://qni.org.uk/wp-content/uploads/2016/09/The-Foot-Health-of-People-Experiencing-Homelessness-2020-1.pdf
14. Cook JA, Reuille J, Ashley S, Kautz DD. Foot care. J Emerg Nurs. 2016 Nov;42(6):532-534. DOI: 10.1016/j.jen.2016.06.013
15. Erik A, Wallace MD, Nikki D, Bloch BA, Cassidy MD. It's not about the feet. J Reg Med Campuses. 2019;2(4): 1-3. DOI: 10.24926/jrmc.v2i4.2160
16. Keegan R. Washing the feet of the homeless: the service project that changed me. Nursing. 2017 Jun;47(6): 46-48. DOI: 10.1097/01.NURSE.0000516221.31896.d4
17. Thomas D. Homeless hope: a voluntary, nurse-lead organisation working to educate and support people sleeping rough. Br J Community Nurs. 2019 Dec 1;24(Sup12): S18-S2. DOI: 10.12968/bjcn.2019.24.Sup12.S18
18. Jolleymore M. Homeless individuals face significant foot health issues: New Dalhousie University study. Dalhousie University. 2017 Feb 2. Available from: https://medicine.dal.ca/news/2017/02/02/homeless_individuals_face_significant_foot_health_issues__new_dal_study.html
19. Kale NN, Marsh J, Kale NK, Miskimin C, Mulcahey MK. Musculoskeletal injuries and conditions among homeless patients. J Am Acad Orthop Surg Glob Res Rev. 2021 Nov 18;5(11):e21.00241. DOI: 10.5435/JAAOSGlobal-D-21-00241
20. Dobbin N. Up to two-thirds of homeless people have serious foot issues, Dal research suggests. Canadian Broadcasting Corporation. 2017 Feb 2. Available from: https://www.cbc.ca/news/canada/nova-scotia/homeless-people-foot-care-dalhousie-aerobics-first-clinic-st-andrews-1.3963541
21. Wainwright MK, Earle M, Kosog K, Gilbert MK, Nolan C, Stellon E, et al. The effect of place of service on diabetic screening adherence in the homeless population. J Community Health. 2020 Feb;45(1): 73-80. DOI: 10.1007/s10900-019-00718-6
22. Hampshire G. For Halifax homeless population, dry socks are a matter of health. Canadian Broadcasting Corporation. 2023 Oct 16. Available from: https://www.cbc.ca/news/canada/nova-scotia/homeless-foot-problems-feet-socks-halifax-1.6994981
23. To MJ, Brothers TD, Van Zoost C. Foot conditions among homeless persons: a systematic review. PLoS One. 2016 Dec 9;11(12):e0167463. DOI: 10.1371/journal.pone.0167463
24. Muirhead L, Roberson AJ, Secrest J. Utilization of foot care services among homeless adults: implications for advanced practice nurses. J Am Acad Nurse Pract. 2011 Apr;23(4): 209-15. DOI: 10.1111/j.1745-7599.2011.00598.x
25. Bourque J, Van Til L, Nadueau J, LeBlanc SR, Ebner-Daigle J, Gibbons C, et al. Physical health status of homeless veterans in Canada: a cross-sectional study J Mil Veteran Fam Health. 2017; 3(2): 1-8.
26. Moes J. Proper fitting shoes: reducing pain, increasing activity, and improving foot health among adults experiencing homelessness. Public Health Nurs. 2019;36(3): 321-329. DOI: 10.1111/phn.12604
27. D'Souza MS, Mirza NA, Karkada SN. Development of a foot care model to determine the risk of foot problems among homeless adults in Canada. Health Soc Care Community. 2021 Sep;29(5): e214-e223. DOI: 10.1111/hsc.13271
28. D'Souza MS, Mirza NA. Towards equitable health care access: community participatory research exploring unmet health care needs of homeless individuals. Can J Nurs Res. 2022 Dec;54(4): 451-463. DOI: 10.1177/08445621211032136
29. Mullins RM, Mannix RE, Marshall NJ, Lewis VJ. Responding to foot health needs of people experiencing homelessness: the role of a publicly funded community-based podiatry service. J Foot Ankle Res. 2022 Feb 16;15(1):15. DOI: 10.1186/s13047-022-00518-7
30. Kuhnke JL, Botros M, Rosenthal S. Skin and wound care advocate to drive change and improvement. Wound Care Canada. 2022;20(2): 20-26.
31. Christensen S, McKelvey M. Sight and sole: partnering to enhance health of the New Britain Homeless. J High Educ Outreach Engagem. 2021;25(2): 1-13.
32. ull J, Giles A, Graham ID. Community-based participatory research and integrated knowledge translation: advancing the co-creation of knowledge. Implementation Sci. 2017 Dec 19;12(1): 150. DOI: 10.1186/s13012-017-0696-3
33. Bailey A, Graham B, Harps M, Sedore G. Vancouver's Alcohol Knowledge Exchange: lessons learned from creating a peer-involved alcohol harm reduction strategy in Vancouver's downtown Eastside. Harm Reduct J. 2023 Jul 26;20(1): 93. DOI: 10.1186/s12954-023-00838-2
34. Ibáñez-Carrasco F, Watson JR, Tavares J. Supporting peer researchers: recommendations from our lived experience/expertise in community-based research in Canada. Harm Reduct J. 2019 Sep 3;16(1): 55. DOI: 10.1186/s12954-019-0322-6
35. Largent EA, Fernandez LH. Paying research participants: Regulatory uncertainty, conceptual confusion, and a path forward. Yale J Health Policy Law Ethics. 2017 Winter;17(1): 61-141.

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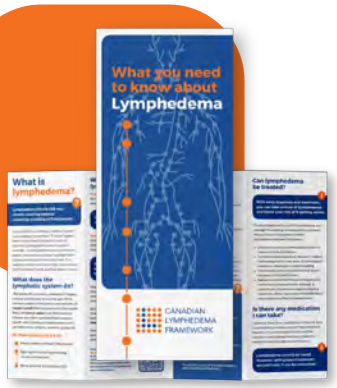

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Influence Of Insoles In The Dynamic And Static Stability Of People With Transtibial Amputation: A Systematic Review

Élise Mahe-Duverger DE podologie, **Yannick Mullie** PhD DO, **Carole Puil** PhD **and Virginie Blanchette** PhD DPM

Abstract: Although one of the main goals of the limb preservation team is to prevent amputations, they are sometimes unavoidable. Amputations, particularly major amputations above the ankle, are a major public health concern and represent a heavy health burden due to their impact on the physical and mental health and quality of life of those affected. With the loss of static and dynamic stability, people with major amputations may require orthopedic support such as foot orthoses. Current literature in the field is sparse and guidelines are lacking. *Objective:* To increase the level of evidence-based knowledge and consider professional recommendations, a systematic review was conducted to investigate the influence of foot orthoses in people with transtibial amputation. *Method:* A search strategy based on the PICO (Population, Interventions, Comparator, Outcomes) question was carried out in the public databases PubMed, Cochrane and PEDRO using keywords alone or combined such as 'leg amputation', 'rehabilitation', 'gait', 'balance' and 'insole'. *Results:* Of the 1856 potential manuscript identified, only two were included in this review. In people with unilateral transtibial amputation using prosthetics, data have demonstrated that rigid orthoses can improve stability. *Conclusion:* Rigid orthoses may play a role in the control of balance in people with transtibial amputations. Benefits of orthoses for this population is poorly investigated and the literature is too scarce to support recommendations.

Key words: *leg amputation, transtibial amputation rehabilitation, insoles, gait, balance, stability.*

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Introduction

Although one of the main goals of the limb preservation team is to prevent amputations, they are sometimes unavoidable.[1] Two types of lower extremity amputations (LEAs) are described: major amputations, which are above the ankle (e.g., below the knee and above the knee) and minor, which are below the ankle (e.g., toe, hallux, mid-tarsal, etc.).[2] Major LEAs, especially, have important individual-, organizational- and systemic- impact, and represent a heavy health burden due to their impact on physical and mental health, as well as on the quality of life of those affected.[3] There are several variations in terms of LEA epidemiology. In high-income countries, there seems to be a downward trend[4-6] due to better limb preservation programs.[7] However, this is a very fragile situation with the rise of chronic diseases such as diabetes, peripheral arterial disease and other multimorbidities, as well as the ageing of the population.[8] Moreover, males are more likely to have LEA. Some marginalized peoples and some ethnicities are also more at-risk.[9-11] Conversely, in developing countries, an increasing trend is indicated.[12] For example, in Brazil, both minor and major LEAs increased between 2019 and 2022, mostly due to vascular-, diabetes-related pathologies.[13]

With the loss of a significant part of the lower extremity, major LEAs often require a prosthesis to maintain as much function as possible. However, this has an inevitable impact on static and dynamic stability during the activities of daily living.[14]

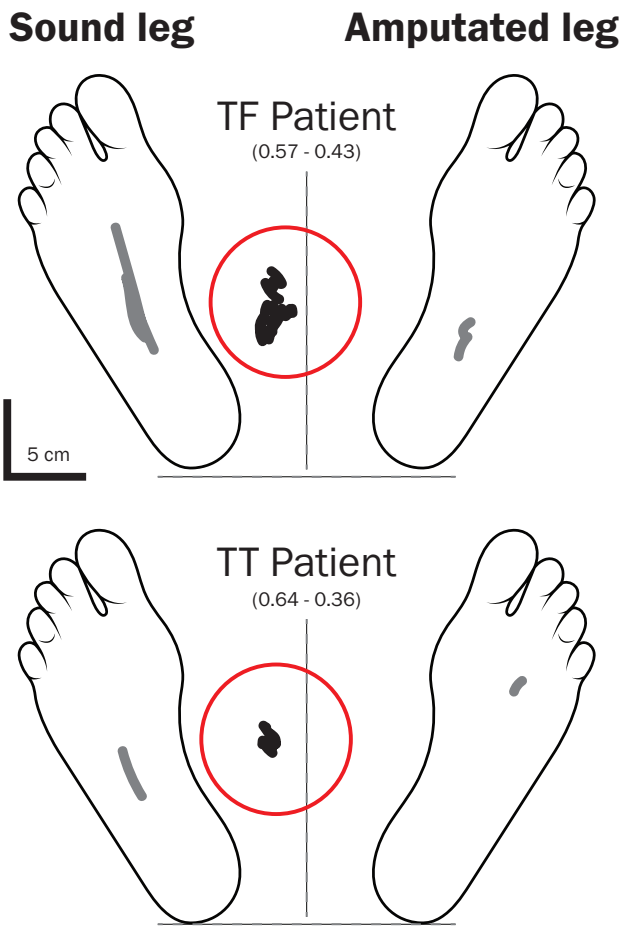

Figure 1: Centre of pressure in static analysis for individual with transfemoral and transtibial LEA. Adapted from: Rougier PR, Bergeau J. Biomechanical analysis of postural control of persons with transtibial or transfemoral amputation. Am J Phys Med Rehabil. 2009 Nov;88(11): 896-903. DOI: 10.1097/PHM.0b013e3181b331af

In addition to the quality of life, LEAs affect the body particularly related to balance and gait.[15] Several modifications of gait pattern and stability were demonstrated in people with major LEA. As an example, in static analysis, the centre of pressure of both feet is shifted to the side of the residual limb, in both transfemoral and transtibial LEA.[16,17] When compared to the residual limb, the centre of pressure of the amputated limb is larger and shifted forward[17] (See Figure 1).

Gait is analyzed using two parameters: biomechanical and spatiotemporal. Several studies have shown modification in spatial parameters, such as an increased step length for the amputated limb particularly in people with transtibial LEA.[18-20] Other studies have demonstrated alterations in both people with transtibial and transfemoral LEA with an increased width and length step for the amputated limb.[21,22] These changes may be explained by the appearance of compensatory strategies. In terms of temporal parameters, gait velocity is decreased.[23] For the amputated limb, the stance phase is decreased and the swing phase is increased, leading to a decreasing gait velocity.[22,24-27] Biomechanics parameters are also altered. For example, it has been shown that the electromyographic signal is increased (i.e., larger amplitude) in people with LEA compared with control individuals since to stabilize the knee and to control the flexion, the body increases its muscle activity in the amputated limb.[28] Other biomechanical parameters are also modified, such as ground forces or power which are both decreased.[29,30]

With the loss of static and dynamic stability in people with major LEA, they may require additional orthopedic support, such as foot orthoses. These devices have demonstrated their benefits in terms of foot health, static balance, gait and support in different tasks.[31,32] However, knowledge about foot orthotics for people with major LEA is limited in terms of stability and balance, in addition to the type and characteristics of the orthotics. Guidelines are lacking to support the evidence-based practices of health-care professionals supporting the feet (or residual foot) of people with LEA, such as podiatrists, chiropodists, orthotists, prosthetists, physiatrists, orthopedists, etc.[33] Therefore, the aim of this study was to investigate the influence of foot orthoses, also identifying their type and characteristics, on static and dynamic balance in people with transtibial LEA.

Method

Study design: The aim of a systematic review is to identify, assess and summarize the literature about a specific PICO (Patient, Intervention, Comparison, Outcomes) question.[34] Our objective was to answer whether plantar orthoses have an influence (I) on static and dynamic stability (O) in people with transtibial LEA (P) compared with

Table 1: Keywords and MeSH based on a PICO-guided search strategy

	French Keywords	OR	English Keywords	OR	French MeSH	OR	English MeSH	
Population	• Amputation: transfémorale et transtibiale)		• Amputation		• Amputation chirurgical		• Amputations	
AND								
Intervention	• Semelles orthopédiques • Semelles texturées		• Orthopedic insoles • Textured insoles		• Orthèses plantaires		• Foot orthoses	
AND								
Comparison	• Pas de traitement • Patients sains • Contrôle		• Control					
AND								
Outcomes	• Locomotion • Marche • Équilibre • Dynamique • Statique		• Locomotion • Walking • Gait • Balance • Equilibrium		• Locomotion • Équilibre postural		• Locomotion	
								N total

the control group, i.e., people without LEA (C)? This study was guided by the PRISMA (Preferred Reporting Items for Systematic Review) methods.[35] This project was not registered in a systematic review database.

Search strategy: A search strategy was developed by combining keywords and MeSH (Medical Subject Heading) terms in the PubMed, Cochrane Library and Pedro databases, and this strategy was adapted to each database. This was guided by PICO (See Table 1).

Eligibility criteria for inclusion in study: The eligibility criteria targeted clinical trial studies that included people/patients with a major LEA, such as a unilateral transtibial or transfemoral amputation with impaired gait and the use of orthopedic support, such as a foot orthotics and/or insoles. There were no other limitations concerning the sociodemographic characteristics of the population or related to the comparison group. We were looking for results related to the effect of the intervention on the person's dynamic and static stability. Studies published in French or English between 2003 and 2023 were targeted.

Screening process: Potential study references were imported into the Rayyan® online tool[36] and we excluded duplicates before titles and abstract selection. Two independent reviewers read the title and abstract and decided whether or not to include the studies based on the inclusion criteria. After this initial selection, a consensus was reached on which studies should potentially be included for full-text review. A third reviewer was available to resolve any discrepancies between the two reviewers to facilitate the full-text-review. After the selection process, the reviewers checked the reference list of potential studies and also contacted the authors to support the identification of relevant ongoing studies on this topic.

Data extraction and management: Data from included studies were extracted via a Microsoft Word PICO-based form by the lead reviewer. No

bias analysis was performed considering the scarce literature on this domain, as well as no meta-analysis. The data were reported in a descriptive manner, given that the objective was to determine the state of knowledge that could form the basis of clinical recommendations for the population targeted by this study.

Results

Included studies: A total of 1856 potential studies were included in Rayyan's databases, including 1843 studies from PubMed, 7 from Pedro and 6 from the Cochrane Library. After removing duplicates, 1833 articles were reviewed based on titles and abstract. At the end of the selection process, only two studies remained which were included in the present analysis (See Figure 2) and reported in a narrative synthesis.

Both included studies assessed the influence of orthoses on the static stability[37] and on the gait.[38] Both are recent studies (2022 and 2021), from the same group of authors from Spain and were conducted on the same population of individuals with transtibial LEA.

Characteristics of included studies are listed in the Table 2. In both studies, hard surface insoles were made with polypropylene PP-DWST with a height of 4 mm and soft comfort surface insoles were made with silicone material (Varisan© hydrogel insoles).

Influence of plantar orthoses on gait: Gait was analyzed through the intensity of muscle activity using electromyography signals for two muscle groups (i.e., hamstrings and quadriceps) under four conditions:

1. Controlled conditions (barefoot)
2. Running shoes
3. Soft insoles and running shoes
4. Rigid orthoses and running shoes) at four different speeds (i.e., V1 (0.7 m/s), V2 (1.0 m/s), V3 (1.3 m/s) and V4 (1.6 m/s) on a treadmill.

In intragroup analysis, i.e., results between the limb with the LEA and the contralateral limb, they found statistically significant differences related to a higher quadriceps activity on the contralateral side compared to the LEA side with bare feet at V4, with soft insoles at V2, V3, V4 and with rigid orthoses at V4.

In the intergroup analysis, i.e., results between the limb with the LEA and compared to the contralateral limb of the control group, decreasing electromyographic activity was found for the quadriceps, no matter the condition at V3 and V4. Moreover, at V4 with rigid orthoses, significative diminution was found for hamstring groups in people with LEA, compared to the control group and in the condition of bare feet in people with LEA. Finally, a trend is observed in this study; with rigid orthoses which seems to have an influence on hamstring activity. Indeed, in bare feet or without insoles, results showed

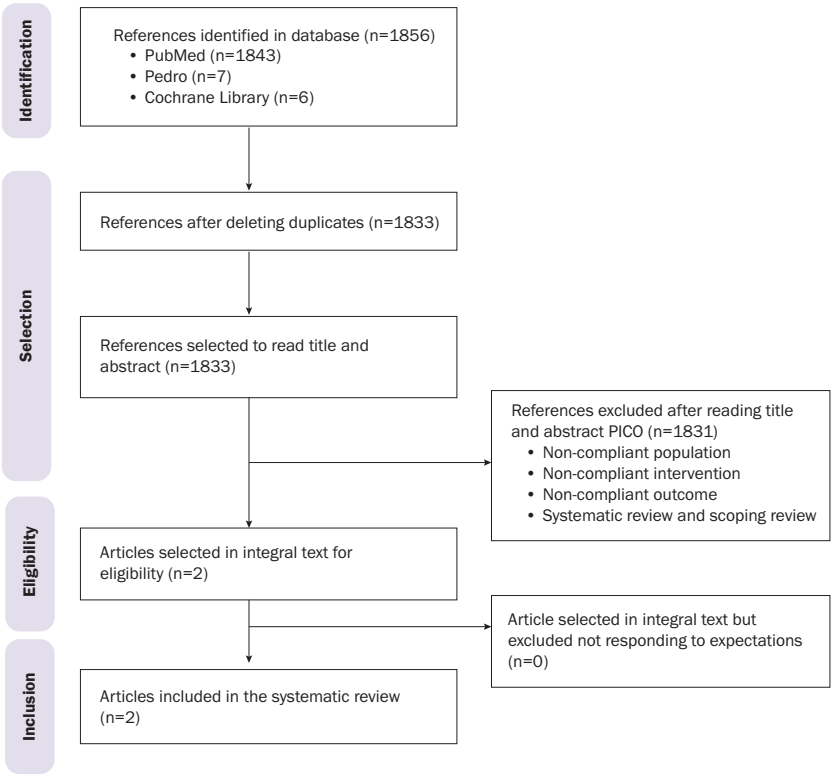

Figure 2: PRISMA Chart flow for identification, selection, eligibility and inclusion.

Table 2: Characteristics on included studies

Authors, Year, Country	Population				Intervention		Results	
	Total	*Mean age*	*Time passed since amputation*	*Type of prosthesis*	*Types of orthoses/ insoles*	*Comparison*	*Outcome*	*Result*
(Sarroca et al., 2021), Spain	N (amputees) = 25 N (control) = 25	44 ± 12.9 yo	At least 2 years	Vari-Flex® prosthetic foot with rigid fitting carbon fibre TSB	Hard orthoses Soft silicone insoles	Bare feet Running shoes	Muscular activity during gait on a treadmill	Significantly decreasing of hamstring activity with hard insole at the highest speed
(Sarroca et al., 2022), Spain	N (amputees) = 25 N (control) = 25 orthopédiques Semelles texturées	44 ± 12.9 yo	At least 2 years	Vari-Flex® prosthetic foot	Hard orthoses Soft silicone insoles	Bare feet	Centre of pressure in static measured with force platform	Better stability with hard insoles

higher hamstring activity for the side with LEA compared to the contralateral limb.

Influence of plantar orthoses on static balance: Static balance was analyzed through displacement and velocity (lateral and anterior) of the centre of pressure with a force platform, in three conditions: controlled condition bare feet, with hard orthoses and with soft insoles. Each of these conditions was assessed with eyes opened and closed. In terms of static stability, a reduction in the length of the displacement of the centre of pressure was observed with hard orthotics. However, in barefoot conditions, the displacement was greater with hard orthotics, but smaller with soft insoles. Regarding the centre of pressure with lateral velocity, significant differences were demonstrated for the control group, with a significant decrease in this velocity with the wearing of rigid orthoses. In barefoot condition, the values were reduced compared with soft insoles, but not higher with rigid orthoses. In the group of people with LEA, significant differences were observed between both soft insoles and rigid orthoses. The latter led to a reduction in lateral velocity compared with soft insoles. Analysis of the anterior velocity of the centre of pressure revealed the same trend as the other parameters studied, with an increase in stability when rigid orthoses were worn (i.e., decrease in the anterior velocity of the centre of pressure). Finally, in ascending order of stability, the different conditions are classified as follows: soft silicone insoles, barefoot and rigid orthoses. Summary of these findings are displayed in Table 3.

Discussion

This study has investigated the influence of foot orthoses on static and dynamic balance in people with transtibial LEA. Our review showed that there is very little literature on this topic. However, the studies included support our hypothesis that foot orthoses lead to improved gait and static balance.[37,38] However, there are many gaps in knowledge about optimal types and characteristics of orthoses for peoples with LEA.

Table 3: Influence of plantar orthoses/insoles on muscle activity and the displacement and velocity of the centre of pressure

Group	Individual as control	Individual with amputation	
Limb	Paired with amputated side	Contralateral side	Amputated Side
Muscle activity			
Hamstring	• Rigid orthoses (1.6 m/s) ↑ *		• Rigid orthoses (1.6 m/s) ↓ *
	• Soft insoles • Rigid orthoses ↓		• Barefoot • Without insoles/orthoses ↑
	• Soft insoles • Rigid orthoses ↑		• Barefoot • Without insoles/orthoses ↓
Quadriceps		• Barefoot ((1.6 m/s) • Insoles (1.0; 1.3 and 1.6 m/s) Rigid orthoses (1.6 m/s) ↑	
			• All condition (1.3 and 1.6 m/s) ↓
Displacement and velocity of CoP†			
Length of displacement of CoP (mm)	• Rigid orthoses ↓ *		• Rigid orthoses ↓ *
	• Soft silicon insoles ↑ *		• Soft silicon insoles ↑ *
Lateral velocity of CoP (mm /sec)	• Rigid orthoses ↓ *		• Rigid orthoses ↓
	• Soft silicon insoles ↑ *		• Soft silicon insoles ↑
Anterior velocity of CoP (mm /sec)	• Rigid orthoses =		• Rigid orthoses ↓ *
	• Soft silicon insoles ↑ *		• Soft silicon insoles ↑ *

Legend and abbreviations
Black blocks: No significant results or observations
†: compared to the condition: bare feet
*: statistically significant
↓ : decreasing
↑ : increasing
=: equal
CoP: Centre of pressure

In barefoot conditions, with soft insoles and rigid orthoses, the quadriceps of the LEA side had decreased activity compared with the control group. When compared to the non-LEA side, the quadriceps activity of the LEA side was smaller with insoles, regardless of the hardness of insoles and under highest speeds. As for the hamstrings of the LEA side, wearing rigid orthoses while walking (at high speed) significantly reduces their muscular activity compared to the control limb.[38] Wearing soft or rigid insoles/orthoses reduces hamstring muscular activity regardless of walking speed. This is a new finding given that in people with major LEA, hamstring muscle activity is generally increased.[39] Orthopedic insoles/orthoses, therefore, have the potential to bring this muscular activity closer to normal physiology (without LEA). Therefore, more investigation is needed to understand why such effects were found. We can hypothesize that during gait with foot orthoses, the body being more stable, the muscles are less

solicited, thus leading to a decrease in muscle activity in people with major LEA.

Some studies have analyzed insole/orthoses wearing and electromyography signals in other populations. For example, it has been proposed that insoles made in a particular way (i.e., according to joint kinematics), reduced muscle activity in the lower limb.[40] A study in ten individuals among 30 females (mean age: 22.8 years) with idiopathic pes cavus foot showed that wearing orthoses significantly reduced muscle activity during gait.[41] This is explained by a better distribution of loads under the feet and, consequently, reduced muscle activity in the participants. Rigid orthoses have been shown to improve stability in older adults.[42,43]

In terms of static balance, wearing rigid orthoses provided greater stability for both people with LEA and the control group, compared with soft silicone insoles and barefoot condition.[37] Thus, rigid orthoses have provided greater stability than bare feet, the latter providing greater stability than soft insoles. These results are coherent with those related to the influence of orthopedic orthoses on stability in other populations, whether it be adults, elderly adults or people with Parkinson's disease.[44-46] This trend between rigid insoles, which provide greater stability, and silicone insoles which, on the contrary, reduce this stability and may even lead to instability were also found in another study with older adults.[43]

Strengths and limitations: This systematic review brings together evidence from the scientific literature on a common and important clinical question concerning the type of and effects on orthoses in this population. It provides clinicians with a quick overview of the current situation. However, our review has limitations. Although it was carried out using a rigorous method, the search strategy could have been validated by a librarian. The small number of studies included limited understanding of the results, which probably explains the lack of guidelines to support evidence-based practices by health-care professionals who support the foot (or residual foot) in people with transtibial LEA. Although the two studies do not assess the same parameters, the total number of patients in this review is limited to 25 individuals with major LEA, with 80% of male individuals in each group, with an average age of 44 years in controls and 38 years in individual with LEA. Furthermore, an error was found in the study regarding the influence of orthoses on the static stability.[37] This study has examined the movements of the centre of mass, which would be equivalent to the displacement of the centre of gravity. However, the analyses were conducted using a force platform, which provides the displacements of the centre of pressure of both feet, not the centre of gravity. Indeed, to analyze the centre of gravity, 3D cameras and other software would be required, which was not stated in this study. This confusion reduces the internal validity of the results. These studies from the same group of authors were heterogeneous in terms of the parameters studied and results reporting.

Nevertheless, our study shows that it is essential to intensify research in this sector, particularly to improve the quality of life of people with major LEA, with a perspective toward limb preservation and rehabilitation. Best practice in foot orthotics for this population has yet to be demonstrated, but patient-centred approaches that also consider the expertise of health-care professionals should be considered. More studies are needed to improve clinical application so that patients with LEA have better care in the orthopedic domain, including rehabilitation and prevention of reamputation.

Conclusion

Benefits of foot orthoses/insoles in people with major LEA are poorly described in the literature but there seems to be a beneficial trend towards stability and bringing muscle activity back close to normal physiology before LEA. Clinicians need to assess each patient's needs and situation individually. ■

Élise Mahe-Duverger DE podologie, is a Master's student in biomedical sciences at the Université du Québec à Trois-Rivières. Her project is funded by the War Amp and related to knowledge mobilization for shared decision-making for people with amputation.

Yannick Mullie PhD DO Paris is with the Brain Institute, Paris, France and is a lecturer at IFPEK, Rennes, France. His research spans from basic neuronal control of locomotion to the rehabilitation of gait in progressive neurological diseases.

Carole Puil PhD is a podiatrist and lecturer and part of team research at IFPEK, Rennes, France. Her research focuses on foot orthoses on standing and dynamic balance.

Virginie Blanchette* PhD DPM is a podiatrist and Associate Professor at the Université du Québec à Trois-Rivières, Canada. She is knowledge mobilization researcher for the prevention and management of diabetes-related foot complications.

*Correspondence should be directed to: Virgnie.Blanchette@uqtr.ca

References

1. Blanchette V, Brousseau-Foley M, Cloutier L. Effect of contact with podiatry in a team approach context on diabetic foot ulcer and lower extremity amputation: systematic review and meta-analysis. J Foot Ankle Res. 2020 Mar 20;13(1): 15. DOI: 10.1186/s13047-020-0380-8
2. van Netten JJ, Bus SA, Apelqvist J, Chen P, Chuter V, Fitridge R, et al. Definitions and criteria for diabetes-related foot disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2024 Mar;40(3): e3654. DOI: 10.1002/dmrr.3654
3. Hawkins AT, Henry AJ, Crandell DM, Nguyen LL. A systematic review of functional and quality of life assessment after major lower extremity amputation. Ann Vasc Surg. 2014 Apr;28(3): 763-80. DOI: 10.1016/j.avsg.2013.07.011
4. Behrendt C-A, Sigvant B, Szeberin Z, Beiles B, Eldrup N, Thomson IA, et al. International variations in amputation practice: a VASCUNET report. Eur J Vasc Endovasc Surg. 2018 Sep;56(3): 391-399. DOI: 10.1016/j.ejvs.2018.04.017
5. Walter N, Alt V, Rupp M. Lower limb amputation rates in Germany. Medicina (Kaunas). 2022 Jan 10;58(1): 101. DOI: 10.3390/medicina58010101
6. Carmona GA, Lacraz A, Hoffmeyer P, Assal M. Incidence de l'amputation majeure des membres inférieurs à Genève: vingt-et-un ans d'observation. Rev Med Suisse. 2014 Oct 22;10(447): 1997-8, 2000-1.
7. Blanchette V, Armstrong DG. An approach that needs patients and their families as partners. Wound Care Canada. 2022;20(1): 67-74.
8. Blanchette V, Armstrong DG, Drudi L, Rizzo M. Upstream comprehensive management of individuals with diabetes with multimorbidity and frailty to act against amputation. J Diabetes Complications. 2023 Mar;37(3):108407. DOI: 10.1016/j.jdiacomp.2023.108407
9. Blanchette V, Patry J, Brousseau-Foley M, Todkar S. Diabetic foot complications among Indigenous peoples in Canada: a scoping review through the PROGRESS-PLUS equity lens. Front Endocrinol (Lausanne). 2023 Aug 14;14: 1177020. DOI: 10.3389/fendo.2023.1177020
10. Brennan MB, Powell WR, Kaiksow F, Kramer J, Liu Y, Kind AJ, et al. Association of race, ethnicity, and rurality with major leg amputation or death among Medicare beneficiaries hospitalized with diabetic foot ulcers. JAMA Netw Open. 2022 Apr 1;5(4): e228399. DOI: 10.1001/jamanetworkopen.2022.8399
11. Fan L, Wu X-J. Sex difference for the risk of amputation in diabetic patients: a systematic review and meta-analysis. PLoS One. 2021 Mar 11;16(3): e0243797. DOI: 10.1371/journal.pone.0243797
12. Abbas ZG. Reducing diabetic limb amputations in developing countries. Expert Rev Endocrinol Metab. 2015 Jul;10(4): 425-434. DOI: 10.1586/17446651.2015.1058151
13. Biagioni RB, Louzada ACS, Biagioni LC, da Silva MFA, Teivelis MP, Wolosker N. Cross-sectional analysis of 180,595 lower limb amputations in the state of Sao Paulo over 12 years. World J Surg. 2022 Oct;46(10): 2498-2506. DOI: 10.1007/s00268-022-06631-9
14. von Kaeppler EP, Hetherington A, Donnelley CA, Ali SH, Shirley C, Challa ST, et al. Impact of prostheses on quality of life and functional status of transfemoral amputees in Tanzania. Afr J Disabil. 2021 Sep 7;10: 839. DOI: 10.4102/ajod.v10i0.839
15. Sagawa Jr Y, Turcot K, Armand S, Thevenon A, Vuillerme N, Watelain E. Biomechanics and physiological parameters during gait in lower-limb amputees: a systematic review. Gait Posture. 2011 Apr;33(4): 511-26. DOI: 10.1016/j.gaitpost.2011.02.003
16. Curtze C, Hof AL, Postema K, Otten B. Staying in dynamic balance on a prosthetic limb: a leg to stand on? Med Eng Phys. 2016 Jun;38(6): 576-80. DOI: 10.1016/j.medengphy.2016.02.013
17. Rougier PR, Bergeau J. Biomechanical analysis of postural control of persons with transtibial or transfemoral amputation. Am J Phys Med Rehabil. 2009 Nov;88(11): 896-903. DOI: 10.1097/PHM.0b013e3181b331af
18. Isakov E, Burger H, Krajnik J, Gregoric M, Marincek C. Influence of speed on gait parameters and on symmetry in transtibial amputees. Prosthet Orthot Int. 1996 Dec;20(3): 153-8. DOI: 10.3109/03093649609164437
19. Kovac I, Medved V, Ostojić L. Spatial, temporal and kinematic characteristics of traumatic transtibial amputees' gait. Coll Antropol. 2010 Mar;34 Suppl 1: 205-13.
20. Robinson JL, Smidt GL, Arora JS. Accelerographic, temporal, and distance gait: factors in below-knee amputees. Phys Ther. 1977 Aug;57(8):898-904. DOI: 10.1093/ptj/57.8.898
21. Uchytil J, Jandacka D, Zahradnik D, Farana R, Janura M. Temporal-spatial parameters of gait in transfemoral amputees: comparison of bionic and mechanically passive knee joints. Prosthet Orthot Int. 2014 Jun;38(3): 199-203. DOI: 10.1177/0309364613492789

22. Varrecchia T, Serrao M, Rinaldi M, Ranavolo A, Conforto S, De Marchis C, et al. Common and specific gait patterns in people with varying anatomical levels of lower limb amputation and different prosthetic components. Hum Mov Sci. 2019 Aug;66: 9-21. DOI: 10.1016/j.humov.2019.03.008

23. Esquenazi A. Gait analysis in lower-limb amputation and prosthetic rehabilitation. Phys Med Rehabil Clin N Am. 2014 Feb;25(1): 153-67. DOI: 10.1016/j.pmr.2013.09.006

24. Jarvis HL, Bennett AN, Twiste M, Phillip RD, Etherington J, Baker R. Temporal spatial and metabolic measures of walking in highly functional individuals with lower limb amputations. Arch Phys Med Rehabil. 2017 Jul;98(7): 1389-1399. DOI: 10.1016/j.apmr.2016.09.134

25. Mattes SJ, Martin PE, Royer TD. Walking symmetry and energy cost in persons with unilateral transtibial amputations: matching prosthetic and intact limb inertial properties. Arch Phys Med Rehabil. 2000 May;81(5): 561-8. DOI: 10.1016/s0003-9993(00)90035-2

26. Nolan L, Lees A. The functional demands on the intact limb during walking for active transfemoral and transtibial amputees. Prosthet Orthot Int. 2000 Aug;24(2): 117-25. DOI: 10.1080/03093640008726534

27. Sibley AR, Strike S, Moudy SC, Tillin NA. The associations between asymmetries in quadriceps strength and gait in individuals with unilateral transtibial amputation. Gait Posture. 2021 Oct;90: 267-273. DOI: 10.1016/j.gaitpost.2021.08.027

28. Tatarelli A, Serrao M, Varrecchia T, Fiori L, Draicchio F, Silvetti A, et al. Global muscle coactivation of the sound limb in gait of people with transfemoral and transtibial amputation. Sensors (Basel). 2020 Apr 29;20(9): 2543. DOI: 10.3390/s20092543

29. Lloyd CH, Stanhope SJ, Davis IS, Royer TD. Strength asymmetry and osteoarthritis risk factors in unilateral trans-tibial, amputee gait. Gait Posture. 2010 Jul;32(3): 296-300. DOI: 10.1016/j.gaitpost.2010.05.003

30. Castro MPd, Soares D, Mendes E, Machado L. Plantar pressures and ground reaction forces during walking of individuals with unilateral transfemoral amputation. PM R. 2014 Aug;6(8): 698-707.e1. DOI: 10.1016/j.pmrj.2014.01.019

31. Mills K, Blanch P, Chapman AR, McPoil TG, Vicenzino B. Foot orthoses and gait: a systematic review and meta-analysis of literature pertaining to potential mechanisms. Br J Sports Med. 2010 Nov;44(14): 1035-46. DOI: 10.1136/bjsm.2009.066977

32. Moisan G, Robb K, Mainville C, Blanchette V. Effects of foot orthoses on the biomechanics of the lower extremities in adults with and without musculoskeletal disorders during functional tasks: a systematic review. Clin Biomech (Bristol, Avon). 2022 May;95:105641. DOI: 10.1016/j.clinbiomech.2022.105641

33. Hafner BJ. Clinical prescription and use of prosthetic foot and ankle mechanisms: a review of the literature. JPO: Journal of Prosthetics and Orthotics. 2005;17(4): S5-S11. DOI: 10.1097/00008526-200510001-00004

34. Higgins JP, Green S. Cochrane handbook for systematic reviews of interventions. 2008.

35. Rethlefsen ML, Kirtley S, Waffenschmidt S, Ayala AP, Moher D, Page MJ, et al. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. Syst Rev. 2021 Jan 26;10(1): 39. DOI: 10.1186/s13643-020-01542-z

36. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev. 2016 Dec 5;5(1): 210. DOI: 10.1186/s13643-016-0384-4

37. Sarroca N, Luesma MJ, Valero J, Del Caso MP, Alonso C, Calleja J, et al. Influence of insole material density in the stability of patients with prosthetic unilateral transtibial amputation. Sci Rep. 2022 May 12;12(1): 7854. DOI: 10.1038/s41598-022-11564-3

38. Sarroca N, Luesma MJ, Valero J, Deus J, Casanova J, Lahoz M. Muscle activation during gait in unilateral transtibial amputee patients with prosthesis: the influence of the insole material density. J Clin Med. 2021 Jul 15;10(14): 3119. DOI: 10.3390/jcm10143119

39. Jaegers SM, Arendzen JH, de Jongh HJ. An electromyographic study of the hip muscles of transfemoral amputees in walking. Clin Orthop Relat Res. 1996 Jul;(328): 119-28. DOI: 10.1097/00003086-199607000-00020

40. Niigg BM, Nurese MA, Stefanyshy DJ. Shoe inserts and orthotics for sport and physical activities. Med Sci Sports Exerc. 1999 Jul;31(7 Suppl): S421-8. DOI: 10.1097/00005768-199907001-00003

41. Choi J-K, Cha E-J, Kim K-A, Won Y, Kim J-J. Effects of custom-made insoles on idiopathic pes cavus foot during walking. Biomed Mater Eng. 2015;26 Suppl 1:S705-15. DOI: 10.3233/BME-151362

42. Losa Iglesias ME, Becerro De Bengoa Vallejo R, Palacios Peña D. Impact of soft and hard insole density on postural stability in older adults. Geriatr Nurs. 2012 Jul-Aug;33(4): 264-71. DOI: 10.1016/j.gerinurse.2012.01.007

43. Park J-H, Jeon H-S, Kim J-H, Yoon H-B, Lim O-B, Jeon M. Immediate effect of insoles on balance in older adults. Foot (Edinb). 2021 Jun;47:101768. DOI: 10.1016/j.foot.2020.101768

44. Palazzo F, Nardi A, Tancredi V, Caronti A, Scalia Tomba G, Lebone P, et al. Effect of textured insoles on postural control during static upright posture following lower limb muscle fatigue. J Sports Med Phys Fitness. 2019 Feb;59(2): 246-252. DOI: 10.23736/S0022-4707.17.08029-X

45. De Morais Barbosa C, Barros Bértolo M, Zonzini Gaino J, Davitt M, Sachetto Z, De Paiva Magalhães E. The effect of flat and textured insoles on the balance of primary care elderly people: a randomized controlled clinical trial. Clin Interv Aging. 2018 Feb 19;13: 277-284. DOI: 10.2147/CIA.S149038

46. Qiu F, Cole MH, Davids KW, Hennig EM, Silburn PA, Netscher H, et al. Effects of textured insoles on balance in people with Parkinson's disease. PLoS One. 2013 Dec 12;8(12):e83309. DOI: 10.1371/journal.pone.0083309

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CASE REPORT

Multidisciplinary Management Of A Complication Of Chronic Diabetic Peripheral Neuropathy: Illustration Of A Dynamic 'Bridge To Care' Model And Multi-site Limb Salvage Team Approach

Susan E Vokey MD FRCSC **and Devon M Jahnke** MClSc-WH DCh IIWCC

Abstract: Using a case study of a young person living with diabetes and a complex foot wound, we illustrate how key players can provide bridges between programs and services in different care locations to provide and expand upon essential interventions for limb preservation. This case study further illustrates the importance of radiographic imaging in the evaluation of a patient with peripheral neuropathy and a foot injury.

Key words: *limb preservation, diabetic foot ulcer, orthopedic surgery, posterior calcaneal avulsion fracture, Achilles tendon reconstruction, multidisciplinary teams.*

How to cite: Vokey SE, Jahnke DM. Multidisciplinary management of a complication of chronic diabetic peripheral neuropathy: illustration of a dynamic 'bridge to care' model and multi-site limb salvage team approach. Limb Preservation Journal. 2024;5(1): 71-76. DOI: https://doi.org/10.56885/CFUR2929.

Introduction

The patient: A 25-year-old Indigenous woman with type 1 diabetes presented to the chiropody department of the Diabetes Care Service Outpatient Services (DCS) with a right heel wound two months subsequent to sustaining a right foot injury.

History Of Presenting Illness

The patient presented to the emergency department of the acute care site after she felt a sudden painful "pop" in the right ankle while descending stairs at work (minimal trauma). A provisional diagnosis of a partial right Achilles tendon injury was made based on physical examination and bedside ultrasound. The patient was admitted to hospital for management of intractable vomiting.

Significant past medical history included:

- Longstanding difficulty with dietary and insulin dose management; current regime includes use of a continuous glucose monitoring system and multiple daily insulin doses with sliding scale for carbohydrate adjustments
- Repeated admissions for diabetic ketoacidosis (DKA)
- Chronic anemia NYD; recurrent vomiting NYD (provisional diagnosis gastroparesis)
- Left Charcot foot six years post-tibiotalocalcaneal fusion; has an ankle foot orthosis but finds it too uncomfortable to wear
- No history of nephropathy or retinopathy.

Significant social history included:

- Employed in the food service industry as shift worker during afternoons and evenings
- Vapes, uses cigarettes and cannabis occasionally
- Typical footwear was standard canvas street shoes.

Initial Investigations

Definitive ultrasound and urgent orthopedic consultation provided a final diagnosis of an in-substance partial Achilles tendon tear. No x-rays were done. Recommended conservative management consisted of progressive weight bearing and a removable cast walker (RCW) with heel lift. Follow up was booked for five weeks.

Three weeks later, the patient stated she felt pressure in the right posterior heel and noted a blister developing. The blister subsequently broke.

Assessment at the orthopedic clinic at five weeks reported a healing blister over the posterior calcaneus secondary to the RCW. Recommendation was made to wean the patient out of the RCW, and begin strengthening in one to two weeks. Follow up was 'as needed'.

Two months later, the patient presented to the DCS with a large wound over the right posterior heel. Drainage was copious, purulent and foul smelling, and the peri-wound tissue was macerated and edematous. The heel was deformed and bulbous; crepitus was palpable. The open wound measured 6 cm x 5 cm, with tunneling depth from 5 to 6.5 cm; probing revealed connection to both the Achilles tendon and the calcaneal bone. Based on the University of Texas Wound Classification System, the wound was noted as 3B (See Figure 1). Pedal pulses were palpable. The open wound was dressed and the patient sent urgently to the Acute Care Hospital (ACH) Emergency Department (ED) for evaluation and treatment by orthopedic surgery.

Preop clinical photo.

The Diabetes Care service had provided a taxi to the ED where the patient arrived unaccompanied. (Note: Once fully accessed and a treatment plan was in place, the patient was frequently accompanied by her partner on subsequent visits.)

In the ED, she was afebrile with stable vital signs, appeared pale and unwell. WBC was 13.2 with left shift; ketones were noted in the urine. Blood cultures were drawn which eventually grew *Streptococcus anginosus* sensitive to ceftriaxone and benzyl penicillin. An admitting diagnosis of mild DKA and probable calcaneal osteomyelitis was made, and treatment was started with IV fluids, insulin and piperacillin/tazobactam.

Figure 1: University of Texas Wound Classification System.

	GRADE				
STAGE		0	1	2	3
	A	Pre-ulcerative lesions No skin break	Superficial wound No penetration	Wound penetrating tendon or capsule	Wound penetrating bone or joint
	B	With infection	With infection	With infection	With infection
	C	With ischemia	With ischemia	With ischemia	With ischemia
	D	With infection and ischemia	With infection and ischemia	With infection and ischemia	With infection and ischemia

Source: Boulton AJM, Whitehouse RW. The diabetic foot. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. South Dartmouth (MA): MDText.com, Inc.; 2023: Figure 2. Available from: https://www.ncbi.nlm.nih.gov/books/NBK409609/figure/diab-foot.F2/

Preop x-ray.

Postop x-ray.

X-rays of right foot revealed moderately displaced fractures at the calcaneus with the upper fragment displaced superiorly and posteriorly. The inferior fragment was displaced posteriorly. There was severe overlying soft tissue edema and possible skin laceration adjacent to the superior segment.

Orthopedic evaluation diagnosed a comminuted avulsion fracture posterior calcaneus (delayed diagnosis) with secondary pressure injury and probable osteomyelitis. In addition, an area of skin over the more proximal bony prominence was significantly thinned and at risk for further breakdown. Urgent surgical management two days later included debridement of the avulsed bony fragments, reconstruction of the Achilles tendon with lengthening via a turn-down flap and reinsertion using trans osseous sutures. Distal flap advancement permitted primary closure of the more distal open wound. The more proximal skin at risk was treated with the expectation that it would likely break down; care was taken to perform the Achilles lengthening in such a way as to minimize pressure in this area. Postoperatively, the ankle was splinted in slight equinus.

Bone cultures grew *Streptococcus anginosus* and *Prevotella denticola*, sensitive to ceftriaxone and benzyl penicillin. Consultation with infectious diseases for ongoing treatment of osteomyelitis recommended ceftriaxone 1g IV daily for six weeks via PICC line. The proximal heel wound broke down as expected and was treated with a silver gel fibre and adhesive foam cover q2d. The patient was discharged from hospital four days postop with home care for IV antibiotics and dressings. She was followed weekly through an outpatient orthopedic clinic for wound and splint care, as well as through the DCS.

The patient did suffer one postoperative complication: at four weeks, blood work revealed severe neutropenia of 0.01, hemoglobin 102, MCV 73, total WBC 2.0 and platelets 209. Urgent medical consultation gave a diagnosis of drug-induced

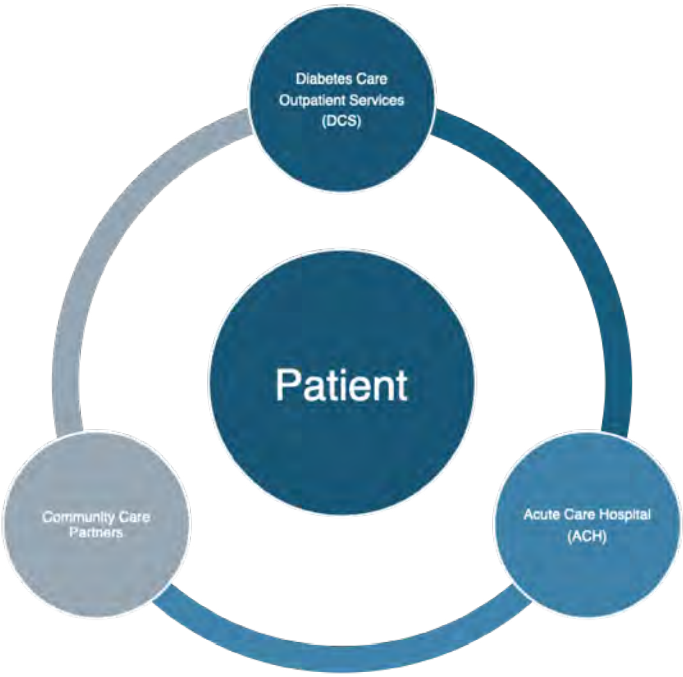

Figure 2: Bridging to Multidisciplinary Care Teams for Limb Preservation. *Diabetes Care Service (DCS)*: Includes diabetes care nurse, social worker, chiropodist, physiotherapist. *Acute Care Hospital (ACH)*: Emergency Department (ED), surgical/medical services, surgical outpatient clinic, diagnostic testing. *Community Care Partners*: Wound care.

Two weeks post op: Wound check, splint padding adjustment. Wound 1.5cm sup/inf x 2.5cm med/lat.

Three weeks postop: Sutures removed, antimicrobial cleanser added to management of the open wound. Wound 1.5 cm sup/inf x 0.8 cm med/lat.

Five weeks postop: Wound closing, transitioned to removable cast walker with no heel lift. Wound size 1.0 cm sup/inf x 0.6 cm med/lat.

Nine weeks postop: Wound fully closed and stable, walking with normal gait without gait aids. Returned to work and awating new footwear.

neutropenia. Recommendation was to discontinue all antibiotic treatment and follow her blood work. The neutropenia resolved over time.

The multidiscipline team members this patient accessed at the DCS provided:

- RSW, Social Work: Patient attended social work appointments through the Diabetes Care Service team, who addressed mental health issues and/or financial concerns due to the patient being temporarily unemployed and/or the need to access other medical benefits.
- NCM (Nurse diabetes case manager): Stabilized and addressed blood glucose readings and targets, provided extensive education on titration of insulin and addressed habitual concerns such as indulging in overnight food eating habits.
- D.Ch: Chiropodist assisted with wound care, attended the surgery for supportive care, provided off-loading and communication with orthopedic surgical team.

Discussion/Conclusion

In an ideal world, patients with complex, multi-system diseases like diabetes with peripheral neuropathy and foot wounds would be managed in a single physical setting with rapid patient access and all pertinent services geared and coordinated toward limb preservation. Unfortunately, this is not always the case. In our institution, the DCS (a team consisting of chiropodists, diabetes nurse educators, physiotherapists and social workers) is remote to the ACH, which provides emergency services, inpatient and outpatient surgical/medical services, diagnostic imaging and lab work. Community Care Partners are provided by a third-party, non-hospital-based organization. Providing comprehensive care for limb preservation in this sort of model requires effective lead communicators (clinicians) who can develop bridges between crucial medical services, allowing sharing of care throughout the entire pathway (See Figure 2).[1,2]

Bridge: From Patients In The Community To DCS Team (Chiropody)

The DCS allows patients to self-refer into the educational program and has a Complex Care Diabetes program which requires a primary care referral. Both programs grant access to chiropody services and maintain an 'open door policy', should any patient with diabetes have an open foot wound.

Bridge: From DCS team (chiropody) To Acute Care Hospital

In this case, the chiropodist was the lead communicator creating the bridge from the DCS to the ACH, where there was access to essential diagnostic services and orthopedic surgical intervention.

Bridge: From Orthopedics To Community Care Services And The DCS team

The orthopedic surgeon became the lead communicator, facilitating a care bridge that provided diagnosis through appropriate radiographic imaging and inpatient surgical care. During the recovery phase for this patient, close communication between surgical services, the chiropody/diabetes team and community care was essential. The DCS team (which also inluded a pharmacist, dietitians, nurse practitioners and an endocrinologist) provided pre- and post-operative support via foot and wound care, blood glucose stabilization, extensive education on titration of insulin and physical rehabilitation, and addressed social concerns.

The surgical team provided outpatient surgical care with wound and splint management which, in this case, led to a successful outcome.

Physiotherapist (PT) provided post-operative regime to improve strength, muscle tone and gait, after fibreglass cast.

Other Management Pearls

This case illustrates a relatively rare complication of chronic diabetic peripheral neuropathy: a posterior calcaneal avulsion fracture.[3,4] This condition can occur with minimal to no trauma and, as in this case, may be mistaken for partial injuries to the Achilles tendon insertion. Plain radiography, if possible full weight-bearing, is the preferred first-line imaging in the diabetic patient presenting with foot complaints,[5] with or without a history of trauma. It is particularly important in patients presenting with visible foot deformity. Other adjuvant imaging modalities (ultrasound, CT, MRI and bone scan) may be used as required, with the caveat that a bone scan is a sensitive but notoriously non-specific investigation when it comes to the differentiation of osteomyelitis, acute fracture and Charcot arthropathy.

Any immobilization device must be used with caution in patients with peripheral neuropathy, with or without a coexisting foot deformity. A removable cast walker is contraindicated in patients with poor balance or severe peripheral vascular disease. It is also not custom-made so may not fit all patients, including those with very short legs, wide feet or severe deformities.[6] In this case, although the immobilizing cast walker used was removable, the mismatch between the immobilizing device and the patient's calcaneal bony deformity produced point elevation of mechanical stress over the two posterior bony prominences. Combined with her diabetic sensory peripheral neuropathy, this allowed the formation of two pressure injuries over the posterior heel. Patient education as well as close monitoring by a healthcare provider is crucial to reduce the risk of soft tissue compromise.[7,8]

Finally, the concept of holistic care should always be foremost when dealing with any patient with a chronic wound. Providing support, education and medical care for the management of her life and her diabetes helped this young woman heal her foot wound and resume an active working life. ■

Susan E Vokey MD FRCSC is an orthopaedic surgeon and Medical Director of the surgical program at Health Sciences North, Sudbury, ON Canada.

Devon M Jahnke MClSc-WH DCh IIWCC is a chiropodist and Diabetes educator at the Centre for Complex Diabetes Care, Health Sciences North, Sudbury ON, Canada.

Conflicts of interest

The authors declare that there are no conflicts of interest.

References

1. Martinez-Singh K, Chandra V. How to build a limb salvage program. Seminars in vascular surgery. 2022; 35(2): 228-233.
2. Kim KG, Dekker PK, Fan KL. Analyzing the population dynamics of limb salvage. Functional limb salvage: the multidisciplinary team approach. New York: Springer International Publishing; 2023.
3. Choi Y, Kwon YW, Sim YS, Kim T, Song D, Lee S. Achilles tenodesis for calcaneal insufficiency avulsion fractures associated with diabetes mellitus. J Orthop Surg Res. 2017 Dec 13;12(1):192. DOI: 10.1186/s13018-017-0695-8

4. Biehl WC 3rd, Morgan JM, Wagner FW Jr, Gabriel R. Neuropathic calcaneal tuberosity avulsion fractures. Clin Orthop Relat Res. 1993 Nov;(296): 8-13.
5. Daneshvar K, Anwande H. Diagnostic imaging of diabetic foot disorders. Foot Ankle Clin. 2022 Sep;27(3): 513-527. DOI: 10.1016/j.fcl.2022.01.002
6. Lavery LA, Higgins KR, La Fontaine J, Zamorano RG, Constantinides GP, Kim PJ. Randomised clinical trial to compare total contact casts, healing sandals and a shear reducing removable boot to heal diabetic foot ulcers. Int Wound J. 2015 Dec;12(6): 710-5. DOI: 10.1111/iwj.12213
7. Bril V, Breiner A, Perkins BA, Zochodne D/ Canadian Diabetes Association. Clinical practice guidelines: chapter 31 neuropathy. Diabetes Canada: 2024. Available from: https://www.diabetes.ca/health-care-providers/clinical-practice-guidelines/chapter-31#panel-tab_FullText
8. Canadian Diabetes Association. Management and self-care. Diabetes Canada: 2024. Available from: https://www.diabetes.ca/about-diabetes/management-and-self-care

Further Reading

DeNamur C, Pupp G Diabetic limb salvage. A team approach at a teaching institution. J Am Podiatr Med Assoc. 2002 Sep;92(8): 457-62. DOI: 10.7547/87507315-92-8-457

Lerman OZ, Kovach SJ, Levin LS. The respective roles of plastic and orthopedic surgery in limb salvage. Plast Reconstr Surg. 2011 Jan;127 Suppl 1:215S-227S. DOI: 10.1097/PRS.0b013e3182006962

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Retroactive Assignment Of DOIs To Previously Published Articles In *Limb Preservation Journal*

Ian Corks

Abstract: A DOI, or Digital Object Identifier, is a string of numbers, letters and symbols used to uniquely identify an article or document and to provide it with a permanent web address (URL).[1] They are used to provide current information, including where the content (or information about it} can be found on the Internet. With Volume 4 Issue 1, *Limb Preservation Journal* began issuing DOI numbers to published clinical articles. At the request of several authors and to help make the content of published articles more easily citable, DOI numbers have now also been retroactively assigned to all qualifying content previously published in the journal. A list of these articles with corresponding DOIs is included.

Key words: *Limb Preservation Journal, DOI, retroactive, digital publishing.*

How to cite: Corks I. Retroactive assignment of DOIs to previously published articles in Limb Preservation Journal. Limb Preservation Journal. 2024;5(1): 78-82. DOI: https://doi.org/10.56885/PFGC3831.

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Following is an index of articles previously published in *Limb Preservation Journal* that have retroactively been assigned DOI identifier numbers. Note that qualifying articles date from Volume 2 Number 1.

Volume 2 Number 1

How A Multidisciplinary Approach Can Change The Fate Of Our Patients With Diabetic Foot Ulcers

Giacomo Clerici MD

Abstract: The rate of death for patients with diabetic foot ulcers is 2.5 times higher than for patients with diabetes who do not have diabetic foot ulcers. Ulceration is also correlated to a higher mortality rate than the most frequent oncological diseases or cancers. A skillful interprofessional team and timely therapeutic strategies are essential

for effectively managing diabetic foot ulcers and a multidisciplinary approach can have a substantial impact in the prognosis of these patients.

How to cite: Clerici G. How a multidisciplinary approach can change the fate of our patients with diabetic foot ulcers. Limb Preservation Journal. 2021;2(1): 6-8. DOI:10.56885/LXJW4723

Management For People Living With Chronic Lower-Limb Ulcers

Barbie Murray MClSc-WH BScN RN and Martin Van der Vyver MD FRCPC

Abstract: Managing chronic lower-limb ulcers involves using both best practice guidelines and strategies for pain management. Developing a patient-centred plan of care, which includes managing the various types of pain and adopting current best practice guidelines such as those published by Wounds Canada, can optimize the care for patients living with lower limb ulcers.

How to cite: Murray B, Van der Vyver M. Management for people living with chronic lower-limb ulcers. Limb Preservation Journal. 2021;2(1): 10-12. DOI:10.56885/RTES3632

The Management Of Foot Infections

Min Lee MD FRCSC and John Steinberg DPM

Abstract: Limb preservation can involve both established and emerging strategies to identify, prevent and surgically manage foot infections in patients living with peripheral arterial disease (PAD), chronic limb-threatening ischemia and diabetes. If a person with diabetes needs treatment, a multidisciplinary approach is recommended that combines antiplatelet agents, a statin, glucose management, exercise therapy, hypertension management and hyperlipidemia management.

How to cite: Lee M, Steinberg J. The management of foot infections. Limb Preservation Journal. 2021;2(1): 12-16. DOI: 10.56885/GAHJ2813

The Prevention Of Recurrent Ulceration And Amputation

Amanda Mayo MD MHSc FRCPC, Connor Pardy MSc CPO and Scott Schumacher DPM DABPS DABPM FAPWHc FASPS FACFAS

Abstract: Patients with recurrent ulceration and amputation can be challenging cases for healthcare teams. There are, however, several different approaches that can prevent the recurrence of ulceration and reduce the incidence of amputation. Clinicians treating recalcitrant wounds should consider the patient's whole health picture, including issues like comorbidities, biomechanics, social supports and barriers to success.

How to cite: Mayo A, Pardy C, Schumacher S. The prevention of recurrent ulceration and amputation. Limb Preservation Journal. 2021;2(1): 17-20. DOI: 10.56885/BELJ2478

Challenges To And Opportunities For Limb Preservation In Rural And Remote Communities

Jeremy Caul RN BScN MClSc AHCP WH CDE and Bijan Najafi MSc PhD

Abstract: Lead author Jeremy Caul serves 33 remote Indigenous communities — 28 of which are fly-ins — whose combined populations equal more than 30,000 people. Currently these communities have documented rates of diabetes in close to 25% of the population. The rates of amputation are four to seven times the provincial (Ontario) average. This article presents work that is being done to identify specific barriers to limb preservation in this region, as well as the opportunities and strengths that Indigenous communities share.

How to cite: Caul J, Najafi B. Challenges to and opportunities for limb preservation in rural and remote communities. Limb Preservation Journal. 2021;2(1): 21-24. DOI: 10.56885/USIH8389

Implementing Best Practice In Alberta: A Diabetes Foot Care Clinical Pathway

Kathy Dmytruk RD CDE and Petra O'Connell BSc MHSA

Abstract: There are significant variations in foot screening practices in Alberta. Despite best practice guidelines, many primary care providers do not perform the recommended annual foot examination on their patients with diabetes. This highlights the need for a systematic approach to increase screening practices across Alberta.

How to cite: Dmytruk K, O'Connell P. Implementing best practice in Alberta: a diabetes foot care clinical pathway. Limb Preservation Journal. 2021;2(1): 26-28. DOI: 10.56885/DBSN8273

Building The Framework: Developing An Ontario Strategy For Lower Limb Preservation

Mike Setterfield MSc and Emma Jowett HBA

Abstract: It has been documented that almost 85% of lower-limb amputations are preceded by a diabetic foot ulcer and that up to 80% of major lower-limb amputations are preventable. This article discusses the efforts by CorHealth, together with a provincial advisory committee of vascular and wound care experts, primary and community care providers and patient and family advisers, chaired by Dr. Ahmed Kayssi towards the development of a multi-year Ontario lower-limb preservation strategy.

How to cite: Setterfield M, Jowett E. Building the framework: developing an Ontario strategy for lower limb preservation. Limb Preservation Journal. 2021;2(1): 30-32. DOI: 10.56885/SCJH2385

How To Convince Decision Makers To Invest In Limb Preservation

Venita Chandra MD FACS, Karim Manji DPM FACFAS and Richard Neville MD FACS DMSVS

Abstract: Limb preservation is a multifactorial challenge that is often limited by financial resources. Those deciding where to invest financial resources within health systems need to be made aware of the importance of adequately funding limb preservation activities and supports.

How to cite: Chandra V, Manji K, Neville R. How to convince decision makers to invest in limb preservation. Limb Preservation Journal. 2021;2(1): 34-35. DOI:10.56885/AIYR8359

The Diabetes Foot Care Facebook Group Study

Helen Ngozichukwuka Obilor MSc (Nursing) RN PhD Candidate and Kevin Woo RN PhD

Abstract: Globally, diabetic foot ulcers (DFUs) are a serious diabetes complication linked to excess disability and morbidity. To prevent foot complications, people with diabetes benefit from lifelong behavioural modifications. This article discusses a research study, conducted in collaboration with Wounds Canada, to explore the feasibility of using social media to engage individuals with diabetes in preventing foot ulcers.

How to cite: Obilor HN, Woo K. The diabetes foot care Facebook group study. Limb Preservation Journal. 2021;2(1): 37-38. DOI: 10.56885/DRET2924

Diabetes, Healthy Feet And You – Train-The-Trainer: A Quality Improvement Inquiry

Janet L Kuhnke BScN MS NSWOC DrPsych and M Gail Woodbury BScPT PhD

Abstract: Diabetic self-management education focused on foot care and footwear, when provided in an organized and structured manner, is a cornerstone of preventing foot problems. *Diabetes, Healthy Feet and You* (DHFY) is an innovative education program developed to address the learning needs of patients and their families/care partners around self-management, diabetes mellitus, foot care, footwear and prevention of foot ulcers and amputations. This article describes the DHFY

program and its associated *Train-the-Trainer* workshop and workbook.

How to cite: Kuhnke JL, Woodbury MG. Diabetes, Healthy Feet and You – Train-the-Trainer: a quality improvement inquiry. Limb Preservation Journal. 2021;2(1): 42-49. DOI: 10.56885/LOPW3349

Volume 3 Number 1

The Impacts Of COVID-19 On Diabetic Foot Care: An Interview With Devon Jahnke And Iris Noland

Janet L Kuhnke RN BScN MS NSWOC DrPsych

Abstract: The author interviewed Devon Jahnke DCh IIWCC CDE MClSc (Wound Healing) and Iris Noland BSc (Biochem) MD MClSc (Wound Healing), to ask them about their experiences and insights in treating patients with diabetes-related foot complications in the age of COVID.

How to cite: Kuhnke JL. The impacts of COVID-19 on diabetic foot care: an interview with Devon Jahnke and Iris Noland. Limb Preservation Journal. 2022;3(1): 6-10. DOI: 10.56885/KQAH8719

A Foot Health Pathway For People Living With Diabetes: Integrating A Population Health Approach

Robyn Evans BSc MD CCFP FCFP, Janet L Kuhnke RN BScN MS NSWOC DrPsych, Virginie Blanchette BSc MSc DPM PhD, Mariam Botros DCh DE IIWCC Med, Sue Rosenthal BA MA, Joel Alleyne BSc MA MISt and Idevania Costa RN NSWOC PhD

Abstract: Complications from diabetes result in significant challenges for individuals, families and health-care systems. However, there are successful evidence-based solutions to prevent four out of five amputations. The Foot Health Pathway presented here—which is based on an approach that has been successfully implemented in other countries—provides a framework that could be used for optimized care delivery in Canada.

How to cite: Evans R, Kuhnke JL, Blanchette V, Botros M, Rosenthal S, Alleyne J, Costa I. A foot health pathway for people living with diabetes: integrating a population health approach. Limb Preservation Journal. 2022;3(1): 12-24. DOI: 10.56885/BJRI9192

Saving Limbs And Lives: Building Out An Ontario Lower Limb Preservation Strategy

Mike Setterfield MSc and Lynn Scholey RKin MSc

Abstract: There are over 1,200 non-traumatic major lower-limb amputations every year in Ontario, the majority resulting from complications of vascular disease, diabetes or both. This equates to one lower-limb amputation every seven hours and results in approximately $140 million in direct amputation health-care costs annually. CorHealth Ontario is collaborating with a provincial Advisory Committee to develop a multi-year provincial Lower-Limb Preservation Strategy. The strategy aims to facilitate a coordinated, integrated and patient-centered approach to lower-limb preservation care in Ontario.

How to cite: Setterfield M, Scholey L. Saving limbs and lives: building out an Ontario lower limb preservation strategy. Limb Preservation Journal. 2022;3(1): 26-28. DOI: 10.56885/LEOP2871

Sex, Gender, Race And Ethnicity Matter In Limb Preservation In North America

Virginie Blanchette BSc MSc DPM PhD and Ahmed Kayssi MD MSc MPH FRCSC CWSP

Abstract: The causes of sex, gender, racial and ethnic disparities in health care are multifactorial and reflect differences in biological vulnerability to disease as well as differences in social resources, environmental conditions and health-care interventions. These factors are well known to influence the fate of people with diabetes-related foot complications such as diabetic foot ulcer,

infection and amputation. In this paper, the authors discuss the important concepts of health equity, equality and disparity in relation to the impact of sex, gender, race and ethnicity on limb preservation.

How to cite: Blanchette V, Kayssi A. Saving limbs and lives: sex, gender, race and ethnicity matter in limb preservation in North America. Limb Preservation Journal. 2022;3(1): 30-36. DOI: 10.56885/FDBN2892

Current And Emerging Treatments For People Living With Lower Limb Ulcers: Session Summary

Robert Fitridge MS FRACS, Deirdre O'Sullivan-Drombolis BScPT MClSc (Wound Healing) and Suzanne Stewart RN NSWOC WOC(C)

Abstract: Lower limb ulcers (LLUs) are common, with a prevalence of 0.8 to 2.2 patients per 1000 population, doubling in incidence in people aged over 65. Lower limb ulcers significantly impact an affected individual's quality of life and are costly to treat. Diagnosing the cause of the ulcer is critical to successful management. Many affected individuals have ulcers with mixed etiology, which makes diagnosis and therapy challenging. (Session summary from Wounds Canada 2021 National Conference.)

How to cite: Fitridge R, O'Sullivan-Drombolis D, Stewart S. Current and emerging treatments for people living with lower limb ulcers: session summary. Limb Preservation Journal. 2022;3(1): 38-43. DOI: 10.56885/CJFN1925

Case Study: Successful Limb Salvage Combining Revascularization Surgery With An Advanced Acellular Dermal Matrix (ADM) In Treating Multiple Non-Healing Diabetic Foot Ulcers

Asem Saleh MSc MD RPVI FRCSC, Idevania Costa RN NSWOC PhD and Paul F Gratzer MASc PhD PEng

Abstract: The number of people with diabetes is increasing each year and is projected to reach 439 million by 2030. Up to 25% are expected to have non-healing foot ulcers. Even with revascularization and best standard wound care practices, significant challenges remain in healing diabetic foot ulcers (DFUs) and avoiding amputations. This report features a case study of a patient with diabetes with multiple non-healing necrotic lesions on both feet. After amputation of the left foot was necessary, a new approach using a combination of revascularization and an advanced acellular dermal matrix (ADM), developed by the third author, was successfully used to preserve the right foot.

How to cite: Salah A, Costa I, Gratzer PF. Case study: successful limb salvage combining revascularization surgery with an advanced acellular dermal matrix (ADM) in treating multiple non-healing diabetic foot ulcers. Limb Preservation Journal. 2022;3(1): 44-48. DOI: 10.56885/YUAI9294. ■

References

1. DOI Foundation. The identifier: What is a DOI? Westwood MA. Available from: https://www.doi.org/the-identifier/what-is-a-doi/

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Recommended Reading

The indirect impact of COVID-19 pandemic on limb preservation care: a retrospective analysis of trends in lower limb revascularisation

Anthony L, Gillies M, Tran M, Goh D

Abstract: Disruptions caused by COVID-19 pandemic have profoundly influenced the management of many conditions, especially vascular pathologies including limb preservation care. The aim of this study is to evaluate the impact of the pandemic on patients with peripheral arterial disease (PAD) focusing on lower limb revascularisation procedure volume, their indication and urgency of surgery. The Australian Vascular Audit (AVA) was used to capture data on revascularisation procedures before and after the onset of the pandemic in Victoria, Australia. This study found that the volume of revascularisation for PAD increased significantly during the pandemic indicating that patients with PAD had significant deterioration of their condition during the pandemic. This is likely multifactorial; due to disruptions to standard provision of podiatry, vascular surgery and endocrinology services to these patients, a decline in overall health and changes in health-related behaviours due to restrictions and infection control methods imposed during the pandemic. The number of elective and semi-urgent procedures also increased during the pandemic which reflects the significant deterioration of PAD patients during the pandemic. This study highlights a concerning trend of worsening PAD when routine care of these patients is disrupted. Such data should be instrumental in contingency planning and resource allocation for managing the ongoing pandemic.

Read at: J Foot Ankle Res. 2023 Aug 9;16(1): 48. DOI: 10.1186/s13047-023-00648-6

Diabetic foot complications among Indigenous peoples in Canada: a scoping review through the PROGRESS-PLUS equity lens

Blanchette V, Patry J, Brousseau-Foley M, Todkar S, Libier S, Leclerc AM, et al.

Abstract: Indigenous peoples in Canada face a disproportionate burden of diabetes-related foot complications (DRFC), such as foot ulcers, lower extremity amputations (LEA), and peripheral arterial disease. This scoping review aimed to provide a comprehensive understanding of DRFC among First Nations, Métis, and Inuit peoples in Canada, incorporating an equity lens. A scoping review was conducted based on Arksey and O'Malley refined by the Joanna Briggs Institute. The PROGRESS-Plus framework was utilized to extract data and incorporate an equity lens. A critical appraisal was performed, and Indigenous stakeholders were consulted for feedback. We identified the incorporation of patient-oriented/centered research (POR). This study provides a comprehensive understanding of DRFC in Indigenous peoples in Canada. It not only incorporates an equity lens and patient-oriented/centred research but also demonstrates that we need to change our approach. More data is needed to fully understand the burden of DRFC among Indigenous peoples, particularly in the Northern region in Canada where no data are previously available. Western research methods are insufficient to understand the unique situation of Indigenous peoples and it is essential to promote culturally safe and quality health-care. Efforts have been made to manage DRFC, but continued attention and support are necessary to address this population's needs and ensure equitable prevention, access and care that embraces their ways of knowing, being and acting.

Read at: Front Endocrinol (Lausanne). 2023 Aug 14;14: 1177020. DOI: 10.3389/fendo.2023.1177020

Disparities in limb preservation and associated socioeconomic burden among patients with diabetes and/or peripheral artery disease in the United States

McDermott K, Bose S, Keegan A, Hicks CW

Abstract: Racial, ethnic, socioeconomic and geographic disparities in limb preservation and nontraumatic lower extremity amputation (LEA) are consistently demonstrated in populations with diabetes and peripheral artery disease (PAD). Higher rates of major LEA in disadvantaged groups are associated with increased health care utilization and higher costs of care. Functional decline that often follows major LEA confers substantial risk of disability and premature mortality, and the burden of these outcomes is more prevalent in racial and ethnic minority groups, people with low socioeconomic status and people in geographic regions where limited resources or distance from specialty care are barriers to access. We present a narrative review of the existing literature on estimated costs of diabetic foot disease and PAD, inequalities in care that contribute to excess costs, and disparities in outcomes that lead to a disproportionate burden of diabetes- and PAD-related LEA on systematically disadvantaged populations.

Read at: *S*emin Vasc Surg. 2023 Mar;36(1): 39-48. DOI: 10.1053/j.semvascsurg.2023.01.007

Defining vascular deserts to describe access to care and identify sites for targeted limb preservation outreach

DiLosa K, Nguyen RK, Brown C, Waugh A, Humphries MD

Abstract: Access to care plays a critical role in limb salvage in chronic limb-threatening ischemia (CLTI). A 'medical desert' describes a community lacking access to medical necessities, resulting in increased morbidity and mortality. We sought to describe vascular deserts, which we defined as regions with decreased access to specialty care. All California providers performing vascular surgery procedures were identified through online provider

and health-care facility searches. Maps depicting care regions demonstrated decreased provider coverage with increasing specialty care, with the VQI provider map showing the most prominent 'desert; regions. Access to vascular care plays a significant role in limb salvage. Through mapping vascular deserts, patient demographics, and social factors in desert regions are better understood, and areas that would benefit most from targeted outreach and limb preservation programs for CLTI are identified.

Read at: Ann Vasc Surg. 2023 Sep;95:125-132. DOI: 10.1016/j.avsg.2023.05.025

Impact of implementing a diabetic limb-preservation program on amputation outcomes at an academic institution in a majority-minority state

Lew E, Collins NP, Marek J, et al.

Abstract: Diabetic foot osteomyelitis may precede major limb amputations and lengthy hospital admission. These complications impact patients' morbidity and mortality. Health-care institutions with dedicated limb-preservation teams realize reduced amputation rates and improved quality of care. This study evaluates the outcomes following the implementation of a rigorous diabetic limb-preservation program at an academic institution. After the implementation of a limb-preservation team, there was a precipitous drop in major limb amputations in favour of minor amputations. The average hospital LOS decreased. These findings demonstrated improved clinical care and outcomes in patients with lower extremity osteomyelitis and reinforce the importance of a diabetic foot-preservation service within health-care institutions.

Read at: Int J Low Extrem Wounds. 2023 May 9:15347346231169879. DOI: 10.1177/15347346231169879

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