What Constitutes a Multidisciplinary CLI Center?

What you need to know to make sure your team and facility fit the standard.

BY VLAD-ADRIAN ALEXANDRESCU, MD, AND MANON DAIX, MD

It is well known that critical limb ischemia (CLI) is a consequence of severe infrainguinal atherosclerotic arterial disease and embodies the most aggressive form of peripheral artery disease (PAD).[1,2] CLI rest pain and ischemic ulcers correspond to clinical presentations of Fontaine classes III and IV and Rutherford categories 4 and 5.[1-3] Updated demographic information shows that more than 200 million individuals worldwide, bridging all socioeconomic strata, endure various degrees of PAD, representing a 24% increase over the last decade.[1,4] The economic weight of PAD is equally cumbersome.[1,2] It was calculated that the total costs of vascular-related hospitalizations reached $21 billion in the United States in 2004 and continue to rise each year.[4] Approximately 40% of the total cost of diabetes care in the United States results directly from inpatient treatment of diabetic vascular complications.[4]

It appears that lacking early recognition and aggressive treatment, CLI habitually inflicts significant morbidity and high rates of major amputation and mortality.[1-3,5,6] For these patients, the likelihood of death has been reported to reach 20% within the first 6 months of CLI diagnosis (all etiologies confounded) and probably exceeds 60% at 5 years after initial clinical onset.[1,6] Contemporary clinical research reveals that patients with CLI symptoms are more likely to have simultaneous coronary or cerebral vascular disease, which confers a higher risk for early death.[1,2,6]

The risk for developing CLI is considerably higher in diabetic patients and patients with impaired renal function, and systemic ischemic events are more frequently reported in these patients compared to the general atherosclerotic population.[1-7] Approximately 80% of diabetic patients die from a range of cardiovascular events, including CLI.[7] For those experiencing CLI, 40% to 50% will undergo amputation, while 20% to 25% of diabetics will die during the first year after CLI diagnosis.[1,6] About 87% of all major amputations occur in diabetic patients who have uncontrolled hyperglycemia for more than 30 months and a chronic, nonhealing foot ulcer.[4-6] Unfortunately, a vast majority of individuals suffering from diabetes do not seem to have ongoing multidisciplinary follow-up to regularly inspect their feet, make sure they have adequate shoes, and provide prompt ulcer assessment and care.[4-6] Contemporary clinical experience has demonstrated that by applying evidence-based multidisciplinary surveillance including revascularization and local wound care as early as possible, up to 50% of major limb loss[8] and 85% of global inferior extremity amputations can effectively be prevented.[3,9]

DOES MULTIFACETED PATHOLOGY ALWAYS REQUIRE A DEDICATED TEAM APPROACH?

The modern interventionist now has more sophisticated knowledge about the mechanisms of CLI and ways to defer irrecoverable tissue loss. Furthermore, it appears that beyond the recognized ischemic threat,[3] CLI has a multifactorial causal design.[1,2,5] In the last decade, a series of concurrent conditions was thoroughly proven to contribute to tissue damage.[1,2,8-10] These complementary influences concern either systemic preoperative risk factors (inflammation, dyslipidemia, hypertension, hyperglycemia, uremia, hypoalbuminemia, matrix tissue decay, hyperhomocysteinemia, cortisone therapy, etc)[1,2,5] or additional postoperative conditions (the type, location, and extent of tissue defect, infection, wound debridement, off-loading, and the revascularization method).[8-11] All of these specific determinants were identified, and their relative risk was stratified either in surgical cohorts (hypoalbuminemia, diabetes mellitus, end-stage renal disease, Rutherford class 6 wounds, and mid- and hindfoot ulcer locations)[12,13] or in endovascular series (end-stage renal disease, nonambulatory status, diabetes mellitus,

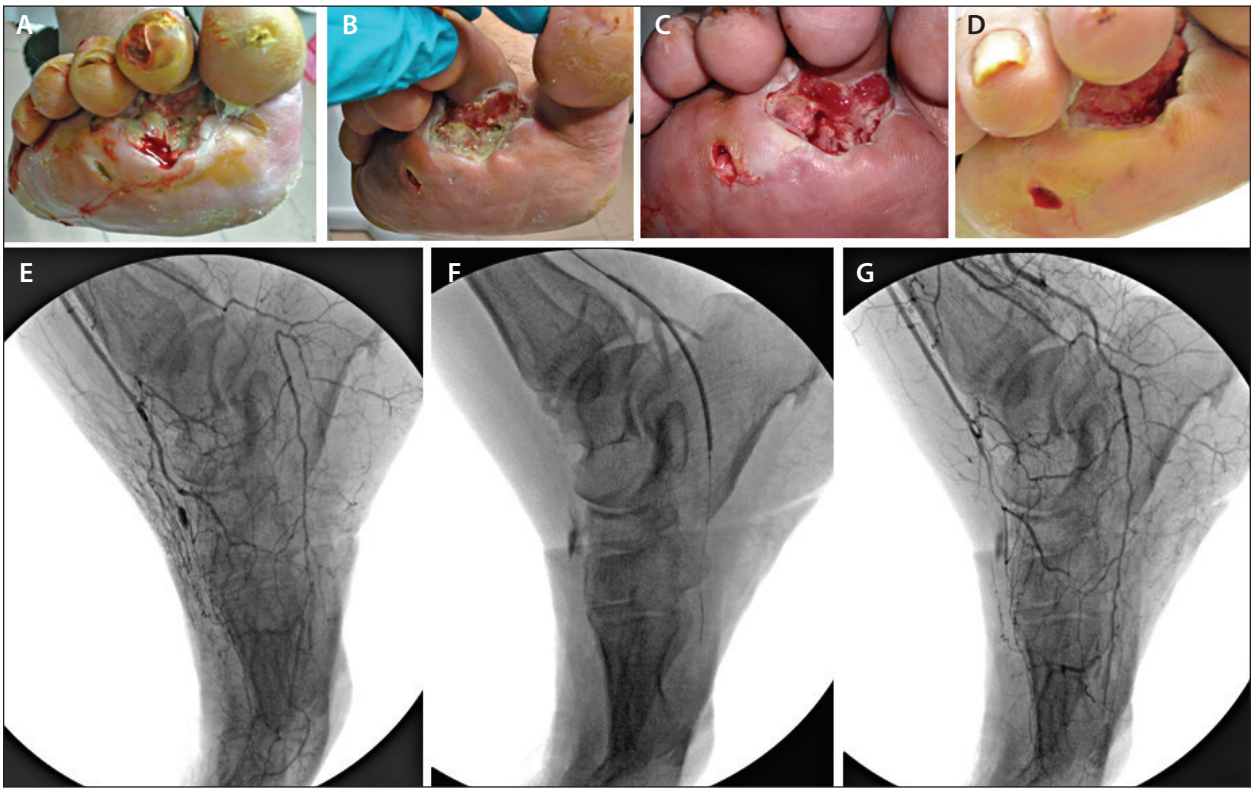

Figure 1. A diabetic patient with a neuroischemic foot (CLI, Rutherford category 5). The initial clinical presentation, showing extended forefoot and plantar sepsis and tissue necrosis (A). Early postoperative evolution (3 weeks) after urgent debridement, plantar compartmental drainage, and targeted posterior tibial (PT) revascularization (B). Midterm evolution at 7 (C) and 12 (D) weeks, showing aggressive infection control with a multidisciplinary team approach. An angiogram revealing complete occlusion of the PT and dorsalis pedis arteries and severe ischemia of the plantar forefoot (characteristic diabetic lack of collaterals) (E). Specific PT wound-directed revascularization (F). The completion angiographic result after intentional PT and plantar artery reperfusion (G). There was complete filling of the plantar arch and first metatarsal perforator after wound-targeted angioplasty and concomitant plantar decompression by the flexor tendon's compartmental drainage.

hypoalbuminemia, presentation with Rutherford class 6, wound infection, nonangiosome-related revascularization, and no vessel distal runoff).[8-12,14,15] Particular consideration was also given to diabetic foot syndrome (DFS) and its multifactorial conditions, such as chronicity (> 10 years hyperglycemia), peripheral neuropathy, local inflammation, infection and edema, Rutherford class 6 presentations, bedridden status, body mass index, impaired arteriogenesis and angiogenesis, hindfoot and heel ulcers, and the uremic context,[5-10,12-16] all of which have influence on peripheral tissue regeneration. Although pure ischemic ulcers probably comprise < 10% of all DFS tissue defects, a 90% majority is made up of either sole neuropathic or, more often, combined neuroischemic foot wounds.[9,10,17]

Evidence

Although there is a lack of heterogeneity in the formal evidence,[1,2,5,9] the vast contemporary literature has progressively demonstrated that a coordinated multidisciplinary approach may improve ischemic wound healing and limb preservation in patients with Rutherford class 4 to 6 CLI.[2,18,19] This was particularly well documented in the diabetic CLI subpopulation.[5,8-10,17-21]

Modern DFS team management undertakes the primary goals of wound closure and ambulation, as expeditiously as possible.[17-21] Clinical assessment can be made by a team of skilled health professionals who understand that DFS is a multifaceted pathology that includes arteriopathy, neuropathy, infection, pressure injuries, foot compartmental syndrome, cellular and molecular metabolic disturbances, and myriad clinical presentations.[2,5,8-10,20,21] It has been extensively described in the literature that effective diabetic care teams can decrease the major amputation risk in DFS by 50% to 80%.[8,10,20]

MAIN PURPOSES OF A MULTIDISCIPLINARY CLI CENTER AND UPDATED RECOMMENDATIONS

Not all CLI complications can be prevented nor effectively treated upon first diagnosis. No single known therapy alone can enhance patient outcomes without concomitant management of all ischemic, metabolic, septic, local pressure, neuropathic, and adequate off-loading measures

(Figure 1). Wound healing represents a complex cascade of molecular events in continuous dynamic interaction.[15,22]

Full-thickness wound repair following most CLI revascularization includes three main phases, succinctly described as the inflammatory ("lag") phase, the tissue formation ("proliferative") phase, and the tissue remodeling phase.[22] These three stages commonly overlap in a dynamic sequence and are conditioned by initial hemostasis and appropriate arterial reestablishment of flow.[22] Both of these factors represent the fundamental activating processes in healthy tissue regeneration.[22,23]

This harmonizing multimodal process gathers three parallel circulatory phases, which were evoked to succeed CLI revascularization: the initiatory flow redistribution, the early or "midterm" flow dispensation, and the retarded postischemic period, including the arteriogenesis and angiogenesis processes.[22-26] However, despite successful reperfusion, this physiologic cascade can still be hampered by hostile hyperglycemic, uremic, septic, inflammatory, or neuropathic milieus that operate simultaneously.[10,21] Risk factor identification and management represent a fundamental task for any multidisciplinary CLI center to achieve.[20]

In this setting, the multidisciplinary diabetic clinic acts as an expressive model for collective and focused therapeutic efforts.[10,20,21,25,26] The main purposes for the management of complex DFS were recently synthesized in practical guidelines of the Society for Vascular Surgery in collaboration with the American Podiatric Medical Association and the Society for Vascular Medicine, following current levels of evidence.[27] This systematic review of dedicated literature addresses the best-available evidence in CLI/DFS management to date.[27] It proposes guidelines concerning five main indicators in current multidisciplinary DFS treatment: (1) wound prevention, (2) off-loading, (3) infection and osteomyelitis control, (4) wound care, and (5) PAD management in DFS.[27] A combination of collective clinical judgment and careful wound interpretation for each presentation has also been proposed by many other publications, with or without a potential need for revascularization.[19-21,27-30]

Practical Points

Prevention and education programs provided by all CLI teams, including the patient as an active member of the multidisciplinary group, are the cornerstone of averting irrecoverable tissue damage and limb loss.[27-30] Educating patients and their families seems to provide positive and cost-effective results.[27,31]

With the knowledge that peripheral neuropathy generates 45% to 65% of DFS neuropathic or neuroischemic ulcers and that patients with neuropathy express > 3.5-fold higher risk for iterative foot ulceration,[27] patients may avail themselves to the particular benefits of this multimodal approach.[21,27,31] Adequate glycemic, lipemic, and inflammatory parameter control also seems appropriate for minimizing detrimental CLI complications and subsequent amputation risk.[27,29,30] It has been shown that an HbA1c blood level > 12% is correlated with decreased neutrophil function and low leukocyte chemotaxis.[30] Recent risk factor analysis demonstrated that for every 1% increase in HbA1c, there is a corresponding 0.028-cm/dL decrease of the healing process in lower extremity wounds.[27,32] Particularly concerning to the vascular interventionist as an indispensable CLI team member, for every 1% increase in HbA1c, there is a 25% to 28% rise in the relative risk of developing CLI and tissue ischemic complications.[30,32]

It is accepted that the use of off-loading devices after revascularization is a critical strategy of multidisciplinary CLI management.[27-30] Pressure reduction provides an added benefit to any other wound-healing strategy when advised by a team of appropriate specialists.[8,21,27,29,30] The same recommendation seems accurate for all high-risk CLI patients during the "prevention" stage, most notably for those with a previous DFS history, minor amputations, previous stump infections, or neuropathic (Charcot) foot deformities.[27,30] Early recognition and treatment of foot osteomyelitis are considered one of the most challenging and contentious aspects of CLI and DFS septic complications.[2,27] Although the systematic treatment is still not clearly defined in contemporary literature reviews,[27-30] each care unit or specialized CLI team must decide the appropriate diagnostic and therapeutic options to improve tissue outcome and limb preservation rates.[8-10,21,27-30]

Local wound care with timely (1- to 3-week intervals) reevaluations and repetitive debridement, if necessary (Figure 1), are both of paramount importance for maintaining local tissue viability and reducing irrecoverable necrosis damage.[8-10,21-23,27-30] Sharp debridement is reputed to lessen the amount of bacteria and may eventually stimulate local growth factor production.[30] A thorough evaluation of eventual infection should be systematically performed, followed by meticulous debridement in each CLI/DFS presentation.[27-30]

Wound size reduction is an early predictor of clinical success for the CLI multidisciplinary approach.[27] Wound surface diminution from 10% to 15% per week, or > 50% in 4 weeks, strongly suggests an increased likelihood of healing and a scarce probability of amputation.[27,30] Correct wound dressing should focus on maintaining a moist wound bed, allowing exudate drainage, without maceration of healthy skin.[8-10,27-30] Similarly to the other priorities mentioned earlier, effective dressing equally represents a flexible team-dependent parameter.[30] It should be tailored to specific CLI pathologies, wound location, characteristics, exudates, inflammation, and pain,[21,30] according to particular team

dialogue. All patients who have CLI with DFS should seek prompt arterial revascularization by either open surgical or endovascular techniques, along with expeditious wound debridement.[8-10,27-30] Concerning the DFS-specific team management, the recent Society for Vascular Surgery recommendations stipulate that "for the wide spectrum of patients with diabetes, ulceration or gangrene with various degrees of arterial insufficiency, the choice of intervention likely depends on the degree of ischemia, the extent of arterial disease, the extent of the wound, the presence or absence of infection, and the expertise of the practitioner."[27] It has already been mentioned that not all bare arterial or mixed neuroischemic and venoarterial "CLI" foot ulcers harbor the same amount of ischemic burden.[1,5,27] For these complex wounds in which basic characteristics cannot accurately translate the severity of the surrounding tissue hypoxia,[1,5,25-27] the multimodal team approach can provide appropriate management for tissue repair.[28,29]

New adjunctive therapies for CLI-concurrent factors have been developed in the last 2 decades, including negative pressure therapy, stem cell therapy, extracellular matrix products, and hyperbaric oxygen treatment. All of these sophisticated treatment methods are advised after a multidisciplinary team deliberation for complex wounds that lack tissue improvement of > 50% area reduction per month of standard therapy application.[27]

Efficient follow-up by local health providers should significantly help to improve wound healing and limb preservation.[29-31] Aggressive control of local sepsis, timely debridement, and thorough macro- and microvascular assessment[16] may require the appropriate clinical judgment of a multidisciplinary unit.[5,27] According to previously mentioned priorities, our institutional group experience also showed significant improvement in clinical success ($P = .04$) after implementing a coordinated multidisciplinary diabetic foot team.[29] Although we used similar endovascular revascularization and wound treatment techniques in homogeneous diabetic subgroups, the multimodal approach allowed lower major amputation rates at 12 and 17 months, with a statistical correlation of $P = .048$.[29]

HOW TO RUN A MULTIDISCIPLINARY CLI WOUND CENTER

Starting with the work of Edmonds (1981–1986) on the potential advantages of coordinated diabetic foot teamwork,[33] publications in the last 2 decades seem to have strengthened the predicted superiority of multidisciplinary CLI care.[10,18-21,27,34] However, concerns about how to establish a proficient referral center in primary to tertiary national hospital lines still remain in contemporary medical communities.[18,27]

Patients are referred to wound care centers, expecting full state-of-the-art local wound care and standardized CLI management. Many of them have either denied their disease status/symptoms or have already exhausted options for ulcer healing before addressing the clinic.[9,20] As with the previously mentioned DFS recommendations, a CLI multidisciplinary clinic should also identify the various presentations of limb-threatening ischemia.[2] Without clear landmarks, patients and referring general practitioners may not be sure which specialist to contact.

Although compression therapy represents the key treatment of chronic venous ulcers (about 70% of all leg ulcers),[22] a recent United States study revealed that only 17% of these patients used compression products appropriately.[28] In the same setting, the Eurodiale study emphasized possible trends in underdiagnosing and undertreating some DFS patients, even among centers of excellence.[17] The same survey revealed that 20% of these patients were treated 3 months after the primary referral, and vascular imaging and revascularization were seldom performed in 56% (range, 14%–86%) and 43% of diabetic CLI presentations, respectively.[17,34]

Recommendations

The primary goal of this multimodal method of CLI management is high-quality care.[2,27,34,35] Multidisciplinary CLI structures should be routinely integrated into wound centers.[5,34] These centers, including DFS clinics, are currently invested in clearly defined National Accreditation and Testing Standards of practice.[35,36] More specifically, in the International Working Group on the Diabetic Foot recommendations,[35] three levels of team activity were delineated, including the minimal, intermediate, and maximal models of diabetic team practice.[34,35] These three standardized platforms try to avoid the regional so-called excellence centers that were initially created by dedicated individuals ("local champions" in specific fields)[34] in very small teams, with or without evidence-based criteria.[34,35]

The International Working Group on the Diabetic Foot recommendations also stipulate that centers of excellence should afford adequate treatment for the vast array of DFS presentations including vascular (CLI) and orthopedic (Charcot neuro-osteoarthropathy) affectations.[35] Independent of their size, centers should provide a working example with evidence-based protocols and have adequate connections to other DFS centers.[34,35] Because CLI wound pathology is multidimensional (like DFS), the optimal therapeutic solution requires a parallel multidisciplinary approach.[35]

Perspectives on Daily Practice

An efficient first-line multidisciplinary CLI center should be able to treat all types of vascular patients (atheroscle-

rotic, diabetic, renal, angiitis, etc) with current clinical diagnostic and procedural (surgical and endovascular) equipment.[34-36] Beyond specialists trained in vascular, orthopedic, and plastic surgery, a skilled "high-volume" CLI center should also have appointed interventional cardiologists and radiologists who are locally available, as well as internal medicine consultants for related systemic vascular disease presentations.[34-36] A vital nucleus of this team must be available around the clock for urgent and scheduled presentations and continually interact with parallel institutional specialists, according to each individual CLI pattern.[27,29,33-36] It is suggested for the core team of this multimodal approach to include a medical coordinator, diabetologist, a certified wound specialist, an orthopedic surgeon, and/or a podiatrist.[27,34,35] Ancillary staff comprising a vascular and orthopedic surgeon, a dermatologist, dietician, and geriatrician, as well as consultation for infectious disease, nephrology, physical therapy, and social assistance, which would complete this exhaustive list of participants.[27,30,34-37] The consultations should match patients' needs and staff availabilities and allow local transportation to laboratories and radiological facilities.[27,35,36] All integrated multimodal urgent centers should be available 7 days per week, along with core lab–appropriate technology.[27,29,34-38]

High-quality functioning in every CLI team is mandatory and implies "evidence-based" care,[27,34-37] defined as "integration of best research evidence with clinical expertise and patient values to facilitate decision making."[36]

CONCLUSION

Evidence-based literature strongly recommends the multimodal team approach for treating ischemic lower limb tissue defects. This goal can be achieved through efficient multidisciplinary wound center application. Stepwise clinical and imaging evaluation, accurate laboratory testing, aggressive infection control, and the best available medical and surgical techniques and skills are key elements to this approach. ■

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Vlad-Adrian Alexandrescu, MD
Department of General, Thoracic, and Vascular Surgery
Princess Paola Hospital/Vivalia
Marche-en-Famenne, Belgium
v.alex@skynet.be
Disclosures: None.

Manon Daix, MD
Department of General, Thoracic, and Vascular Surgery
Princess Paola Hospital/Vivalia
Marche-en-Famenne, Belgium
Disclosures: None.