Charcot Neuroarthropathy: Salvage Or Amputation? Tools For Decision Making

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Abstract: Charcot neuroarthropathy (CN) can be a challenging management problem. When advanced, it requires making decisions regarding complex salvage surgeries with extended convalescence versus leg amputations. It is essential to make informed decisions to attempt limb salvage versus proceeding to early-on amputation of a limb for patients with CN. This article presents three scoring tools to facilitate making salvage versus leg amputation decisions for CN using objective criteria.

Key words: *Charcot neuroarthropathy, limb salvage, amputation, decision making tools, foot and ankle*

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Charcot neuroarthropathy (CN) can be a challenging management problem. When advanced, it requires making decisions regarding complex salvage surgeries with extended convalescence versus leg amputations. Its most common presentations are on the foot and ankle. Presentations are consistently associated with neuropathy; with diabetes mellitus being the most common cause of the neuropathy.

The etiology of CN remains perplexing. Proposed causes of CN appear to be a combination of events including trauma, occult or overt; infection; inflammation and/or hyperemia secondary to loss of sympathetic vasomotor control. The consequences are resorption and eventual collapse of the bones of the foot and/or ankle.[1,2] This leads to deformities, wounds and inability of the foot and ankle to serve as stabilizing platforms for standing and walking. Complications from CN are potentially limb-threatening. Appropriate initial management includes stopping progression with rest and offloading, maintaining foot-leg alignment with a plantigrade foot and selecting appropriate protective footwear. When wounds and deformities become serious enough to consider amputations, surgeons' roles are to eliminate wounds and infections, correct deformities and realign the foot and ankle.

Limb preservation is the goal in most situations. Lower limb amputations may be appropriate when infection and/or pain is uncontrolled, compliance issues make it unlikely the patient will adhere to the six to nine-months of convalescence required, foot salvage will not improve the patient's mobility due to concurrent comorbidities, perfusion is inadequate for healing or combinations of these.[3]

It is essential to make informed decisions to attempt limb salvage versus proceeding to early-on amputation of a limb for patients with CN. Consideration also needs to be given to both cost-benefit/effectiveness and quality of life. In a subset of patients, primary amputation is the treatment of choice, due to the severity of the CN problem and consideration of the patients' overall health status and goals. To help us with this challenge, we utilize three user-friendly, objective 0-10 score evaluation tools. These are the *Wound, Wellness* and *Goal Scores*.[4-7] These three scoring tools facilitate making salvage versus leg amputation decisions for CN using objective criteria.

Objectifying Evaluation

Scoring systems have been formulated to stage and evaluate CN deformities, but little attention has been given to determining the severity of the deformity or wound. The Wagner diabetic foot wound classification and management system is not applicable for CN problems. All decisions in the Wagner system regarding salvage versus amputation are based on ankle-brachial indices and deformity is only mentioned in his Grade-0 (no wound with underlying bone deformity). In our experiences, perfusion is not the problem with CN. This is consistent with the pathophysiology previously described. We are unaware of any scoring systems used in the evaluation and management of CN that help with decision making for limb-salvage versus amputation.

Surgery needs to be considered for patients with Charcot if there is a deformity not manageable with customized protective foot wear and/or bracing, deeply infected wound, limb threatening foot ischemia, rapidly progressive deformity or combinations of these. The goal of reconstruction is a stable, plantigrade foot aligned with the leg and amenable to ambulation with protective footwear. The challenge is how to add objectivity to decision making for limb salvage versus amputation in the patient with the outlined problems. The three scoring tools meet this requirement. The scores use objective criteria for each grade, can be rapidly ascertained and interpretations become intuitively obvious. These tools were adapted from the lead author's Long Beach Strauss Wound Score and his work on limb preservation, along with the co-authors' career experiences. Our algorithm provides a guide for evaluation and management of the CN spectrum (See Figure 1).

Long Beach Strauss Wound Score

This score quantifies the seriousness of a wound. It is derived by summing five assessments. These include: 1) Appearance of the wound, 2) Size, 3) Depth, 4) Infection and 5) Perfusion (See Table 1).

Table 1:

Long Beach Strauss Wound Score

Assessment/ Grade points	2	1.5	1	0.5	0
Appearance Base/skin margins	◯ Healthy	◯ Maceration	◯ Yellow/White	◯ Exudate	◯ Black/Necrotic
Size Include recesses	◯ < Thumb Print	◯ In-between	◯ TP-to-fist	◯ In between	◯ > Fist
Depth Include tract depth	◯ Skin	◯ Subcutaneous	◯ Muscle/Tendon	◯ Bursa/Cicatrix	◯ Bone/Joint
Sepsis	◯ Skin Flora	◯ Contamination	◯ Localized Abscess Osteo Cellulitus Indur	◯ Left shift	◯ Systemic Fever/Chills Dysgly/B-remia
Perfusion Colour, Temperature, Capillary refill	◯ Palpable Pulses Pink Warm<2 sec	◯ Mixed findings	◯ Doppler Pale Cool 2-5 sec	◯ In between	◯ Imperceptible Cold > 5 sec Black-White

LBSWS_____Pts **Wound Type:** ☐ **Healthy** 7½ to 10-Pts ☐ **Problem** 3½ to 7-Pts ☐ **End-stage** 0 to 3-Pts

Legend: B-remia = Bacteremia, **Dysgl** = Dysglyemia, **Osteo** = Osteomyelitis, **Pts** = Points, **TP** = Thumb print

This score integrates the main criteria used by four of the most commonly used diabetic foot wound scoring systems; namely perfusion (Wagner which uses the ankle-brachial index),[8,9] infection (Infectious Disease Society of America Diabetic Foot Infection guidelines),[10] depth (National Pressure Injury Advisory Panel grades)[11] and infection + ischemia + depth (San Antonio Texas/Lavery classification).[12] The Long Beach Strauss Wound Score (LBSWS) provides objective (i.e., quantifiable) criteria for amputation, i.e., LBSWS ≤3-points that are not amenable to revascularization or, if done, are not beneficial versus justification for salvage (LBSWS ≥3,5 Points). However, patients with an LBSWS in a 'Transition Zone' (2.5 to 4-points) who are motivated to avoid an amputation require additional information before making the salvage/amputation decision. This is provided by using objective-derived information from our Wellness (WS) and Goal (GS) Scores.[13-16]

Wellness Score

This score provides information that is obtainable from the initial evaluation of the patient with a wound or deformity (See Table 2). While scores such as the SF-MPQ-2, the FRAIL index and the Charlson Score provide systems to evaluate health status, they use differing assessments, without the scores being intuitive to interpret. The Wellness Score (WS), like the LBSWS, is a 0 to 10-point scoring system that uses five assessments with each graded on 2 (best) to 0-point (worse) objective criteria. It also becomes intuitively obvious, like the LBSWS, that high scores on the 10-point scale are desirable and low scores reflect worrisome health and function concerns. The WS summarizes the assessments of: 1) Ability to do activities of daily living, 2) Ambulation, 3) Co-morbidities (excluding the separate assessment of neurological status), 4) Inhibitors (e.g., smoking, steroids, and/or antimetabolites) and 5) Neurological impairment (See Table 2).

The WS offers guidance for deciding when collaboration with specialists is indicated. This is almost always necessary when making salvage versus amputation decisions in the impaired or decompensated host. Thus, information helps in patients whose comorbidities are so severe that limb salvage will not improve their mobility or quality of life. Wellness Scores in the 0 to 3-point range are associated with the decompensated patient who is bedridden, minimally to non-responsive and has serious wounds, with or without joint contractures. The Wellness Score provides objective information for what management decisions, i.e., foot salvage, leg amputation, minimal infection source-control surgeries or comfort care measures should be done.

Wellness Score

Differentiating Biological from Chronological Ages

Assessment/ Grade	2-Points	1-Point	0-Points
	Use half points if grades are mixed or intermediate between 2-points		
ADLs Activities of daily living	○ Full	○ Some	○ None
Ambulation Minus 1/2 point if aids required	○ Community	○ Household Minus ½ point if aids required	○ None
Comorbidities Other than neuro	○ None Significant	○ Impaired Ailment that is most concerning	○ Decompensated
Inhibitors Smoking, steroids, immunosuppressors	○ None	○ Prior Use	○ Current
Neuro Deficits	○ None	○ Mild-to-Moderate Sensory/motor deficits	○ Severe Paralysis, CVA contractures
Host Status:	☐ **Healthy** 7½ to 10-Pts	☐ **Problem** 3½ to 7-Pts	☐ **End-stage** 0 to 3-Pts

***Decomp'd** = Decompensated; requires tertiary care providers such has Critical Care Specialists, Cardiologists, Nephrologists, Hematologists, etc.,

Goal Score

This score quantifies the patient and/or the family's desire for limb salvage (See Table 3).

The Goal Score (GS) is obtained by summing the assessments, again on 2 to 0- point grades of: 1) Patient motivation, 2) Patient comprehension, 3) Patient compliance, 4) Care providers (e.g., self/family, nursing services, or none) and 5) Patient (or durable Power of Attorney) insight. It serves three purposes: firstly, it complements the information derived from the Wound and Wellness Scores. A second benefit of scores greater than 4-points (on the 10-point scale) is that they confirm that the patient (and/or family) is mindful of the problem, can make decisions regarding the options and can do or assist in activities of daily living and wound care.

Thirdly, this score provides criteria for how often the patient needs to be followed as an outpatient during convalescence and after the wound heals. For example, 7.5 to 10-point scores justify yearly visits to assess risk factors and appropriateness of footwear; while 3.5 to 7-point scores justify quarterly visits focusing on compliance issues such as skin care, toenail care and using protective footwear. Finally, low scores (i.e., <3.5 points) indicate that the patient needs to be checked weekly or every couple of weeks to avoid new wounds, optimize skin and toenail care, reiterate the importance of compliance with using protective foot wear (as well as nutrition, diabetes and smoking cessation management) and monitor for attenuated skin, new wounds or worrisome deformities. If a concern is raised for a new wound, immediate offloading, wound management and/or proactive surgeries need to be done.

The importance of care providers, the fourth of the five GS assessments, can be witnessed in the impact on both good initial outcomes and long-term durable results. This assessment is best provided by the patients themselves or the family and to a lesser extent, institutions, home health nurses and patient care assistants.

The Decision-Making Algorithm

By utilizing the scores generated from the LBSWS, Wellness and Goal Scores, rational decisions arise for patient management (See Figure 1).

If the LBSWS is in the transitional zone (i.e., 2.5 to 4-points) or higher and the Wellness and Goal Scores are greater than 4 points, quantifiable justification exists for doing everything possible to heal the wound and avoid leg amputations. This includes debridement, antibiotics and management of deformities. If either the Wellness or Goal Score is less than 4-points, even with a LBSWS equal to or greater than 3.5 points, palliative care should be the primary consideration. Palliative care, in this permutation, implies keeping the patient as healthy, comfortable and functional as possible without consideration for a lower limb amputation. Wound interventions would include infection source control, minimally invasive surgeries, such as toes or forefoot, utilization of wound off-loading devices and providing the simplest possible wound care. Finally, if both the Wellness and Goal Scores are less than 4-points, leg amputation is justified based on our algorithm.

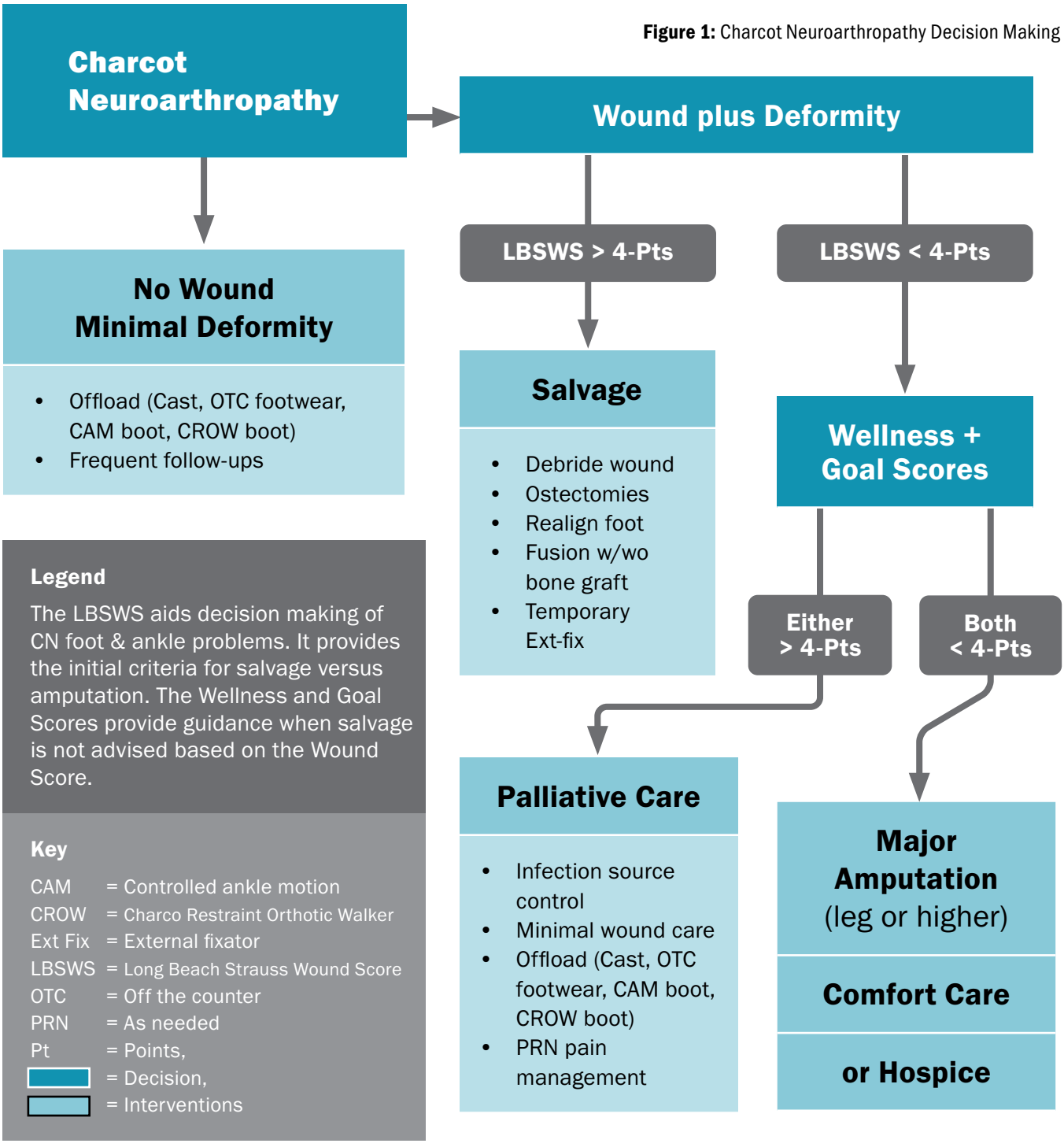
Table 3: **Goal Score**

Assessment/ Grade	Full (2-Pts)	Some (1-Pt)	None (0-Pts)
	Use half points if grades are mixed or intermediate between 2-points		
Comprehension			
Motivation			
Compliance Adherence	Consistently	To some extent	Not at all
Care/Support	Self / Family	Institution	Almost none
Insight			

Scoring:

- ☐ **7.5 to 10-Points:** Mindful (i.e., comprehension & insight) of problem and has satisfactory care/support and goals
- ☐ **3.5 to 7-Points:** Consider Wound and Wellness scores before making management decisions
- ☐ **0 to 3-points:** Comfort care, palliative care, or major amputations

Figure 1: Charcot Neuroarthropathy Decision Making



Discussion

The Long Beach Strauss Wound, Wellness, and Goal Scores provide quantifiable information for justifying limb salvage versus amputation in patients with severe Charcot neuroarthropathy deformities, with or without limb-threatening wounds. When the Wellness and Goal Scores are both less than 4-points, even if the LBSWS is in the Problem Wound range (i.e., 3.5 to 7-points) or there is no wound, but a marked deformity is present, amputation is recommended. If either are greater than 4-points, then palliative interventions, but not leg amputation, are justified.

Of course, the final decisions regarding salvage attempts versus amputation rest on the patient, family or durable Power of Attorney's decision. With quantitative information from our three user-friendly, intuitively obvious and objective grading 0 to 10- point scoring tools, rational recommendations are made for the decision-makers. We are unaware of any publications that attempt to quantify decision-making using published health status scoring systems for management recommendations of Charcot neuroarthropathy.

Limitations

This information in this paper has limitations, with the chief one being that it represents the authors' experiences, be they extensive, and of decades of observations. Secondly, other scores are available for evaluating wellness and comorbidities with no attempt being made in this paper to utilize them or make comparisons with our system to generate a Wellness Score. Thirdly, while parameters are offered for the grading of each assessment for determining the three scores, the intermediate grades (i.e., 1.5- and 0.5-points) are 'crutches' when whole number grades are mixed or in between two numbers. Fourthly, as in any biological system, outliers exist so judgment by the care provider and insight by the patient (or family) ultimately determine the decision between attempting limb salvage and leg amputation in the CN patient. Finally, the role of pain in decision-making for the CN patient is not elaborated-on. While pain is often a crucial consideration in amputation decisions in the vasculopath or patient with severe traumatic extremity injuries, it is almost never a consideration in the CN patient. This is attributed to the dense sensory neuropathy almost always present in the patient with CN.

Conclusions

The Wound, Wellness and Goal scores provide objectivity for making crucial decisions about limb salvage versus amputation for the Charcot neuroarthropathy patient. Their utilization in an algorithm approach provides understandable information to the patient (and family) for crucial CN-making decisions. Studies to evaluate these scoring tools' reliability, validity and predictability of outcomes are warranted. Our CN scoring tools are useful for comparative effectiveness research studies, since outcomes of treatment interventions become comparable in wounds with similar scores. In addition, the quantification of progress, i.e., Minimal Clinical Important Difference, is achieved with serial LBSWSs in conjunction with the use of our algorithm for the Charcot neuroarthropathy.

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