

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

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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.*

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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



Preop clinical photo.

Department (ED) for evaluation and treatment by orthopedic surgery.

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.

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.



Postop x-ray.

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

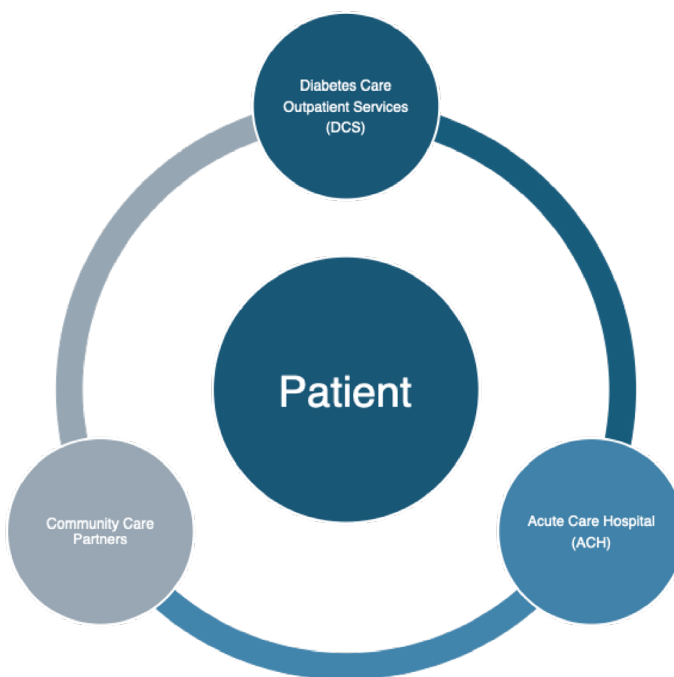


Figure 2: Bridging to Multidisciplinary Care Teams for Limb Preservation. *Diabetes Care Service (DCS)*: Includes diabetes care nurse, social worker, chiropodist, physiotherapist. *Acute Care Hospital (ACH)*: Emergency Department (ED), surgical/medical services, surgical outpatient clinic, diagnostic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

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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Further Reading

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