Remote Thermometry for Early Detection of Chronic Recurrent Wounds

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Introduction

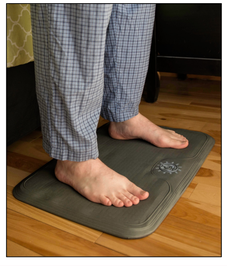
Diabetic foot ulcers (DFU) are known to be associated with increased morbidity, mortality, and resource utilization [1-3]. These costs are borne disproportionately by patients who have healed from a prior wound: between 30% and 40% of patients suffer reulceration in the year after achieving closure [4-8], and lifetime recurrence is estimated to be as high as 70% for patients who have a history of diabetic foot ulcer [9]. In fact, Armstrong and colleagues suggest that the concept of remission may be useful for allocating resources, organizing care, and communicating information about risk [10]. Furthermore, they recommend the use of foot temperature monitoring for the prevention of recurrence in this high-risk cohort.

A thermometric telemedicine smart mat* has been utilized as a screening device to detect increased heat due to inflammation. This mat can be used to remotely detect the inflammation due to emerging recurrent DFU on average 5 weeks prior to clinical presentation [11]. This case report illustrates the use of remote temperature monitoring (RTM) for a patient with a history of a particularly challenging chronic DFU.

Methods

The smart mat is prescribed for high-risk veterans followed at the PAVE Clinic. Veterans are instructed to augment standard preventative foot care with daily use of the mat.

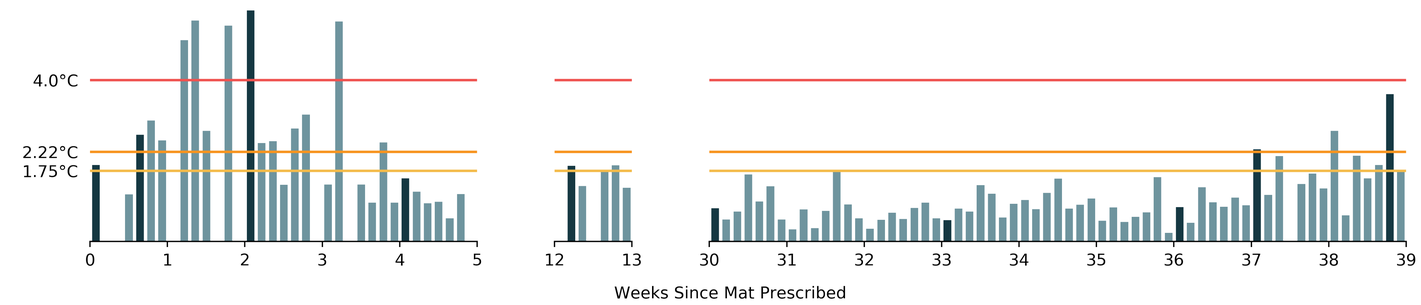
After the patient uses the mat, it securely de-identifies and transmits the temperature data, referred to as a scan, so that it can be subsequently accessed by clinical staff through an online physician portal. The data in the portal are automatically analyzed for asymmetry between the left and right feet at six locations consistent with the literature [11-14]. Temperature asymmetry exceeding a site threshold over two or more consecutive days triggers an alert to clinical staff, at which point the veteran is considered “in episode.” A phone call is made to the veteran to encourage proper offloading, decreased walking, elevation of feet, and visual exam at home. In the event of ulceration, patient is instructed to suspend daily scans until healed and no longer requiring a dressing.



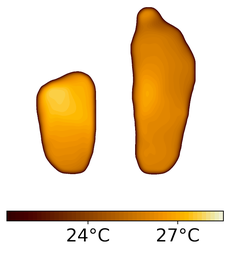


*Podimetrics RTM System, Podimetrics, Inc., Somerville, MA

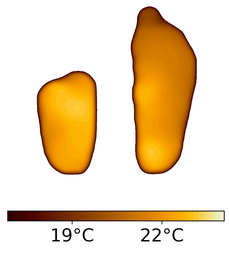
Case Report



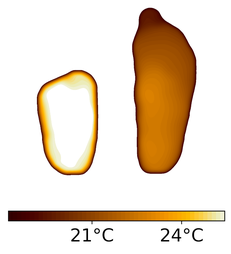
- 66-year-old male veteran with NIDDM2 (HbA1c 5.7%), neuropathy, CKD stage 5 requiring hemodialysis, CHF, HLD, secondary hyperparathyroidism. Patient had a right-sided TMA performed under the care of another clinic. When patient presented to our facility, he had a DFU to the distal TMA stump that had been present for 2 years.
- From the date of initial consult until the wound achieved tenuous epithelialization 3 years later, many advanced modalities were used including up to twenty prudent applications of negative pressure wound therapy (NPWT), amniotic grafting, silver absorbent dressings, and collagen products.
- Once healed, the patient was then followed quarterly for diabetic foot checks and routine followup. Veteran was found to qualify for RTM due to his history of DFU, amputation, and peripheral neuropathy and was dispensed a mat.
- The patient was found to be in episode during the first week, with peak thermal asymmetry following on day 9 of 5.4°C to the right distal TMA stump, the location of his previous DFU. Patient was called and educated to decrease walking and assess the condition of his diabetic inserts. A trend of decreasing thermal asymmetry following week two could suggest adherence in offloading in response to outreach.
- High right foot temperatures presented again during week 3 and patient was seen in the clinic in week 5, where he reported malodor for the previous two weeks. He is unable to visualize his feet and was told by staff at dialysis there was a visible ulcer to the right plantar TMA stump. A recurrent DFU measuring 0.8 x 0.4 x 0.1cm was debrided and a collagen product was applied to the wound bed. Patient was dispensed dressing change supplies and instructed to wear his diabetic shoe with toe filler.
- At clinic visit in week 7, the patient had decreased the dressing to a bandaid. Ulcer measured 0.5 x 0.2 cm x < 0.1cm. Periwound callus was debrided and the area was dressed with wound gel and a bandaid. The ulcer was healed in week 11. Callus was again pared and the patient was instructed to resume scans on the mat.
- Patient reulcerated in week 13 at the same location, likely due to a reported acute increase in activity. Patient was seen in clinic two days later with macerated 3.0 x 2.4 x 0.1 cm wound and a betadine dressing was applied. Re-education on the risks of reulceration and the importance of early intervention were addressed. At this time, the care team lowered threshold for thermal asymmetry for the site from 2.22°C to 1.75°C to be more commensurate with very high-risk population being monitored.
- The patient healed in week 29 and the RTM system showed dramatically lower asymmetry over the following seven weeks. In week 37, the patient showed elevated asymmetry, with temperature spiking again at the distal right TMA stump. The patient entered another episode at the 1.75 °C threshold in week 38. When contacted, the patient denied any wounds, and an appointment was made for clinical exam. Upon exam, a 0.7 x 0.4 x 0.2cm uninfected (UT1A) recurrent wound was found.



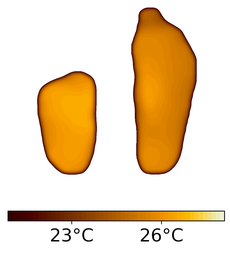
Day 0



Day 5



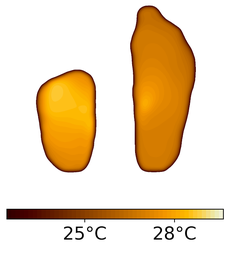
Week 2



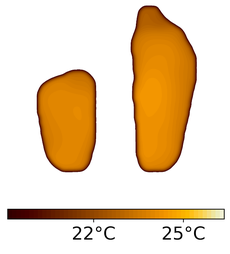
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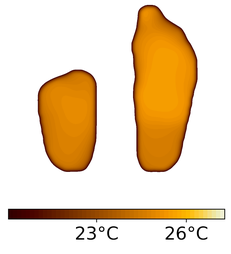




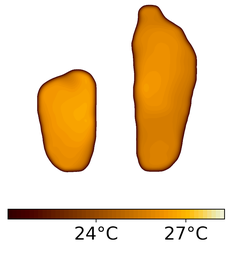
Week 12



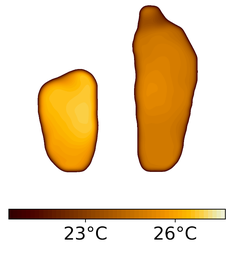
Week 30



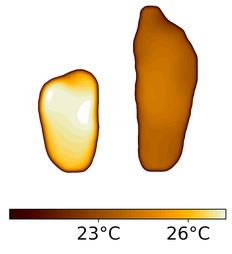
Week 33



Week 36



Week 37



Week 38

Conclusion

Patient’s prior DFU required nearly five years to heal at great cost with advanced modalities. A recurrent DFU was identified by RTM more than three weeks before clinical presentation and resolved in less than two months without the need for NWPT or bioengineered tissues. A subsequent recurrent DFU was identified by RTM prior to the care team or patient becoming aware of it, prompting an unscheduled clinical exam and allowing for ongoing early intervention.

Given the high incidence of DFU recurrence, the use of an at-home thermometric monitor for patients who have recently healed from chronic wounds has the potential to mitigate morbidity, mortality, and resource utilization, consistent with the findings of this case. More work is warranted to quantify the potential impact of remote monitoring in high-risk populations such as those patients in the first year after healing from a chronic wound.

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Acknowledgements

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