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# Remote Temperature Monitoring in High Risk Patients: Incidental Inflammation Secondary to Trauma

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## Introduction

Pedal ulceration can occur from many precipitating factors including diabetes, neuropathy, deformity, and direct trauma. The pathophysiology of diabetic foot ulceration is multifactorial, but peripheral neuropathy is thought to be responsible for most cases [1]. Although the majority of foot ulcerations are secondary to repetitive plantar microtrauma in a diabetic patient, there are many cases where an acute traumatic process is involved. Collectively, these pedal wounds are known to be associated with increased morbidity, mortality, and significant resource utilization, and the consequences of acute injury can be heightened by factors such as age and other comorbidities [2].

A thermometric telemedicine smart mat\* has been developed as a screening device to detect inflammation in the feet. Research conducted on this technology shows its ability to detect early inflammation, and it has previously been employed for diabetic foot ulcer (DFU) detection in a high-risk diabetic population [3].

In this case series we illustrate how the mat detected acute inflammation stemming from trauma in 3 neuropathic patients and permitted early communication and intervention. The thermal asymmetries prompted a telephone call to the patient, foot inspection, and medical advice based on the information gathered.

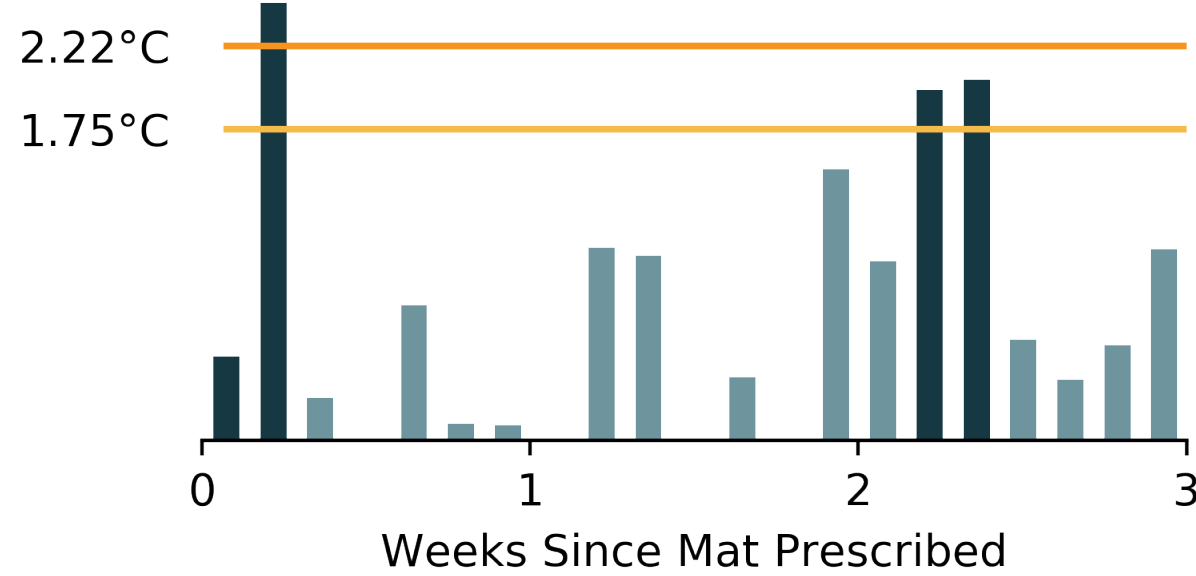
## Methods

The three patients in this case series were deemed to be high risk and issued a mat based on clinical encounters at the SAVAHCS PAVE clinic. To qualify for remote temperature monitoring with the mat, a patient must have at least three of the following: history of foot ulceration, history of amputation, deformity, vascular impairment, and neuropathy. All three patients in this case series have peripheral neuropathy.

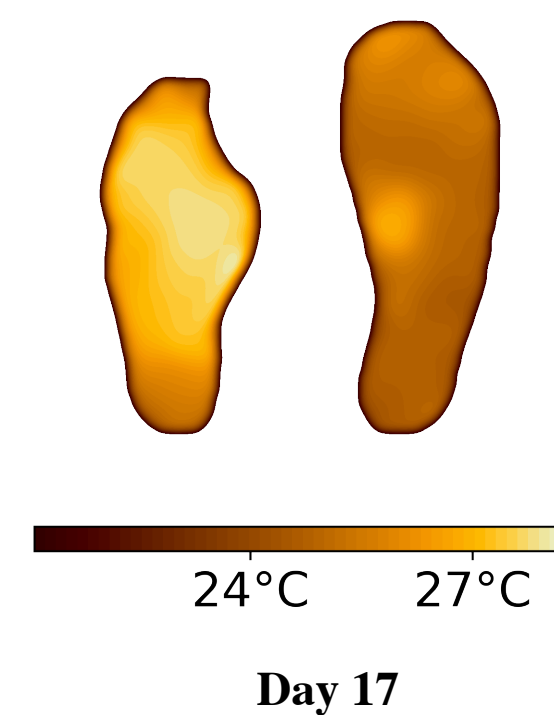
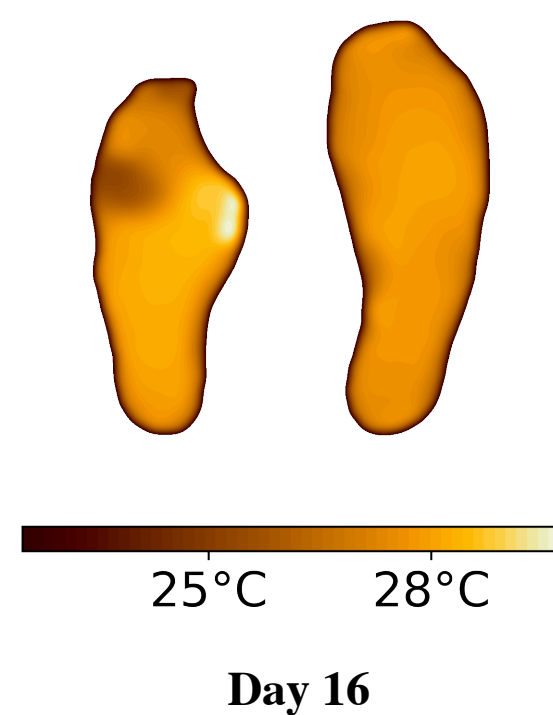
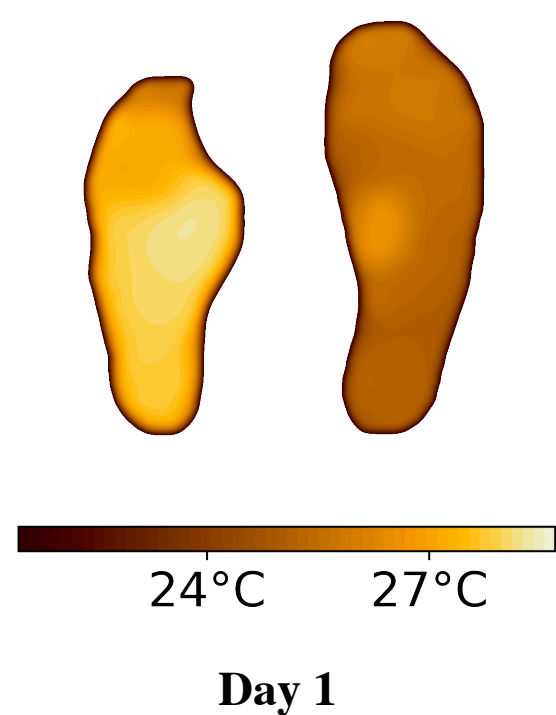
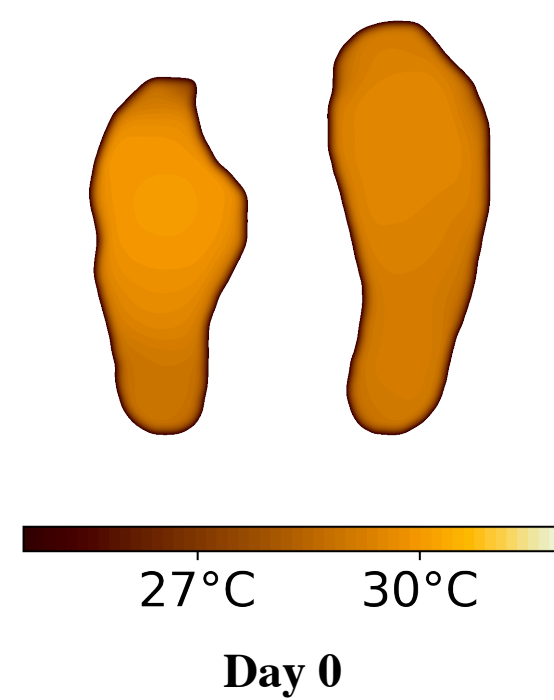
Patients stood on the mat once daily. Alerts were generated to clinical staff whenever thermal asymmetry was detected  $>1.75^{\circ}\text{C}$  for two consecutive days using the approach described in [3]. Index date is the day the patient received the mat.



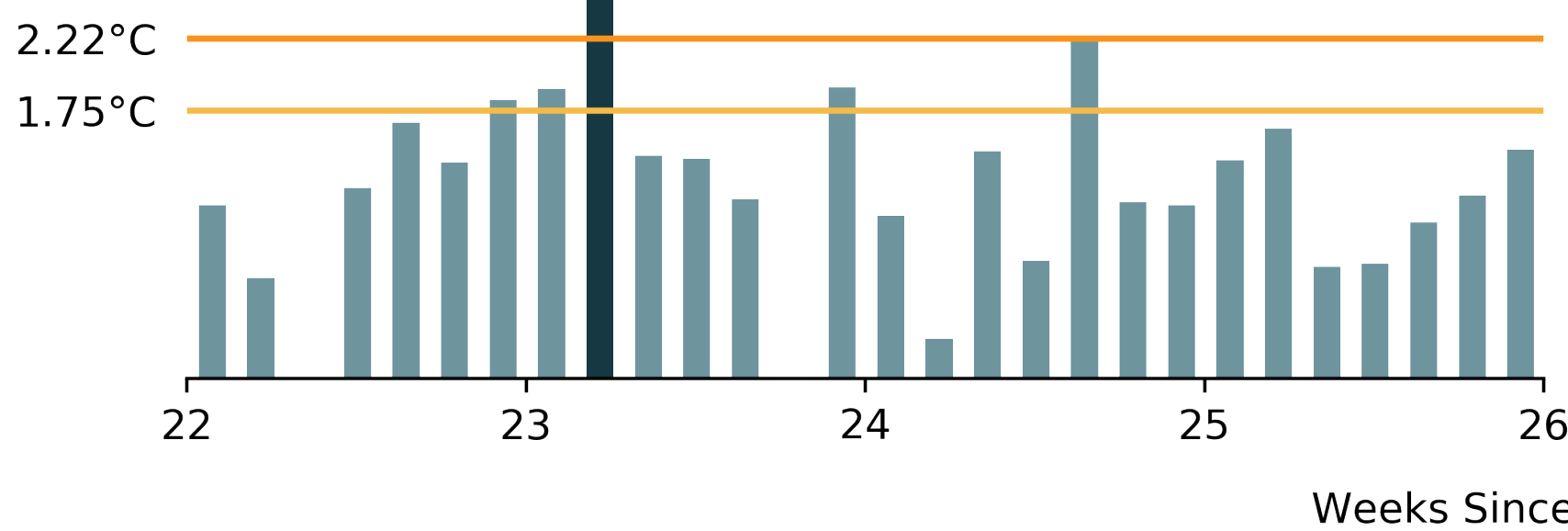
## Case 1



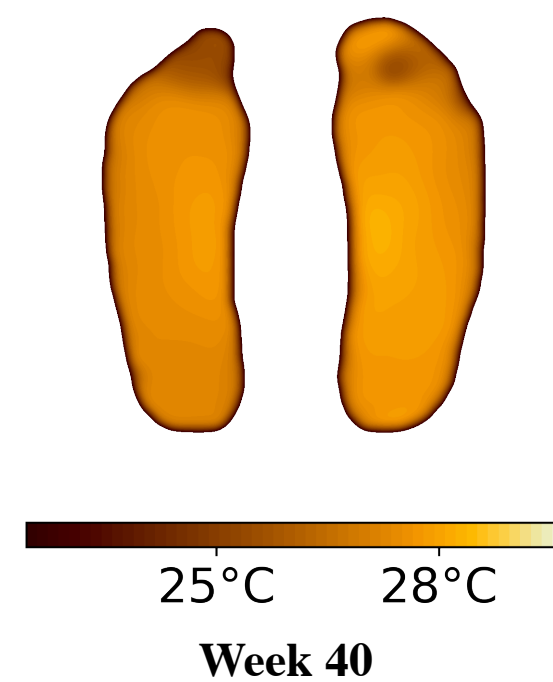
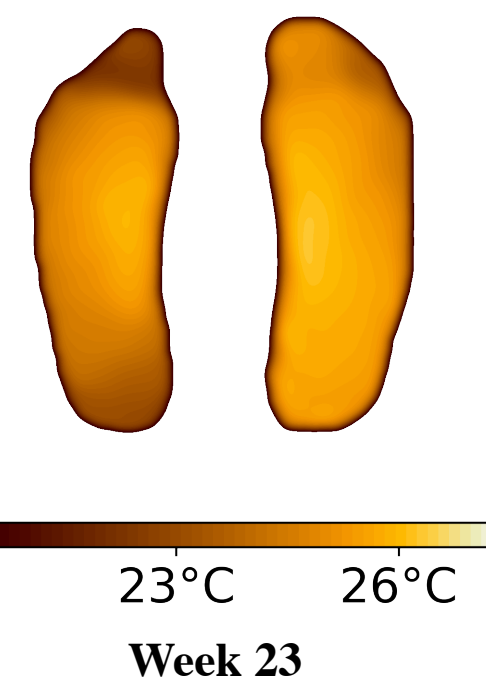
- 58-year-old male veteran with NIDDM2 with neuropathy (A1c 8.8%), hepatitis C, obesity, and right partial 1st and 2nd ray amputations 2.5 years before index due to chronic osteomyelitis from a DFU.
- Patient had recurrent amputation stump ulcerations until an amputation revision was performed 4 months prior to index. Complete healing of surgical incisions was observed one month prior to index.
- The initial asymmetry alert for the right foot occurred during week 2. When called about the notification, patient reported “scraping his foot in an outside shower” two weeks prior, potentially correlating with the transient asymmetry on day 1. Patient had supplies at home from his previous wound and was dressing it with collagen and a silver absorbent dressing under gauze and tape.
- Upon presentation to clinic three days later, he was found with noninfected 0.8 x 0.7 x 0.1cm (UT1A) ulcer to the right sub 5th metatarsal head. The ulcer was treated with debridement, an injectable amniotic graft, then collagen with DSD. Smoking cessation was discussed and a social work consult was placed for outpatient support group.
- The ulcer was found to be healed at the patient’s next scheduled exam.



## Case 2

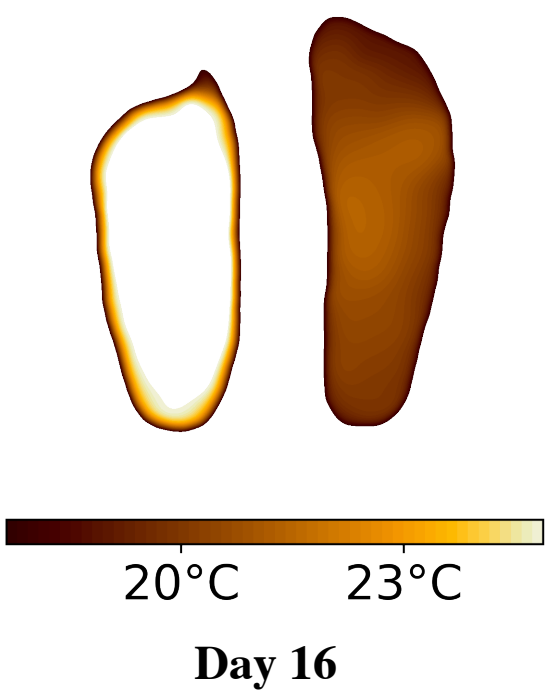
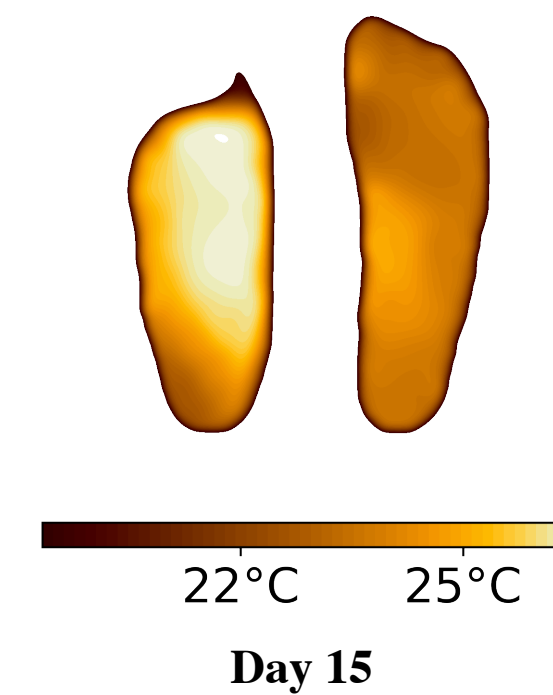


- 80-year-old non-diabetic male veteran with neuropathy of unknown origin, CHF, CAD, hypothyroidism, HTN, gout, and right 2nd toe amputation due to chronic osteomyelitis three months prior to index.
- At the beginning of week 23, an asymmetry alert to the left foot triggered a phone call for triage. The patient’s wife observed a superficial scrape to the dorsal left foot which resolved without further intervention
- Before week 40, another asymmetry alert to the left foot prompted another phone call. The patient’s wife reported a plantar puncture wound that looked “scabbed over.” This, too, resolved without further intervention.



## Case 3

- 56-year-old male veteran with NIDDM2 (HbA1c 9.3%), peripheral neuropathy, right Charcot foot, CKD stage 3, HLD, and HTN.
- Five weeks prior to index, the diagnosis of acute Charcot to the right foot was made. He was placed in a CAM walker and instructed to be fully NWB.
- The initial asymmetry alert to the right foot was during the second week following index. The asymmetry peaked at  $5.1^{\circ}\text{C}$  to the arch.
- When called, patient reported a “popped blister” to the arch of his right foot, which he attributed to wearing coarse socks. Discussed having veteran check the blister daily and education was given on acute SOI. He was instructed o keep the area clean by doing daily betadine soaks and to not use the mat when he has an open wound.



## Conclusion

Peripheral neuropathy can significantly hinder a person’s ability to detect injury to their feet. Decreased pain perception can lead to delayed awareness of the pathology and initiation of care. Although it may not be possible to prevent acute injury in neuropathic patients, thermometry may allow earlier detection to improve patient outcomes. A thermometric mat may be a good option for a patient at high risk for acute foot trauma due to neuropathy, history of amputation or deformity, and clinical exam findings. With these cases, remote temperature monitoring may have resulted in early communication, allowing for early intervention and reductions in resultant morbidity, mortality, and resource utilization. Future study may focus on whether inflammation secondary to acute injury presents differently than inflammation due to repetitive microtrauma.

## References

- [1] Crawford F, Inkster M, Kleijnen J, Fahey T. Predicting foot ulcers in patients with diabetes: a systematic review and meta-analysis. Journal of the Association of Physicians. 2007 Feb 1;100(2):65-86.
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- [3] Frykberg RG, et al. Feasibility and Efficacy of a Smart Mat Technology to Predict Development of Diabetic Plantar Ulcers. Diabetes Care, 2017

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