

Innovations in Amputation Prevention: Remote Temperature Monitoring

This simple mat can help reduce amputations.

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Amputation prevention efforts continue to confound providers and patients. The number of variables that affect whether a limb at risk goes on to a wound, infection, and amputation is daunting. This starts with chronic degenerative diseases like diabetes, chronic kidney disease, peripheral arterial disease, and sensory neuropathy of any cause, and ending with psychological factors which limit a patient's will or ability to control factors in

is more effective than standard control for prevention of amputation, and home monitoring of foot skin temperature, therapeutic footwear, and integrated interventions are effective for preventing incidence and/or recurrence of foot ulcers.”³

In a study published in 2017 looking at 129 patients in a randomized controlled trial, Fryberg, et al., using a standard threshold asymmetry temperature of 2.22°C (used in previous studies), found that the system correctly identified 97% of observed DFUs, with an average lead time of 37 days and a false-positive rate of 57%. Approximately 86% of the cohort used the system at least three days a week on average over the study.

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their own lives and follow self-care practices. Healthcare providers are left with the task of controlling as many of these variables as they can, understanding that they cannot control them all. Patient education products that promote self-footcare behaviors abound and have not had the intended impact on a population-based scale.

A new tool in the arsenal for providers is the remote temperature monitoring (RTM) mat which has the potential to significantly reduce the kinds of foot wounds that commonly lead to amputation. As early as 1997, Armstrong and Lavery, et al.¹ postulated that measuring contralateral plantar temperature might provide clinical information before clinical signs of injury become apparent. In 2007, a research team led by Armstrong and funded by a VA HSR&D Merit Award 20-059, titled *Skin Temperature Monitoring Reduces the Risk for Diabetic Foot Ulceration in High-risk Patients*² provided clinical evidence that measuring high temperature gradients between feet may predict the onset of foot wounds and that self-monitoring may reduce the risk of ulceration. Further work by AHRQ meta-analysis concluded that “intensive glycemic control

Current VA Pilot

As of September 2021, the Veterans Health Administration has enrolled 2,851 patients from 81 different sites in (RTM). Veterans show high adherence to this program with 84% using their smart mats at least weekly in their first year of enrollment. Data from multiple quality improvement analyses show reduced rates of re-ulceration and major amputation for veterans enrolled in remote monitoring. Data also suggests reduced clinic and emergency department visits as well as reduced hospital admissions for enrollees. These reduced resource utilization rates have led to decreased overall healthcare costs for those enrolled in RTM.

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Clinical Innovations

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RTM has spread throughout the VHA via multiple mechanisms. In 2019, the VHA Innovation Ecosystem launched the Initiative End Diabetic Limb Loss in VA. Through this initiative, a team of key stakeholders across the organization convened to design, test, and replicate a care model that incorporated remote temperature monitoring in Prevention of Amputations in Veterans Everywhere (PAVE) care. This team worked together to evaluate the clinical and economic impacts of this care model and bring broader awareness to the field. After scaling to 52 medical centers, and 1,300 Veterans, Remote temperature monitoring was selected as a winner of the VHA's

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National Shark Tank Competition. This program is modeled after the ABC version of Shark Tank. During the final round of the competition, medical center and VISN directors bid resources to bring new and innovative programs to their facilities. Winners of the Shark Tank Competition are given national attention and assigned teams to help disseminate their practices throughout the VHA.

In addition to winning this national competition, Remote Temperature Monitoring was awarded national funding from the VHA's Innovation Ecosystem in early 2021. This funding allowed smart mats to be purchased at the national level, which reduced the financial burden on local prosthetic departments. This change encouraged other VA sites to adopt this program. The VHA Innovation Ecosystem has also supported dedicated staff to help disseminate and standardize this program throughout the VHA.

Through the launch of The Initiative to End Diabetic Limb Loss in VA, the VHA Innovation Ecosystem (VHAIE) led the design, testing, scaling, and evaluation of RTM for high-risk Veteran patients. By convening key stakeholders across the organization to include, Podiatry/PAVE, Health Equity, Office of Connected Care, Office of Information & Technology, Prosthetics & Sensory Aid Services, National Center for Collaborative Healthcare Innovation, and Diffusion of Excellence, the VHAIE discovered and solved local and national challenges to scale, making remote temperature monitoring available to all high-risk Veteran patients in VA. The VHAIE secured \$7M in CARES Act funding to advance and further scale this pilot program and plans to operate at full scale by 2024.

Disparities in diabetic foot ulceration and amputation related to race, ethnicity, and rural residence are well described. RTM can help reduce these disparities, as it improves overall quality of care for diabetes and allows all patients with diabetes to achieve better health outcomes. The VHA Office of Health Equity (OHE)

works with Podiatry/PAVE, the VHA Innovation Ecosystem, and VHA Health Services Research and Development to support the equitable distribution of RTM mats to veterans and to evaluate the effectiveness of this new technology in different groups of veterans. This information can help guide VA deployment of remote temperature monitoring in a way that maximizes efficiency and health benefits. **PM**

References

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