

## Researchers develop mobile app to help diabetic patients monitor foot health

March 15 2024

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(L-R) Tan Tock Seng Hospital Senior Consultant Dr. Liew Huiling, NTU's Lee Kong Chian School of Medicine (LKCMedicine) and Head of Psychology at NTU's School of Social Sciences Associate Professor Andy Ho Hau Yan, and NTU's LKCMedicine Research Fellow Dr. Anita Pienkowska, posing with the WellFeet app. Credit: NTU Singapore

A group of researchers, led by Nanyang Technological University, Singapore (NTU Singapore), has developed a mobile application to educate individuals living with diabetes and their caregivers with knowledge of the disease and assist them in monitoring their day-to-day activities, which includes medication, physical activity, and their diet.

The app, WellFeet, was developed in consultation with clinicians from Tan Tock Seng Hospital and the National Health care Group. It aims to help prevent a serious diabetes complication: diabetic foot ulcers (DFUs), which occur in a third (34 percent) of individuals living with the disease. In Singapore, about one in twelve Singapore residents (8.5 percent), or around 32,000 people, have diabetes.

People living with diabetes are more prone to wounds on their feet that are hard to heal. When not monitored or treated well, diabetic foot ulcers can lead to lower limb amputation and an increased risk of death. The high reoccurrence rate means that DFUs often lead to financial burdens among patients due to the recurring costs of medication and operations, say the researchers.

The app has been tested by 40 pairs of patients and their caregivers from Tan Tock Seng Hospital and rigorously evaluated in a qualitative and quantitative study. After one month of using the app, the study participants observed positive changes in footcare behavior and diabetes self-care routines.

WellFeet app was also part of an earlier research project, "Preventing limb losses in Singapore," where an additional 835 patients and caregivers recruited across five [health](#) care institutions in Singapore also tested the app.

This larger research project involving patients and caregivers from National University Hospital, Ng Teng Fong General Hospital, Tan Tock

Seng Hospital, Admiralty Medical Centre under Khoo Teck Puat Hospital, and Toa Payoh Polyclinic, investigated the current foot care behaviors among people living with diabetes and their caregivers.

WellFeet aims to fill a gap in mobile applications for diabetic foot ulcers, as current apps do not include education and mostly focus on measuring ulcer progression. Unlike other existing education apps, WellFeet includes comprehensive patient education delivered through animations in English, Mandarin, Malay, and Tamil, catering to Singapore's multi-ethnic population.

Patient education is crucial to promote effective prevention, foot self-care, and the importance of seeking prompt assistance for foot wounds. Delivered on mobile phones, WellFeet offers the potential for a scalable and cost-effective intervention.

Project principal investigator Associate Professor Andy Ho Hau Yan, Head of Psychology at the School of Social Sciences and Joint Associate Professor at NTU's Lee Kong Chian School of Medicine (LKC Medicine), whose research centers on psychosocial gerontology, said, "WellFeet reflects our commitment to addressing the unique needs of patients and caregivers at risk of or dealing with DFUs."

"WellFeet goes beyond traditional approaches by delivering a DFU-specific training program, aiming to enhance health literacy and instigate behavior change for the prevention and care of [diabetic foot ulcers](#). It is a practical and empowering tool tailored to make a meaningful impact on the lives of individuals dealing with diabetes in our community."

WellFeet is an example of how modern technologies can be leveraged to deliver health care over mobile devices, tablets, PDAs, and computers, known as mobile health or mHealth, and can offer cost-effective and scalable solutions.

Site principal investigator Dr. Liew Huiling, Endocrinologist at Tan Tock Seng Hospital, said, "WellFeet stands as a testament to the transformative power of digital education in diabetes patient care—an inherently scalable and potentially cost-effective intervention with a proven track record of enhancing health outcomes."

"Through researching and fine-tuning the app to fit patients' and their caregivers' needs when it comes to day-to-day care, instant access to a wealth of carefully curated footcare-related information, WellFeet introduces an all-in-one monitoring system that consolidates essential health aspects in a single, user-friendly interface."

"As WellFeet would be rolled out as a free-to-use app, it would not only support the journey of diabetes management but also ensure accessibility and ease for both patients and caregivers, ushering in a new era of comprehensive and empowering health care."

Giving an independent opinion on WellFeet, podiatric surgeon Professor David Armstrong, Professor of Surgery at University of Southern California, U.S., and founder and co-chair of the International Diabetic Foot Conference, said, "With WellFeet, the NTU research team is reaching people at every point in care in diabetes, including managing their diet and foot health, and meeting them where they are."

"WellFeet will no doubt make an enormous difference in eliminating preventable amputations and suffering not only in Singapore but, I think, worldwide."

The study, which represents an advance in education and care for diabetes patients, reflects NTU's commitment to responding to the needs and challenges of healthy living and aging, which is one of four humanity's grand challenges that the University seeks to address through its NTU 2025 strategic plan.

## **Helping patients and caregivers put their best foot forward**

WellFeet is accessible in English, Mandarin Chinese, and Malay. It offers various personalization levels, engaging users through gamification with daily tasks and tracking actions through daily tasks (see video).

In addition to serving as a log and diary for patients and caregivers, doctors can customize patient-specific exercise goals and monitor their patients' progress by reviewing diary entries.

The app also has a chatbot that supports patients in their journey, fostering empathy by encouraging users to understand and connect with the experiences of others, such as health care providers or fellow patients.

The chatbot also prompts self-reflection within users, which can help them gain insight into their own thoughts and feelings, identify patterns or triggers, and make positive changes in their behavior or mindset. It may involve considering how their actions impact themselves and others, as well as exploring their motivations and goals for their health journey.

During a one-month study with 40 participants, which included patients and caregivers, both groups reported finding WellFeet easy to use and beneficial for health care access. Patients appreciated its usability, navigation, and feedback, while caregivers found it well-organized and useful.

One of the patients who participated in the study, said, "Before bedtime, I check my toenails for any signs of fungus. I use a spray that I always keep handy to protect my feet. In the past, I used to indulge in

reflexology or soak my feet in hot water, but now, with the knowledge gained from this app, I've learned better and no longer follow those practices."

Another study participant, a caregiver, said, "I've become more involved in managing my mom's medications. Previously, I would leave it to another family member, but now I'm more conscious of the medication names, dosages, and their effects on her. I regularly check in with her, asking about the specific medicine and dosage she's taking and how it's impacting her."

Following the feasibility tests, the NTU-led research team will fine-tune the app by potentially integrating AI and human health coaching to render more timely and personalized support. There are plans to make the app available publicly later this year.

Project Manager Dr. Anita Pienkowska, Research Fellow at NTU's LKC Medicine, said, "The team's focus is on crafting a WellFeet user experience for caregivers and patients that is not only visually engaging but also intuitively functional. Above all, it is to deliver evidence-based foot care education for real-life behavior change."

"Before rolling out the app by mid-2024, we are meticulously refining the app, ensuring it aligns seamlessly with the needs of our users. Our goal is to create an accessible, user-friendly platform that prioritizes the well-being of patients in Singapore."

Dr. Liew added, "It's very satisfying to see that we can have a real impact on people's lives and that we can strengthen health care providers' efforts in preventing and managing DFUs. WellFeet, serving as an extension of high-quality diabetes care in Singapore, is a great addition to the support provided to people living with diabetes. Even small changes in daily routines matter."

Assoc Prof Ho added, "As we step into the future, WellFeet is committed to broadening its impact by expanding its reach. Our vision includes collaborating with the MOH Office for Health care Transformation and discussions with potential investors, ensuring that our innovative app continues to be at the forefront of fostering positive health outcomes for even more individuals and communities."

Provided by Nanyang Technological University

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