

Diabetic Foot Screening Guidelines and the Role of Artificial Intelligence: Time to Turn the Tide!

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Cynthia Formosa, PhD^{1,2} , Nachiappan Chockalingam, PhD^{1,2} ,
Nikolaos Papanas, MD, PhD³ , and Alfred Gatt, PhD^{1,2} 

Abstract

Despite medical and technological advancements, foot amputations continue to rise. Thus, the effort of diabetic foot management should be toward prevention and early diagnosis. Healthcare professionals need to be trained, equipped, and supported with adequate resources to be able to identify and deliver appropriate foot care. Every effort should be made to minimize the impact of complications and to ensure prompt access to care for everyone. Artificial intelligence and smart technology could provide a significant opportunity to improve efficiency in diabetes care, which may reduce diabetic foot complications. The possible potential of the new technologies which are emerging together with their current developing applications for diabetic foot care are suggested. A call for immediate change in diabetes foot screening guidelines is imperative to save limbs and lives.

Keywords

artificial intelligence, diabetes, diabetic foot, prevention, medical technology

In 2019, ~537 million people had diabetes mellitus (DM) in the world. Diabetes was also among the 10 leading causes of death in adults, responsible for an estimated 4.2 million deaths worldwide.¹ The impact of this life-long condition on health and well-being is often underestimated, not to mention its substantial economic burden on health budgets—estimated at ~9% of European Union health expenditure in 2019.² Diabetes care is still suboptimal and inconsistent both within and between countries.³ DM-related amputations have not decreased over the past 20 years, notwithstanding substantial advances in medical care and the use of smart technology.¹

The 5-year mortality rate following DM-related amputation is as high as 78%.⁴ It is well known that 85% of amputations are preceded by diabetic foot ulcerations (DFUs) and 75% of the latter are preventable. While this is a positive aspect, this is clearly not being achieved by health systems worldwide, as evidenced by the lack of reduction in amputation rates worldwide.⁴

Recent evidence suggests that within European countries up to 70% of individuals with DM are not aware of having DM complications. With a screening rate of <30%, not even one-third of individuals receive the recommended full annual health check currently,⁵ indicating a substantial lack of utilization of adequate screening procedures and management paths.^{6,7}

This complex and progressive condition requires innovative changes to “turn the tide”: changes in the currently recommended screening and care delivery approaches. We started a critical debate on diabetic foot screening guidelines 8 years ago,³ but the number of amputations is still alarmingly high, implying that current foot screening and management are still ineffective. As was reported then, every 20 s a limb is still lost somewhere in the world due to diabetes. Moreover, every 1.2 s someone develops diabetic foot ulceration, and every 7 s someone dies from diabetes.⁸ The reason for this might be the diverse concepts and guidelines worldwide for screening, diagnosis, and treatment.³ Screening tools commonly proposed in current guidelines do not have enough sensitivity for early risk detection, while novel approaches incorporating digital artificial intelligence (AI) are not yet widely used or proposed.³

¹Faculty of Health Sciences, University of Malta, Msida, Malta

²Centre for Biomechanics and Rehabilitation Technologies, Staffordshire University, Stoke-on-Trent, UK

³Diabetes Centre-Diabetic Foot Clinic, Second Department of Internal Medicine, Democritus University of Thrace, Alexandroupolis, Greece

Corresponding Author:

Cynthia Formosa, Faculty of Health Sciences, University of Malta,

Tal-Qroqq, Msida, MSD 2080, Malta.

Email: Cynthia.formosa@um.edu.mt

Furthermore, once healed, foot ulcerations frequently recur. Hence, current management of DFUs is not effective, clearly demonstrating the need for the implementation of new and effective strategies aimed primarily at prevention of ulceration.⁹

Call for Action

We need to act now without further delay. In 2014, only 4 out of 30 European countries could provide evidence indicating a good level of screening rate, while no country could demonstrate good outcomes for amputation rates in DM.¹⁰ A revolutionary health intervention that improves diabetes foot screening designed to detect and stratify risk early and effectively in individuals with DM is warranted. We need standardized and affordable screening tools and guidelines for early detection, as well as adequate preventative and therapeutic strategies to ameliorate disease burden and improve the quality of life.

Central to this is the need for diabetes to be addressed as a priority by all policymakers at national, European, and global levels. Indeed, despite the many daily challenges and fears that DM imposes,¹¹ subjects can lead long, healthy, and fulfilling lives thanks to appropriate treatments. Targeted foot screening and early action can help save lives. To this purpose, foot screening guidelines need to be more explicit and accurate to facilitate adoption and adherence by all healthcare providers to improve outcomes.

The introduction of AI and Digital Technology in Diabetes Care Guidelines

AI can make advanced inferences based on a large amount of data. The 3 primary objectives for using AI in diabetes care include the recognition of patterns in behaviors and building its own logic, it can help with the early diagnosis of diabetes and its complications and it provides personalized healthcare recommendations.¹²

Innovative digital technologies and AI offer several opportunities for identifying needs and delivering healthcare from prevention and health promotion to curative interventions and self-management. Healthcare systems need to respond to the changing technological environment in which they operate and be well-positioned to obtain and expand on the benefits arising from the opportunities associated with digitalization of society and other innovation horizons. Guidelines need to be reviewed more often as new scientific studies produce newer methodologies and technologies that may open a pathway for innovation in the overall screening and management of this condition.¹³

These innovative methods and technologies need to be included in diabetes screening guidelines to be effective and their adoption in Health Systems is crucial; otherwise,

they would simply remain interesting academic lab-based exercises that would leave no significant impact on patient care. People need to have an open mind to adopt and adapt them to daily clinical practice.

AI and other emerging digital technologies are needed to transition the health sector into accessing innovation. It has been reported that AI could be used to improve several areas of diabetes management including big data and pattern recognition to help speed up diagnostics and treatment delivery and deliver diabetic foot remission.¹³ It has been reported that the utilization of deep machine learning and AI has the potential to identify patients who are at risk of developing future diabetes complications including DFUs which in turn could identify individuals at risk, with the system flagging up any alarming developments in a timely manner so that immediate action can be taken to help avoid further diabetes complications.¹⁴

Although AI and digital technology will never replace the consultant's decision-making and one-to-one consultations,¹³ people should not fear AI-based technology because if used correctly this could offer efficient solutions to complicated cases and help clinicians detect complications at an earlier stage, utilizing more efficient and simpler means for identifying those persons requiring actual immediate care. Although some innovative technologies might be difficult to interpret by healthcare professionals, employing different techniques to make these technologies user-friendly will ensure a wider utilization of these technologies for improved patient care.¹⁵

AI will introduce a paradigm shift in diabetes care from conventional management strategies to building more precise care,¹⁶ as it has already successfully shown with diabetic retinopathy screening programs globally.¹⁷ Furthermore, the combined use of telehealth with the latest technologies and techniques such as additive manufacturing or 3D printing utilized in the design, development, and delivery of many assistive technology products has the potential to have a significant positive socio-economic impact around the world. It can enable access to assistive technology for rural and remote communities allowing access to assistive technology without the need to travel to a hospital/clinic. This will not only result in reduced cost and time for both assistive technology providers and service users, but also support the goal of reducing carbon emissions in healthcare.¹⁸

Recent advancements in digital health technologies, especially AI, could provide a significant opportunity to achieve better efficiency in diabetes care, which may diminish the increase in diabetes-related healthcare expenditures and related diabetes complications. Both AI and emerging technologies have great potential, but require specific work to overcome barriers to implementation by both healthcare professionals and patients alike. It has been suggested that a global digital eye health task force could facilitate coordination of funding, infrastructural development,

and democratization of AI and digital health to drive progress forward in this domain.¹⁹ Furthermore, more research needs to be conducted utilizing AI and smart technology in diabetic foot care to maximize the predictive performance of AI using large amounts of organized data and abundant computational resources with the aim of dramatically improving the predictive accuracy of diabetic foot diagnosis, prevention, and treatment.¹²

Conclusion

The whole ethos of diabetic foot management should be geared toward prevention, earlier diagnosis, and avoiding diabetic foot complications. Healthcare professionals need to be trained, equipped, and supported with adequate resources to be able to identify and deliver appropriate foot care. AI and smart technology could provide a significant opportunity to achieve better efficiency in diabetes care, which may diminish the increase in diabetes-related complications. The possible potential of the new technologies which are emerging together with their current developing applications for diabetic foot care are suggested. Preventing or delaying the onset of diabetes and its complications could translate into huge savings for the healthcare system. A call for immediate action is imperative if we are to save limbs and save lives!

Declaration of Conflicting Interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Nikolaos Papanas has been an advisory board member of TrigoCare International, Abbott, AstraZeneca, Elpen, MSD, Novartis, Novo Nordisk, Sanofi-Aventis, and Takeda; has participated in sponsored studies by Eli Lilly, MSD, Novo Nordisk, Novartis, and Sanofi-Aventis; received honoraria as a speaker for AstraZeneca, Boehringer-Ingelheim, Eli Lilly, Elpen, Galenica, MSD, Mylan, Novartis, Novo Nordisk, Pfizer, Sanofi-Aventis, Takeda, and Vianex; and attended conferences sponsored by TrigoCare International, AstraZeneca, Boehringer-Ingelheim, Eli Lilly, Novartis, Novo Nordisk, Pfizer, and Sanofi-Aventis.

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ORCID iDs

Cynthia Formosa  <https://orcid.org/0000-0002-4251-1621>
 Nachiappan Chockalingam  <https://orcid.org/0000-0002-7072-1271>
 Nikolaos Papanas  <https://orcid.org/0000-0002-7320-785X>
 Alfred Gatt  <https://orcid.org/0000-0002-0489-6479>

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