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Role of the Healico® Wound Care Smartphone Application in Preventing a Foot Amputation in a 65-Year-Old Patient with Diabetes

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Manuscript Preparation E
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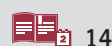
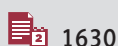
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Patient: Male, 65-year-old
Final Diagnosis: Diabetic foot
Symptoms: Ulceration
Medication: —
Clinical Procedure: —
Specialty: Podiatry

Objective: Management of emergency care**Background:** Healico® is an innovative smartphone application designed to assist healthcare professionals in managing wounds in their daily practice. The application records all clinical information of the wound, facilitating its monitoring, and may lead to the selection of the best treatment for the patient. In addition, the application allows secure data sharing among healthcare professionals.**Case Report:** We report the successful use of Healico® in aiding the avoidance of foot amputation in a 65-year-old patient with diabetes. The patient had a diabetic foot ulcer, the main cause of lower limb amputation in Spain. Amputations negatively impact the quality of life of patients and are an enormous economic burden. The treatment of diabetic foot ulcers requires a multidisciplinary approach with good coordination between healthcare professionals from different fields and between different levels of care (primary care centers, sociosanitary centers, and hospitals). Through the use of Healico®, the patient with severe clinical signs of infection was referred urgently from primary care to the referral hospital and was quickly treated with antibiotics and underwent surgery. As a result, the infection was successfully delimited and excision of the foot was prevented.**Conclusions:** Healico® promoted rapid communication between the primary care center and hospital, enabling urgent referral of the patient to a specialist. This clinical case reports the value that a digital application can bring to the healthcare sector and, in particular, the value of Healico® implementation in the daily practice of healthcare professionals to optimize the management of wounds, such as diabetic foot ulcers.**Keywords:** Diabetes Complications • Diabetic Foot • Mobile Applications • Wound HealingFull-text PDF: <https://www.amjcaserep.com/abstract/index/idArt/936359>

Background

Medical care is increasingly moving toward a holistic, patient-centered approach when appropriate. Digital tools have much to contribute to this progress. This is a report of Healico®, an innovative smartphone application for healthcare professionals aimed at improving wound care.

Healico® takes, organizes, and saves pictures of wounds, in addition to recording all clinical patient-related data. This allows healthcare professionals to visualize the evolution of their patients' wounds and to share the information safely and securely with other members of the wound-care team. Furthermore, Healico® includes a chat feature that allows direct and fast communication in case of an emergency and provides access to a training guide to help healthcare professionals care for patients (Figure 1).

To the best of our knowledge, Healico® is a unique wound-care application that centralizes all wound information in a shared

view among a wound-care team. For that reason, this smartphone application has been awarded the prestigious Prix Galien in France for its scientific innovation and after 9 months, in January 2022, it had already been downloaded by more than 3800 healthcare professionals in France and Germany [1].

In Spain, a pilot trial was recently conducted among 11 healthcare professionals from 6 primary care centers, 2 hospitals, and 2 sociosanitary centers. After downloading the application, the healthcare professionals received training on how to use Healico® and began to record information on their patients' wounds.

Among the recorded wounds was a diabetic foot ulcer (Figure 2), one of the most serious complications of patients with diabetes and the main cause of lower limb amputation [2]. In Spain, there are more than 5 million people with diabetes, and it is estimated that 20% will have amputation if it is not prevented in time [3,4]. Research has shown that up to 85%

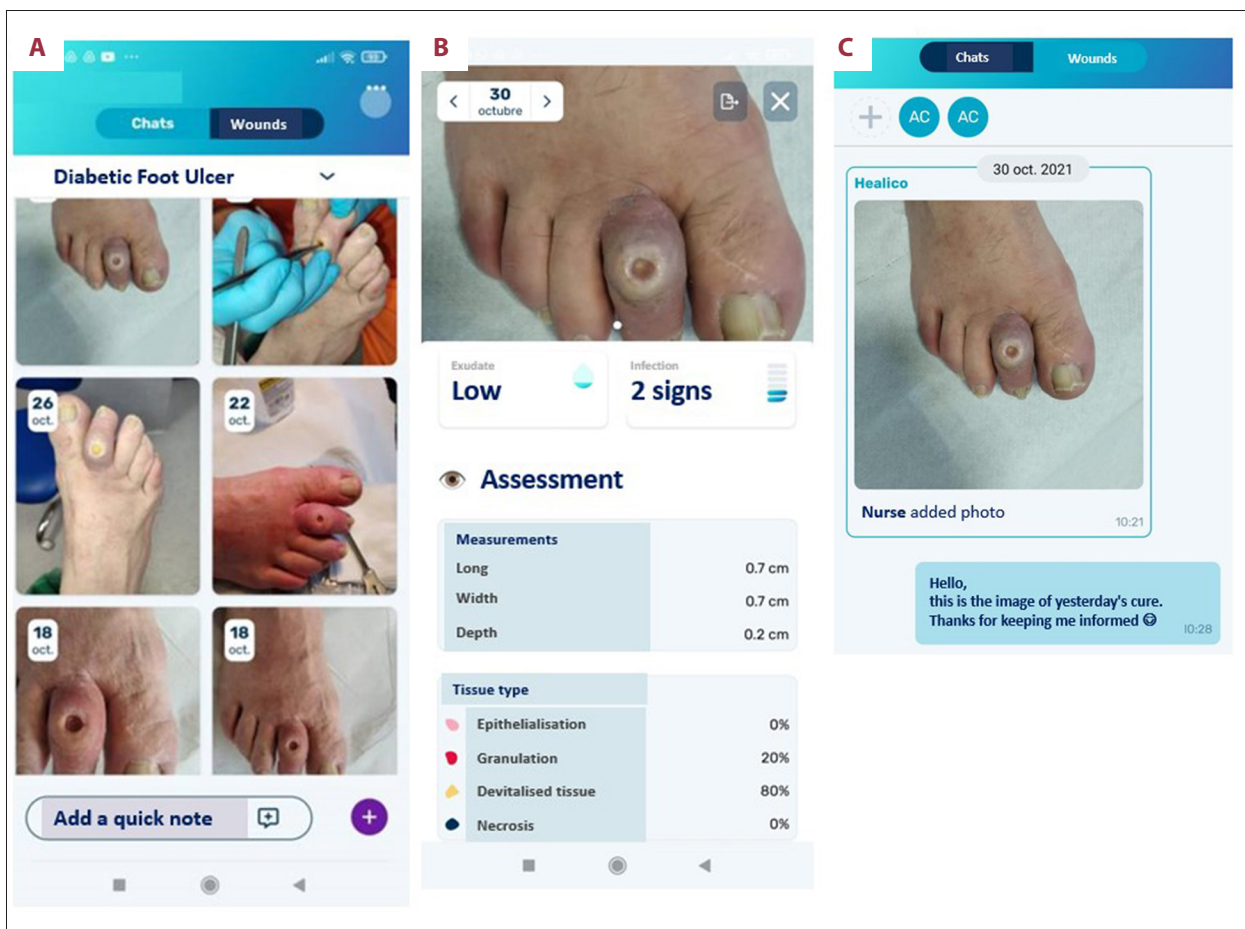


Figure 1. Healico® interface. (A) Dashboard of Healico® with images of different states of the same wound. By selecting 1 of the pictures, all the clinical data of the wound appears. (B) Dashboard with the clinical information of the wound: level of exudate, signs of infection, measures, and type of tissue, among other data. (C) Chat of the wound-care team. In this case, a nurse sent a picture of a patient's ulcer after the cure to the podiatrist to inform her about the patient wound evolution.



Figure 2. Clinical case of a 65-year-old patient with diabetes. (A) Baseline photograph of the patient's diabetic foot ulcer with signs of infections (day 1). (B) Image of the patient's ulcer when cured with ammonium polyacrylate polyabsorbent fibers and technology of lipid-colloidal and silver salts in the health center (day 4). (C) Photograph of the patient's ulcer after being cured in the hospital (day 8). (D) Evolution of the patient's ulcer (day 12). (E) Image of the ulcer before surgery (day 16). (F) Photograph of the arthroplasty surgery of the toe with tenotomy (day 18). (G) Image of the ulcer after the surgery (day 21). (H) Image of the healed ulcer (day 43).

of lower extremity amputations of diabetic feet are preventable [5]. However, when a diabetic foot ulcer is referred late for expert assessment, it is more likely to result in an amputation [6]. Furthermore, from an economic perspective, it is estimated that managing 1 diabetic foot ulcer could range between \$13 561 USD (management of a diabetic foot ulcer) to \$45 000 USD (if it ends in an amputation) [7]. Therefore, diabetic foot ulcers negatively impact the health of patients and lead to an economic burden for society [8].

Successful treatment of diabetic foot ulcers involves ensuring sufficient blood supply, controlling blood glucose levels, offloading device implementation, guaranteeing adequate local care, and managing local and systemic infection [9]. Therefore, a multidisciplinary approach is required in which good coordination between healthcare professionals from different disciplines (eg, medical specialists, nurses, and podiatrists) is the cornerstone.

On the other hand, the primary point of contact for diabetic foot ulcer's patients is the health center; thus, it is essential

that patients at higher risk are referred urgently to the hospital to avoid an amputation. For this reason, an effective coordination between the different levels of care (primary care center and hospitals) is mandatory [10].

Case Report

Consultation, Day 1

A 65-year-old man with diabetes and poor adherence to general treatment went for consultation. The patient presented a diabetic foot ulcer on the second toe of the right foot, which had been present for 3 weeks. The pedal and posterior tibial pulses were palpated. The ulcer had clinical signs of infection (warmth, redness, swelling, and pain), a size of 1.5×1.5×2 cm, and a sloughy tissue covering 20% of the wound bed tissue. A probe-to-bone test was positive, suggesting bone infection [11]. If not treated adequately, bone infections in people with diabetes can be associated with poor outcomes, such as

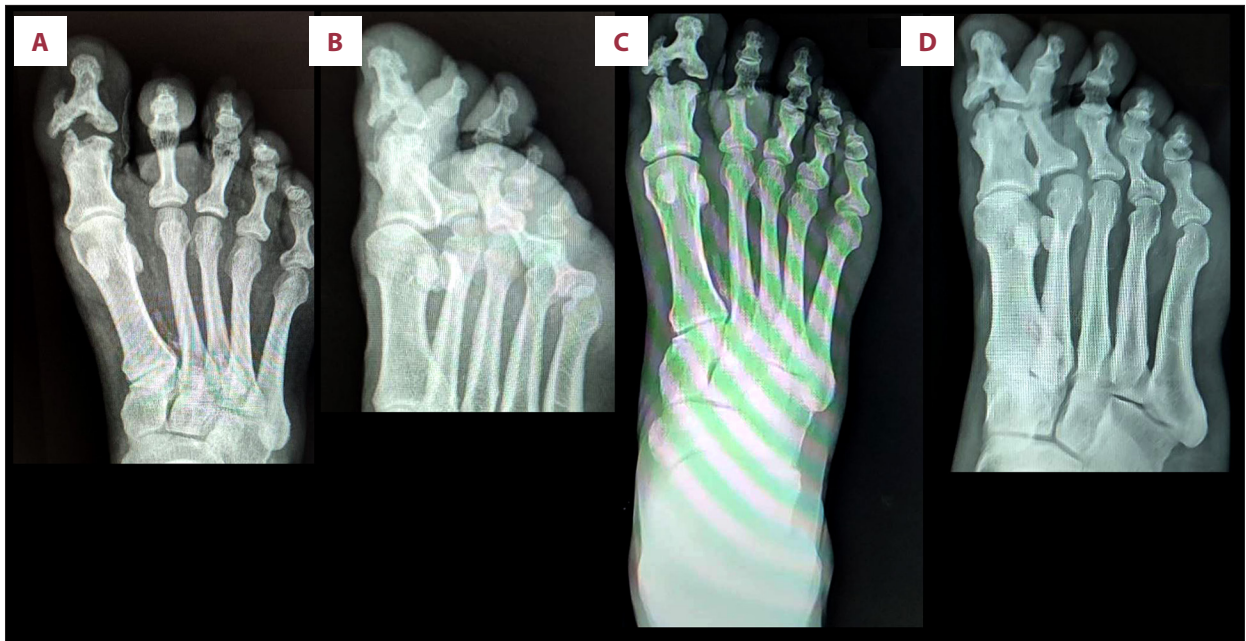


Figure 3. Plain X-ray radiographs. (A) Preoperative frontal plane radiograph. (B) Preoperative dorsal plane radiograph. (C) Postoperative frontal plane radiograph. (D) Postoperative dorsal plane radiograph.

lower limb amputations, in patients with feet at high risk. This occurs mainly when the patient presents with diabetic neuropathy, rigid deformity, history of repeated ulceration in the same location, poor metabolic control, and poor adherence to treatment, including adequate footwear, metabolic control, and preventive care [11,12].

An antimicrobial dressing with ammonium polyacrylate poly-absorbent fibers and technology of lipid-colloidal and silver salts was then applied. The community doctor prescribed oral antibiotics (ciprofloxacin 500 mg every 12 h for 7 days), and the patient was referred urgently to the Diabetic Foot Unit-Vascular Surgeon Service at the Ramón y Cajal Teaching Hospital. Through the Healico® application, the community nurse contacted the podiatrist specializing in diabetic feet in the hospital unit to alert her to the seriousness of the patient's situation and to avoid amputation of the toe. Since then, the patient was treated at the hospital, but follow-up wound care was performed at the primary care center.

Furthermore, the nurse explained the severity of the situation to the patient to make him aware of the importance of treatment adherence.

Day 2

The patient was seen by the vascular surgeon and podiatrist. A vascular and neurological exploration was performed. The patient had an ankle-brachial pressure index of 1.5, a pressure digital-brachial index of 0.6, a transcutaneous oxygen

pressure of 45 mm Hg, and all palpated pulses at the clinical examination.

In the neurological examination, the patient was positive to the Semmes-Weinstein monofilament and tuning fork tests. Anatomically, the patient's foot presented a claw toe, which might have been the cause of the ulcer development together with inappropriate footwear. Radiographs were requested to confirm osteomyelitis, and the patient was referred to the endocrinologist.

Day 4

The patient's glycosylated hemoglobin level was 8.5%, indicating poor diabetes control. The patient was seen by the endocrinologist to adjust his treatment in order to regulate the blood glucose levels.

Day 8

Plain radiographs were taken (Figure 3). Joint dislocation with osteopenia, loss of trabecular architecture, and signs of disruption of the cortex at the medial level of the head proximal phalanx were seen [13]. A positive probe-to-bone test and simple radiography confirmed the presence of osteomyelitis [14].

The presence of osteomyelitis and the claw toe structure required early surgical intervention. Thus, a preoperative appointment was requested. Furthermore, the podiatrist recommended the patient wear an orthopedic boot. The nurse and the podiatrist kept in contact through Healico®. They sent

photographs of the wound care and continued to inform one another of the patient's condition.

Day 9

A tendon tissue culture sample was biopsied.

Day 11

The culture was positive for *Staphylococcus aureus* and sensitive to ciprofloxacin. An antibiogram was performed and systemic antibiotics were maintained (ciprofloxacin 500 mg every 12 h until 1 week after surgery).

Day 19

The patient underwent surgery for arthroplasty of the toe with tenotomy.

Day 36

The wound was healed and the patient was discharged. He was prescribed compensatory silicone and footwear therapy. The patient was included in the risk-control system to be supervised regularly. Furthermore, the patient began taking his diabetes more seriously. He began wearing an interstitial glucose monitoring sensor and adhering to his treatment.

Discussion

The fast communication between the primary care and hospital staff through the Healico® application facilitated the early attention of the patient. Within 48 h, the patient was referred to the hospital, enabling the diagnosis of a bone infection and a surgical intervention, which was scheduled in a short period of time (18 days from clinical diagnosis of the osteomyelitis). The infectious process was resolved with an adapted systemic treatment in less than 2 weeks, saving the foot anatomical structure.

This clinical case demonstrates that the Healico® application could be very useful for communication between professionals in different healthcare settings. In addition, this application may be particularly helpful in the prevention of foot ulcer complications in the diabetic patient at risk, because it facilitates early action in the case of an adverse event. The prevention of an amputation positively impacts the quality of life of the patient and will reduce healthcare costs.

A limitation of the introduction of Healico® could be its integration in current healthcare systems. Furthermore, digital

applications also require training for non-digitally native healthcare professionals to be more comfortable with the technology. However, we believe that the benefits outweigh the possible difficulties. Indeed, Healico's® interface is very intuitive; the professionals from the advisory board (n=11) rated their level of satisfaction with the application as 9.1 out of 10.

The widespread adoption of Healico® should be accompanied by further research on larger populations to demonstrate its effectiveness in preventing amputations and managing other complex wounds.

The use of digital applications could also help the remote assistance of patients. Although Healico® is currently not available for patients, it would be interesting to explore its use for telemedicine, which has been shown to be particularly beneficial during the COVID-19 pandemic, when face-to-face assistance was reduced. Decreasing the burden of healthcare professionals and increasing the comfort and convenience for patients could be some of the advantages of Healico®.

Lastly, this clinical case also highlighted the importance of having an inclusive dialogue with the patient. Our patient was more involved in his care and was encouraged to adhere to treatment, ultimately improving his health condition. Healico® could be an effective tool to promote this patient-centered approach in wound healing.

Conclusions

We reported a successful management of a diabetic foot ulcer using the Healico® smartphone application. Healico® records all clinical data of a wound, securely facilitating healthcare professionals' complex wound monitoring and data sharing within the wound-care team.

In the present case, Healico® promoted rapid communication between the primary care center and hospital, enabling the urgent referral of the patient to a specialist, and, as a result, a foot amputation was prevented. Moreover, the patient became more aware of the importance of treatment adherence and caring about his health condition. Implementation of this innovative application could set a precedent in the management of complex wounds, such as diabetic foot ulcers.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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