INDO AMERICAN JOURNAL OF PHARMACEUTICAL RESEARCH

ROLE OF ARTIFICIAL INTELLIGENCE IN DIABETIC WOUND CARE AND MANAGEMENT: A REVIEW

N.V.L. Suvarchala Reddy V, M. Ganga Raju, P. Saritha, D. Krishnaveni, N. Maheshwari

Department of Pharmacology, Gokaraju Rangaraju college of Pharmacy, Bachupally, 500090, Hyderabad, India

ARTICLE INFO

Article history

Received: 01.06.2025

Available online: 27.06.2025

Keywords

Artificial Intelligence,
Diabetes,
Wound healing,
Diabetic wounds,
Diabetic foot ulcers.

ABSTRACT

Diabetic wounds, particularly diabetic foot ulcers, are among the most debilitating complications of diabetes mellitus, often leading to chronic infection, poor quality of life, and even limb amputation. The wound healing process in diabetic individuals is profoundly impaired due to prolonged hyperglycaemia, vascular insufficiency, neuropathy, and an altered immune response. These factors contribute to delayed healing, increased risk of infection, and elevated healthcare costs. Recent advances in Artificial Intelligence (AI) have introduced novel opportunities to address the multifaceted challenges of diabetic wound care. AI-powered tools can facilitate early detection, wound classification, risk stratification, personalized treatment planning, and continuous remote monitoring. Technologies such as deep learning, computer vision, and predictive modelling are being integrated into smartphone apps, wearable devices, and clinical decision support systems to enhance both diagnosis and therapeutic outcomes. Despite promising progress, limitations including data quality, algorithm transparency, and clinical validation remain significant barriers. This review explores the pathophysiology of diabetic wound healing, the clinical complications, and the emerging role of AI in revolutionizing wound care, while highlighting current limitations and future directions for research and implementation.

Corresponding author

Dr. N V L Suvarchala Reddy V

Professor and Head,
Department of Pharmacology,
GRCP, Hyderabad, Telangana State.
E-mail: suvarchala8018@grcp.ac.in

*Please cite this article in press as **N V L Suvarchala Reddy V** et al. Role of Artificial Intelligence In Diabetic Wound Care and Management: A Review. Indo American Journal of Pharmaceutical Research.2025:15(06).*

Introduction

Diabetes mellitus is a metabolic complaint that's characterized by hyperglycemia associated with differences in carbohydrate, protein, and fat metabolism[1]. According to the International Diabetes Federation(IDF) Diabetes Atlas(2024), Number of people with diabetes in world is over 8.1 billion living with diabetes worldwide and it's estimated to 9.7 billion by 2050[2].

Hyperglycemia, a physiologically aberrant state typified by persistently high blood glucose levels, is a hallmark of diabetes mellitus, also referred to as diabetes[3]. The vasculature of the organ systems is disrupted structurally and functionally by hyperglycemia, which results in micro and macro vascular problems[4]**.** Impaired wound healing is one of the complications associated with diabetes. Chronic inflammation, hypoxia, autonomic and sensory neuropathy, micro and macro circulatory dysfunction, hyperglycemia, and compromised neuropeptide signaling all contribute to delayed wound healing.[5]. Wounds are unavoidable in life and can result from physical, chemical, or microbial factors. Wound healing is a complex process involving various cells, cytokine mediators, and the extracellular matrix, progressing through distinct yet overlapping stages: hemostasis, inflammation, proliferation and remodeling. This creates a continuous healing process. For effective healing, the damaged tissue requires a sufficient supply of blood and nutrients[6].

Importance of Wound healing

Diabetic ulcers can result in the following outcomes if they are not managed and treated.

1. **Infection:** Patients with diabetes have weakened immune systems, which makes ulcers more susceptible to infection and slows down the healing process. Severe infections pose a hazard to the body's health because they can spread to nearby tissues and bones.
[7][8].
2. **Deep tissue damage:** Due to neuropathy and circulation concerns, diabetic ulcers typically develop in the foot and can harm the deep tissues, including muscles, ligaments, and bones[9]. Joint stiffness, muscular weakness, and even fractures may result from this[10].
3. **Chronic pain:** Persistent discomfort from diabetic ulcers may impair a patient's everyday activities and quality of life. Emotional and mental health can be negatively impacted by chronic pain[11][12][13].

Pathophysiology of Wound Healing in Diabetes

Haemostasis : Haemostasis begins with exudate components like clotting factors. Fibrinogen in the exudate triggers the clotting process, leading to the coagulation of the exudate (blood lacking cells and platelets). This, along with the creation of a fibrin network, forms a clot in the wound, halting bleeding. The clot then dries into a scab, offering strength and support to the damaged tissue[14].

Inflammation: Inflammation manifests clinically as redness, heat, swelling, discomfort, and loss of function. Blood clotting is started by vasoconstriction and platelet aggregation, which are followed by vasodilation and phagocytosis to increase inflammation at the wound site[15].

Proliferation: The proliferative phase occurs nearly contemporaneously or just after the migration phase and rudimentary cell proliferation, which lasts for between 2 and 3 days. Granulation towel is formed by the in-growth of capillaries and lymphatic vessels into the crack and collagen is synthesised by fibroblasts giving the skin strength and form[16].

Remodelling phase: This phase involves the conformation of cellular connective towel and strengthening of the new epithelium which determines the nature of the final scar. Cellular grainy towel is changed to an acellular mass from several months up to about 2 years[17][18].

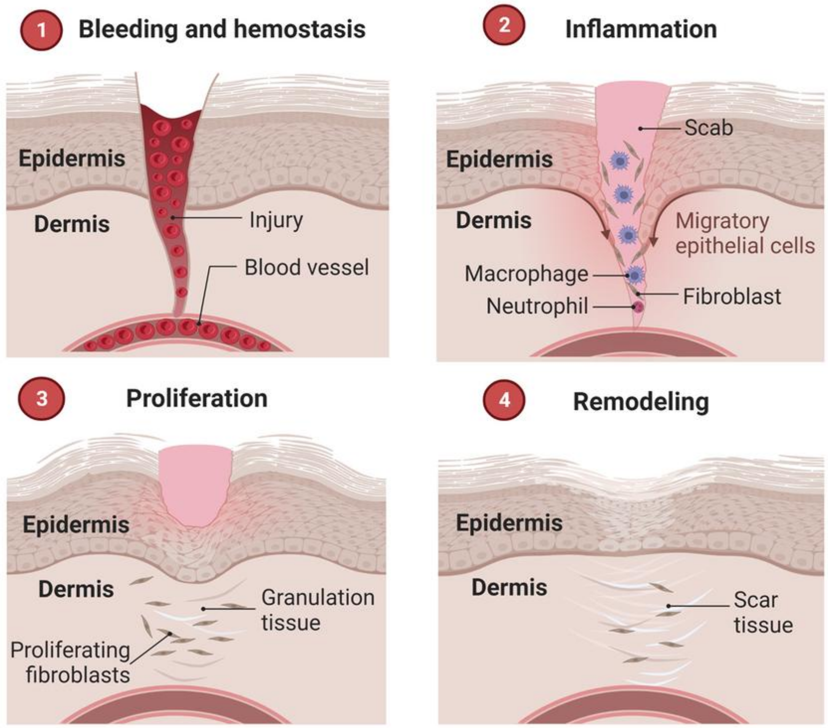

Figure 1 : Phases of wound healing Stages of the wound healing cascade. Created by using BioRender.com. | Download Scientific Diagram [19]

Diabetes-related poor wound healing is typified by disturbances in several phases of the typical healing process. The key pathophysiological changes include:

1. **Impaired Inflammatory Response:** Diabetes delays the recruitment of immune cells such as neutrophils and macrophages by altering the usual inflammatory cascade. This hinders the removal of bacteria and lowers the production of pro-inflammatory cytokines, which are necessary to start the healing process[20].
2. **Endothelial Dysfunction and Reduced Angiogenesis:** Damage to endothelial cells brought on by hyperglycemia impairs vasodilation and lowers nitric oxide production. This reduces the amount of blood that reaches the wound site, which limits the availability of nutrients and oxygen needed for tissue regeneration[21].
3. **Oxidative Stress and Increased Reactive Oxygen Species (ROS):** Oxidative stress brought on by high glucose damages cells and slows down the healing process. The production of extracellular matrix (ECM) and fibroblast proliferation are further hampered by ROS buildup[22].
4. **Altered Growth Factor Expression:** Important growth factors that are essential for cell migration, proliferation, and extracellular matrix deposition, including vascular endothelial growth factor (VEGF), transforming growth factor-beta (TGF-β), and platelet-derived growth factor (PDGF), are expressed less frequently in people with diabetes[23].
5. **Delayed Collagen Synthesis and ECM Remodeling:** Reduced collagen production as a result of impaired fibroblast function jeopardizes the structural integrity of newly created tissue. ECM remodeling is further delayed by the disruption of the equilibrium between matrix metalloproteinases (MMPs) and tissue inhibitors of metalloproteinases (TIMPs)[24].

6. **Neuropathy and Impaired Sensory Perception:** Because diabetic neuropathy impairs pain perception, there is a greater chance of invisible injuries turning into chronic wounds[25].

Common Types of Diabetic Wounds

Diabetic Foot Ulcers (DFUs)

Patients with diabetic foot ulcers are classified as neuropathic if they have peripheral neuropathy, ischemic if they have PAD but no peripheral neuropathy, and neuroischemic if they have both microvascular disease and peripheral neuropathy[26]. The potential complications associated with DFU encompass the necessity of amputation due to gangrene and infection [27].

Ischemic Ulcers

Insufficient blood flow results in local ischemia in the skin and underlying tissues, which leads to ischemic ulcers. If treatment is not received, these ulcers, which frequently begin at the fingertips, can develop into blue discolouration, necrosis, or gangrene and increase the risk of amputation[28].

Arterial Ulcers

Patients with diabetes are more susceptible to arterial ulcers, which produce excruciating pain due to inadequate blood flow into the peripheral blood arteries. The transport of oxygen and vital nutrients to the tissues is diminished by inadequate blood circulation, which has negative consequences and ultimately results in cellular death, also known as necrosis[29].

Neuropathic Ulcers

Ulcers that are neuropathic, a physiological process that results in diminished sensory function, motor weakness, and loss of autonomic function, is the cause of these ulcers[30]. Approximately 8.2% of diabetic patients are affected by neuropathic ulcers and commonly experience a loss of peripheral sensation[31].

Neuroischemic Ulcers

People who have peripheral neuropathy and ischemia from PAD develop neuroischemic foot ulcers[32]. Individuals with neuroischemic ulcers were less likely to feel pain and more likely to cite external triggers for their ulcers than individuals with ischemic ulcers[33].

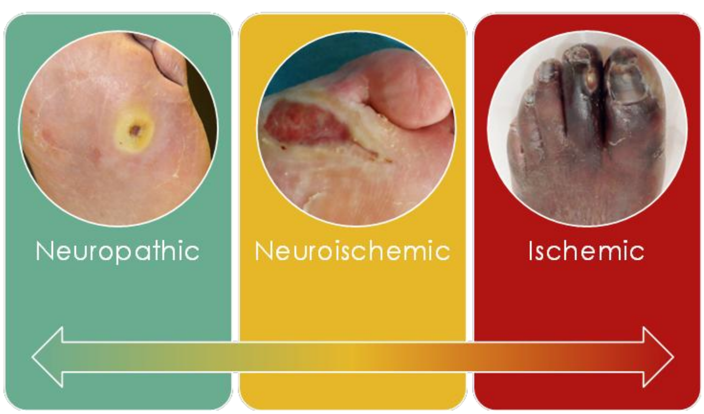

Figure 2 : Diabetic wounds

Foot Ulcers: Spectrum of Ischemia | Michael Cumming, MD, MBA [34]

ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Artificial intelligence is a field of computer science focused on creating systems or models that can analyze data and manage complex tasks across various applications[35]. Diabetes wounds have been prevented, diagnosed, and treated by computer technology. Recent technology advancements in healthcare have been mostly driven by AI approaches, computer vision and digital image analysis methodologies, machine learning, and deep learning[36]. Better prognoses, preventative measures, and more individualized care have all been made possible by AI[37].

A convolutional neural network and super pixel segmentation are two deep learning technologies that have been developed to classify pressure and diabetic wound photos more accurately than previously possible[38][39]. One model, called "Alexnet architecture," achieved 99% specificity, 99% sensitivity, and 99% accuracy[40]. Such high numbers are required to track the healing process. Mohammed et al. saved around two minutes on each wound evaluation by using an AI digital application to take high-quality wound photos and determine the surface area of the wound more quickly than clinic employees using a conventional digital camera[41].

Digital support for diabetes care has been developed through the use of machine learning and deep learning techniques. These include of k-nearest neighbor, decision trees, random forests, naïve Bayes, support vector machines, artificial neural networks, and classification and regression trees[42].

Figure 3: Advantages of AI

AI AND DIABETIC WOUND DIAGNOSIS

Diabetic wound detection is a time-consuming task that calls for specialized knowledge and abilities. However, not every part of the world has access to this expertise. Telemedicine and computer-aided technologies can enhance medical facilities in these isolated locations[36].

Treatment times for diabetic issues can be shortened by early detection. Additionally, it can lessen the likelihood of morbidity and imputation. Delays in diagnosing diabetic ulcers may result from a lack of medical knowledge and other resource limitations. Infrared thermography is mostly used in computer-aided diagnosis (CAD) to identify ulcers in diabetic patients. It displays the plantar foot's temperature distribution. The meaning of thermographs and the state of a patient's wounds is complicated. Data mining, machine learning, and deep learning techniques can be used to examine and evaluate these trends. CAD systems have been shown to be highly successful in identifying areas that are prone to ulcers[36].

AI IN WOUND MANAGEMENT

Many Smartphone applications (apps) have been designed to facilitate wound monitoring at home, where most wound management happens. These applications accurately diagnose and evaluate chronic wounds by using factorization-based segmentation, removing background "noise," and automatically calibrating color and measurement in images of wound tissue[43][44]. Additionally, one app can identify the oxygenation of wounds' underlying tissue. Early detection of these issues may help stop future worsening, as poor wound oxygenation can delay recovery[45].

Recent developments in AI have led to innovative approaches in promoting wound healing, such as the creation of an AI-powered bandage. Kalasin and colleagues designed a smart bandage that integrates a flexible sensor and a deep neural network algorithm. This bandage includes MXene, a graphene-like, two-dimensional transition metal compound that boosts conductivity and sensing abilities. The dressing is made from a poly(vinyl acrylic) gel blended with polyaniline, which reacts to the pH level of the wound. As the wound's pH changes, the dressing produces a voltage signal that reflects different healing stages. The deep learning model interprets this signal to determine the wound's healing phase with 95% accuracy, enabling healthcare providers to make more informed treatment decisions[46].

AI IN WOUND PROGNOSIS

Chronic wounds are difficult to heal because of various interconnected factors such as weakened immunity, poor blood flow, and ongoing inflammation, often leading to poor outcomes. Making accurate predictions about healing requires extensive data collection, and researchers have turned to AI for help. Topaz and colleagues created a natural language processing tool that extracts detailed wound-related information from unstructured clinical notes, enabling the collection of thorough data on comorbid conditions, risk factors, and root causes of wounds[47]. AI’s powerful data extraction capabilities make it useful for predicting outcomes and recovery prospects. Robnik-Sikonja and colleagues applied machine learning to examine how various factors related to the wound, the patient, and the treatment impact the rate of wound healing[48]. Ngo and colleagues explored the use of machine learning to analyze texture patterns in thermal images of venous leg ulcers to forecast delayed healing. Using a Bayesian neural network, they reached a sensitivity of 79% and a specificity of 60%. While the model showed moderate sensitivity, its lower specificity means healthcare providers must still confirm results carefully to prevent unnecessary treatments caused by false positives[49].

As AI-powered tools like smart mattresses and bandages are developed, the fair distribution of resources becomes increasingly important. Guided by the ethical principle of justice, resource allocation often focuses on patients in the most critical condition or those most likely to benefit and avoid severe outcomes. While many studies have focused on predicting wound healing, AI also holds potential in forecasting wound occurrence. For example, Alberden and colleagues developed a machine learning model to predict the risk of pressure ulcers in surgical critical care patients[50].

AI-DRIVEN PERSONALIZED TREATMENT IN DIABETIC WOUND CARE

The use of artificial intelligence in creating individualized treatment programs for diabetic wounds, especially diabetic foot ulcers (DFUs), is growing. AI systems can customize interventions to meet the needs of each patient by incorporating patient-specific data, improving healing outcomes and lowering complications.

1. Predictive Analytics for Risk Stratification

In order to forecast healing trajectories and possible problems, AI models examine clinical data, including wound dimensions, tissue types, infection signs, and patient comorbidities. This makes it possible for doctors to proactively modify treatment programs and identify high-risk individuals[51].

2. Integration with Wearable Technologies

Through the tracking of variables including plantar pressure, temperature, and mobility, wearable technology contributes to real-time foot health monitoring. By offering early warnings of possible problems, these devices enable prompt treatments and enhance patient outcomes in the prevention of DFU[52][53].

3. AI-Powered Wound Dressing Development

A paradigm shift in wound care, the incorporation of AI into wound dressing development radically changes how dressings are created, evaluated, and optimized. The capacity to establish a closed-loop feedback system that combines computer simulations, real-world clinical data, and laboratory studies is one of the biggest benefits of AI-powered clothing development[54].

AI ASSISTED WOUND HEALING PRODUCTS

PETAL: Battery-Free AI-Enabled Sensor Patch

Together, the Institute of Materials Research and Engineering (IMRE) at A*STAR and the National University of Singapore (NUS) have developed a novel technique that enhances wound care and management by offering a quick, easy, and efficient way to track wound healing[55]. Among other biomarkers, the PETAL (Paper-like Battery-free in situ AI-enabled Multiplexed) sensor patch measures the wound's temperature, moisture content, pH, trim ethylamine, and uric acid levels. These indicators were carefully chosen to assess inflammation, infection, and the condition of the wound environment[55].

Smart Bandages with AI-Integrated Sensors

Smart wound dressings that use AI and sensor technologies for ongoing monitoring have been developed as a result of recent developments. AI algorithms that forecast and optimize tissue regeneration paths can use the real-time data from these dressings' ability to detect a variety of wound factors, including temperature, moisture, and biochemical markers[56].

AI-Powered Mobile Applications for Wound Assessment

AI is used by Smartphone apps such as CARES4WOUNDS to evaluate wound properties, such as tissue classification, size, and depth data. These applications improve the precision and effectiveness of wound care by forecasting the risk of infection and suggesting treatment strategies[57][58].

3D Bio-Printable Patches

Biomaterials and 3D printing are opening door to creative regenerative medicine solutions[59]. Debridement, or the surgical removal of damaged tissue, is typically the next step in treating skin wounds like DFU. The production of 3D patches needs to be completed as soon as possible to avoid contaminating debrided wounds[60]. AI systems can create customized bio-printable patches to treat diabetic foot ulcers by using 2D photos to create 3D wound models.

CLINICAL APPLICATIONS AND CASE STUDIES OF AI IN DIABETIC WOUND HEALING

KroniKare : AI-Driven Wound Assessment System

An AI-based tool called KroniKare was created in Singapore to automate the evaluation and treatment of chronic wounds. By analyzing wound photos using computer vision and semantic segmentation, it drastically cuts the assessment time from thirty minutes to about thirty seconds. Clinical studies conducted at facilities such as Changi General Hospital and St. Andrew's Community Hospital showed enhanced wound monitoring and early problem detection[61].

CARES4WOUNDS (C4W): Mobile AI Tool for DFU Monitoring

AI is used in the C4W application to help with wound measuring and imaging. The app showed strong intra-rater reliability (0.933–0.994) across several devices in a study with 28 DFU patients. The equipment worked well for regular wound monitoring, despite its limits in determining wound depth[58].

DFUC are: Smartphone-Based DFU Monitoring Platform

Using smart phone photos, DFU Care is a deep learning-based technology that automatically detects, classifies, and tracks DFUs. It incorporates models such as InceptionResNetV2 for infection and ischemia classification and YOLOv5s for wound location[62]. Its clinical value for remote wound monitoring was supported by a pilot research conducted at the Postgraduate Institute of Medical Education and Research in India, which demonstrated strong agreement with physician assessments[63].

3D Bio-Printable Patches for Diabetic Foot Ulcers

An actual clinical trial at the Catholic University of Korea's Eunpyeong St. Mary's Hospital in Seoul, Korea, using a case study to illustrate the efficacy of AiD Regen (IRB PC21EOSE007). The patient had Type 2 diabetes and was a 67-year-old lady. Using a 3D bio-printer called Dr. Invivo, the doctor created a 3D patch model using AiD Regen and manufactured an MA-ECM patch. The patch produced by AiD Regen was 9797% the same size as the one made by a professional using a CAD modeling tool, 96% of the patient's wound was closed within 34 days following therapy, indicating a significant healing of the wound[58].

Case Study: Smartphone App for Chronic Foot Ulcer Management

A patient-facing smartphone application helped a 57-year-old man with type 1 diabetes and a chronic foot ulcer effectively manage his conditions. Remote monitoring was made possible by the app, which led to better healing results and prompt treatments[64].

CHALLENGES WITH AI IN WOUND CARE

Despite its promise to greatly improve wound care, artificial intelligence presents a number of difficulties. Transparency and documentation, risk management, data validation with clear indications of intended use, ensuring unbiased and quality data, protecting privacy and data security, and encouraging cooperation among regulatory bodies to secure safe usage of AI are the six difficult but essential regulatory areas listed by the World Health Organization for the thoughtful application of AI in health[65].

LIMITATIONS

LIMITATIONS OF ARTIFICIAL INTELLIGENCE

The application of AI in diabetes care has several limitations.

Human factors

Some research have assessed the factors impacting the usage of AI in the treatment of diabetes. Younger individuals were found to benefit more from mobile apps for diabetes treatment in a meta-analysis of 14 randomized control studies, and the impact size was increased with input from medical professionals[66]. AI has the potential to de-skill doctors by generating dependency. This could create a vicious loop of insufficient precision because AI itself needs to be improved on a regular basis by professionals[67].

Technical factors

Cost, implementation, and accessibility are obstacles to the application of AI in diabetes care. Interoperability is cited as a frequent possible obstacle to the use of increasingly diverse devices and apps in the management of diabetes[68].

Limitations of data

One of the most frequent problems in diabetes management is the lack of supporting data needed to create precise and logical algorithms. For digital applications to create effective solutions, data sets will need to be increasingly developed and organized. Regulations, security, and data protection issues are also impeding the smooth integration of technology in diabetes care[69].

Limitations of design

Retrospective data sets have been used to validate current AI models and applications in the treatment of diabetes. There is potential for automating diabetes management if these technological advancements are validated prospectively[67].

FUTURE DIRECTIONS FOR AI IN WOUND HEALING

Personalized care paths could be developed by AI-powered decision support systems utilizing patient-specific information such as age, comorbidities, wound kind, and healing status. Precision wound care may be made possible by the integration of lifestyle, proteomic, and genetic data. Amputation risk, infection risk, and wound healing times can all be predicted using machine learning algorithms. Early warning systems can identify wounds that are not healing or recommend preventative measures.

AI-enabled biosensors and smart dressings can continuously check pH, moisture content, temperature, and infection biomarkers. Real-time feedback loops could improve healing outcomes by dynamically adjusting treatment. In distant or resource-constrained environments, smartphone apps that use AI-enhanced wound imaging can increase access to wound treatment. Patients can submit photographs of their wounds to clinics via asynchronous monitoring devices, which cuts down on in-person visits. The accuracy of diagnosis and decision-making can be improved by merging imaging data, lab results, clinical notes, and patient-reported symptoms through a single AI model. The kind and quantity of bacteria present in the lesion frequently affects how quickly the wound heals. More precise evaluations of healing may be made possible by research into using AI to the analysis of bacteriology, periwound regions, and wound exudates[70].

Asynchronous learning and the establishment of global wound databases can enable AI models to learn from dispersed datasets without violating patient privacy. Clinicians may be able to visually evaluate various therapies and simulate wound progression thanks to advanced imaging and AI-driven 3D modeling. Future developments could include AI-powered robots that aid with wound care, changing dressings, administering treatments, or independently monitoring recovery.

CONCLUSION

With its promising breakthroughs in early identification, individualized treatment planning, remote monitoring, and predictive analytics, artificial intelligence has the potential to revolutionize the field of diabetic wound care.

By harnessing diverse data sources ranging from clinical imaging to wearable biosensors AI-driven solutions can enhance diagnostic accuracy, reduce healing time, and minimize the risk of complications such as infections or amputations. However, despite these advancements, several challenges remain, including data standardization, model generalizability, and regulatory hurdles. The key to incorporating AI smoothly into standard wound care procedures will be addressing these limits by strong clinical validation, moral AI implementation, and interdisciplinary co-operation. With continued innovation and refinement, AI has the potential to significantly improve outcomes and quality of life for individuals suffering from diabetic wounds.

Acknowledgements
The authors are grateful to the Principal Prof. M. Ganga Raju and Management of the Gokaraju Rangaraju College of Pharmacy, for the constant support and encouragement during the course of the work.

References

1. Lowell Dilworth, Aldeam Facey and Felix Omoruyi, Diabetes Mellitus and Its Metabolic Complications: The Role of Adipose Tissues, international journal of molecular sciences, 2021, 22, 7644.
2. IDF Diabetes Atlas 11th Edition – 2025, page no-43, IDF Diabetes Atlas Global Diabetes Data & Statistics
3. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2014;37:S81-90.
4. American Diabetes Association. Microvascular complications and foot care: Standards of medical care in diabetes—2018. Diabetes Care 2018;41:S105-18.
5. Dimitrios Baltzis, Ioanna Eleftheriadou, Aristidis Veves, Pathogenesis and Treatment of Impaired Wound Healing in Diabetes Mellitus: New Insights, Advances in Therapy(2014) 31:817–836.
6. Porth, Carol, Essentials of pathophysiology: Concepts of altered health states. Hagerstown, MD: Lippincott Williams &Wilkins. P. 270. ISBN 0-7817-7087-4, 2017.
7. Wang W, Yan X, Lin Y, Ge HQ, Tan Q. Wnt7a promotes wound healing by regulation of angiogenesis and inflammation: issues on diabetes and obesity, J Dermatol Sci. 2018;91(2):124–133. doi:10.1016/j.jdermsci.2018.02.007.
8. Mohana sundaram T, Ramachandran V, Bhongiri B, Emdormi Rymbai, Rinu Mary Xavier, Gaddam Narasimha Rao, Chintha Narendar, The promotion of antioxidant and anti-inflammatory activity by Nrf2 amplifier is a potential technique in diabetic wound healing-a review, Review. Pharm Sci. 2023;29(3):255–262. doi:10.34172/ps.2022.45
9. Dasari N, Jiang A, Skochdopole A, Updates in diabetic wound healing, inflammation, and scarring. Article. Semin Plast Surg. 2021;35 (03):153–158. doi:10.1055/s-0041-1731460
10. Baltzis D, Eleftheriadou I, Veves A. Pathogenesis and treatment of impaired wound healing in diabetes mellitus: new insights. Review. Adv Ther. 2014;31(8):817–836. doi:10.1007/s12325-014-0140-x.
11. Greenhalgh DG, Wound healing and diabetes mellitus. Article. Clin Plast Surg. 2003;30(1):37. doi:10.1016/s0094-1298(02)00066-4.
12. Baltzis D, Eleftheriadou I, Veves A. Pathogenesis and treatment of impaired wound healing in diabetes mellitus: new insights. Review. Adv Ther. 2014;31(8):817–836. doi:10.1007/s12325-014-0140-x.
13. Ahmed AS. Does diabetes mellitus affect tendon healing? In: Ackermann PW, Hart DA, editors. Metabolic Influences on Risk for Tendon Disorders Advances in Experimental Medicine and Biology. Berlin: Springer-Verlag; 2016:179–184.

14. Martin P, Wound healing - Aiming for perfect skin regeneration. Science 276:75–81,1997
15. Pallavi N. Mohod, V. Bihani, Kailash, R. Biyani, A REVIEW ON EXPERIMENTAL ANIMAL MODEL OF WOUND HEALING ACTIVITY, International Journal for Research Trends and Innovation, IJRTI Volume 9, Issue 1,ISSN: 2456-3315, 2024.
16. JOSHUA S. BOATENG, Wound Healing Dressings and Drug Delivery Systems: A Review, JOURNAL OF PHARMACEUTICAL SCIENCES, VOL. 97, NO. 8, AUGUST 2008.
17. Musset JH, Winfield AJ, Wound management, stoma and incontinence products. In: Win f ield AJ, Richards RME, editors. Pharmacy practice. 2nd edition. UK: Churchill Livingstone. pp 176–187, 1998.
18. Eccleston GM. 2007. Wound dressings. In: Aulton ME, editor. Pharmaceutics: The science of dosage form design. 3rd edition. UK: Churchill Living stone. pp 264–271.
19. Maria E. V. Barreto, Rebeca P. Medeiros, Adam Shearer, Marcus V. L. Fook, Maziar Montazerian, and John C. Mauro, Gelatin and Bioactive Glass Composites for Tissue Engineering, A Review Jouranal of Functional Biomaterials. 2023, 14, 23. https://doi.org/10.3390/jfb14010023.
20. J. Moura, J. Rodrigues, M. Gonçalves, C. Amaral, M. Lima, E. Carvalho, Impaired T-cell differentiation in diabetic foot ulceration, Cell Mol. Immunol. (2016) 21.
21. Y. Nishikori, H. Okunishi, N. Shiota, The role of mast cells in cutaneous wound healing in streptozotocin-induced diabetic mice, Arch. Dermatol. Res. 306 (2014) 823–835.
22. S. B. Mallik, B. S. Jayashree, R .R .Shenoy, Epigenetic modulation of macrophage polarization-perspectives in diabetic wounds, J. Diabetes Complications (2018), doi.j.jdiacomp.2018.01.015.
23. S. Barrientos, O. Stojadinovic, M.S. Golinko, H. Brem, M. TomicCanic, Growth factors and cytokines in wound healing, Wound Repair Regen. 16 (2008) 585–601.
24. L. Pradhan, X. Cai, S. Wu, N.D. Andersen, M. Martin, J. Malek, Gene expression of pro-inflammatory cytokines and neuropeptides in diabetic wound healing, J. Surg. Res. 167 (2011) 336–342.
25. Satish Patel, Shikha Srivastava, Manju Rawat Singh, Deependra Singh, Mechanistic insight into diabetic wounds: Pathogenesis, molecular targets and treatment strategies to pace wound healing, Biomedicine & Pharmacotherapy, Volume 112, April 2019, 108615.
26. Alexiadou K, Doupis J. Management of diabetic foot ulcers. Diabetes Ther. 2012;3:4.
27. Zhang J, Guan M, Xie C, Luo X, Zhang Q, Xue Y. Increased growth factors play a role in wound healing promoted by noninvasive oxygen-ozone therapy in diabetic patients with foot ulcers. Oxid Med Cell Longev. 2014;2014:273475.
28. Spentzouris G, Labropoulos N. The evaluation of lower-extremity ulcers. Semin Interv Radiol. 2009;26:286-295.
29. Aydin A, Shenbagamurthi S, Brem H. Lower extremity ulcers: venous, arterial, or diabetic? Emerg Med. 2009;41:18-24.
30. Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. N Engl J Med. 2017;376:2367-2375.
31. Spiliopoulos S, Festas G, Paraskevopoulos I, Mariappan M, Brountzos E, Over coming ischemia in the diabetic foot: minimally invasive treatment options. World J Diabetes. 2021;12:2011-2026.
32. Liao X, Li SH, El Akkawi MM, Fu XB, Liu HW, Huang YS. Surgical amputation for patients with diabetic foot ulcers: a Chinese expert panel consensus treatment guide. Front Surg. 2022;9:10033391.
33. Suriadi Jais, Various Types of Wounds That Diabetic Patients Can Develop: A Narrative Review, Clinical Pathology Volume 16: 1–6.
34. Foot Ulcers: Spectrum of Ischemia | Michael Cumming, MD, MBA

35. Contreras I, Vehi J. Artificial intelligence for diabetes management and decision support: literature review. Journal Med Internet Res 2018;20 (5):e10775.
36. Samabia Tehsin, Sumaira Kausar, Amina Jameel, Diabetic wounds and artificial intelligence: A mini-review, World Journal of Clinical Cases, 2023 January 6; 11(1): 84-91 ISSN 2307-8960.
37. Ovya Ganesan, Miranda Xiao Morris, Lifei Guo, Dennis Orgill1, A review of artificial intelligence in wound care Surgery, DOI:10.20517/ ais.2024.68,
38. Swerdlow M, Guler O, Yaakov R, Armstrong DG. Simultaneous segmentation and classification of pressure injury image data using Mask-R-CNN. Comput Math Methods Med 2023;2023:3858997. DOI PubMed PMC.
39. Zahia S, Sierra-Sosa D, Garcia-Zapirain B, Elmaghraby A. Tissue classification and segmentation of pressure injuries using convolutional neural networks. Comput Methods Programs Biomed 2018;159:51-8. DOI PubMed.
40. Eldem H, Ülker E, Işıklı OY. Alexnet architecture variations with transfer learning for classification of wound images. Eng Sci Technol Int J DOI 2023;45:101490.
41. Mohammed HT, Bartlett RL, Babb D, Fraser RDJ, Mannion D. A time motion study of manual versus artificial intelligence methods for wound assessment. PLoS One 2022;17:e0271742. DOI PubMed PMC.
42. Dankwa-Mullan I, Rivo M, Sepulveda M, Park Y, Snowdon J, Rhee K. Transforming diabetes care through artificial intelligence: the future is here. Popul Health Manag 2019;22(3):229–42.
43. Chairat S, Chaichulee S, Dissaneewate T, Wangkulangkul P, Kongpanichakul L. AI-assisted assessment of wound tissue with automatic color and measurement calibration on images taken with a smartphone. Healthcare 2023;11:273. DOI PubMed PMC
44. Kavitha I, Suganthi SS, Ramakrishnan S. Analysis of chronic wound images using factorization based segmentation and machine learning methods. In: Proceedings of the 2017 International Conference on Computational Biology and Bioinformatics (ICCBB '17); New York, USA. pp. 74-8. DOI.
45. Kaile K, Leiva K, Mahadevan J, et al. Low-cost smartphone based imaging device to detect subsurface tissue oxygenation of wounds. In: Optics and Biophotonics in Low-Resource Settings V; San Francisco, USA. 2019. pp. 62-5. DOI.
46. Kalasin S, Sangnuang P, Surareungchai W. Intelligent wearable sensors interconnected with advanced wound dressing bandages for contactless chronic skin monitoring: artificial intelligence for predicting tissue regeneration. Anal Chem 2022;94:6842-52. DOI PubMed.
47. Topaz M, Lai K, Dowding D, Automated identification of wound information in clinical notes of patients with heart diseases: developing and validating a natural language processing application. Int J Nurs Stud 2016;64:25-31. DOI PubMed.
48. Robnik-Sikonja M, Cukjati D, Kononenko I. Comprehensible evaluation of prognostic factors and prediction of wound healing. Artificial Intelligence Med 2003;29:25-38. DOI PubMed.
49. Ngo QC, Ogrin R, Kumar DK. Computerised prediction of healing for venous leg ulcers. Sci Rep 2022;12:17962. DOI PubMed PMC.
50. Alderden J, Pepper GA, Wilson A, Predicting pressure injury in critical care patients: a machine-learning model. Am J Crit Care 2018;27:461-8. DOI PubMed PMC.
51. Ramawat,Y.,Nitesh,K.,Kumar,V.,Pareek.S, The Role of Artificial Intelligence in Chronic Wound Assessment and Management, The Wocsi Journal of Medical Science 1(1) (2023)
52. Van Netten JJ, Woodburn J, Bus SA. The future for diabetic foot ulcer prevention: A paradigm shift from stratified healthcare towards personalized medicine. Diabetes Metab Res Rev. 2020;36 Suppl 1:e3234.

53. Gosak L, Svensek A, Lorber M, Stiglic G. Artificial Intelligence Based Prediction of Diabetic Foot Risk in Patients with Diabetes: A Literature Review. Appl Sci. 2023;13:2823. doi: 10.3390/app13052823.
54. Amit Gefen, Promoting wound healing through artificial intelligence-powered dressing development, Wounds International 2025 Volume: 16 Issue: 1.
55. Zheng XT, Yang Z, Sutarlie L, Battery-free and AI-enabled multiplexed sensor patches for wound monitoring. Sci Adv. 2023;9(24):eadg6670.
56. panelDrishya Prakashan , Ajeet Kaushik , Sonu Gandhi ,Smart sensors and wound dressings: Artificial intelligence-supported chronic skin monitoring – A review, Chemical Engineering Journal, Volume 497, 1 October 2024, 154371.
57. CARES4WOUNDS Wound Management System, Tetsuyu Healthcare 2022 Mar 19,
58. Chan KS, Chan YM, Tan AHM, Liang S, Cho YT, Hong Q, Clinical validation of an artificial intelligence-enabled wound imaging mobile application in diabetic foot ulcers. *Int Wound J*. (2022) 19(1):114–24. doi: 10.1111/iwj.13603.
59. Qasem Ramadan and Mohammed Zourob. 3d bioprinting at the frontier of regenerative medicine, pharmaceutical, and food industries. Frontiers in Medical Technology, 2:25, 2021.
60. Han Joo Chae Seunghwan Lee HyewonSon , Generating 3D Bio-Printable Patches Using Wound Segmentation and Reconstruction to Treat Diabetic Foot Ulcers, arXiv:2203.03814v1 [eess.IV] 8 Mar 2022, ROKIT Healthcare, Inc.
61. KroniKare How Does It Work?— KroniKare. (accessed 2024-02-24). KroniKare%20is%20an%20AI%2Dbased,integrated%20within%2 0the%20AI%20server
62. Sendilraj, V.; Pilcher, W.; Choi, D.; Bhasin, A.; Bhadada, A.; Bhadadaa, S.K.; Bhasin, M. DFUCare: Deep learning platform for diabetic foot ulcer detection, analysis, and monitoring. Front. Endocrinol. 2024, 15, 1386613. [CrossRef] [PubMed].
63. Yap, M.H.; Cassidy, B.; Pappachan, J.M.; O’Shea, C.; Gillespie, D.; Reeves, N.D. Analysis towards classification of infection and ischaemia of diabetic foot ulcers. In Proceedings of the 2021 IEEE EMBS International Conference on Biomedical and Health Informatics (BHI), Virtual Conference, 27–30 July 2021; pp. 1–4.
64. A 57-Year-Old Man with Type 1 Diabetes Mellitus and a Chronic Foot Ulcer Successfully Managed with a Remote Patient-Facing Wound Care Smartphone Application, Ling Yuan Kong* ACDE 2,3 Jose Luis Ramirez-GarciaLuna* A 4,5 Robert D. J. Fraser AE 5,6 Sheila C. Wang, American Journal of Case Rep, 2021; 22: e933879 DOI: 10.12659/AJCR.933879.
65. World Health Organization. WHO outlines considerations for regulation of artificial intelligence for health. 2023. Available from: https://www.who.int/news/item/19-10-2023-who-outlines-considerations-for-regulation-of-artificial-intelligence-for-health. [Last accessed on 2 Nov 2024].
66. Hou C, Carter B, Hewitt J, Francisa T, Mayor S. Do Mobile Phone Applications Improve Glycemic Control (HbA1c) in the Self-management of Diabetes? A systematic review, meta-analysis, and GRADE of 14 randomized trials. Diabetes Care 2016;39(11):2089–95.
67. Buch V, Varughese G, Maruthappu M. Artificial intelligence in diabetes care. Diabetes Med 2018;35:495–7.
68. Fagherazzi G, Ravaud P. Digital diabetes: perspectives for diabetes prevention, management and research. Diabetes Metab 2019;45 (4):322–9.
69. Samer Ellahham, MD,a, b aClevel and Clinic, Lyndhurst, Ohio; b Cleveland Clinic Abu Dhabi, Abu Dhabi, United Arab Emirates, Artificial Intelligence: The Future for Diabetes Care, The American Journal of Medicine, Vol 133, No 8, August 2020.

70. Le DTP, Pham TD. Unveiling the role of artificial intelligence for wound assessment and wound healing prediction. Explor Med 2023;4:589-611. DOI.

54878478451**240804**