Medical Science

To Cite:
Gawrysz Ż, Derewjanko S. The second and third-degree thermal burn in a patient with diabetic polyneuropathy – Case report. *Medical Science* 2025; 29: e216ms3726
doi: https://doi.org/10.54905/disssi.v29i165.e216ms3726

Authors' Affiliation:
[1]Wielospecjalistyczny Szpital Samodzielny Publiczny Zakład Opieki Zdrowotnej w Nowej Soli, ul. Chałubińskiego 7, 67-000 Nowa Sól, Poland
[2]Collegium Medicum Uniwersytetu Zielonogórskiego, ul. Zyty 28, 65-046 Zielona Góra, Polska

***Corresponding author:**
Żanna Gawrysz
Wielospecjalistyczny Szpital Samodzielny Publiczny Zakład Opieki Zdrowotnej w Nowej Soli, ul. Chałubińskiego 7, 67-000 Nowa Sól, Poland
ORCID: 0009-0001-9929-1332
e-mail: zhanna.gavrysh@gmail.com
tel. +48734393139

ORCIDs & Email:
Żanna Gawrysz MD 0009-0001-9929-1332 zhanna.gavrysh@gmail.com
Stanisław Derewjanko 0009-0009-2308-2575 bmalive.tag@gmail.com

Peer-Review History
Received: 14 August 2025
Reviewed & Revised: 09/September/2025 to 19/November/2025
Accepted: 23 November 2025
Published: 27 November 2025

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

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The second and third-degree thermal burn in a patient with diabetic polyneuropathy – Case report

Żanna Gawrysz[1]*, Stanisław Derewjanko[2]

ABSTRACT

Diabetes mellitus is a chronic metabolic disease of civilization characterized by elevated blood glucose levels. It results from insufficient insulin production by the pancreas or from ineffective insulin management by the body. Hyperglycemia is a common effect of uncontrolled diabetes. Over time, it can lead to damage to the body's crucial systems, such as the nervous and circulatory systems. In the course of diabetic polyneuropathy, there is a loss of sensation of touch, vibration, pain, and temperature, which can directly contribute to the development of burns. In this publication, we present a case review of a 74-year-old male patient who was admitted with burns located on both feet to the Department of Plastic Surgery and Burn Treatment. Upon admission, the burn was classified as grade IIB/III, covering approximately 3% of the total body surface area. In the initial phase, we included insulin and antibiotic therapy, burn wound disinfection, and dressing treatment. We performed a necrosectomy after cleaning the wound and exposing the demarcation zone. We covered soft tissue defects with free skin grafts and observed a gradual improvement in the local condition. We stabilized the blood glucose levels of the patient and started treatment of diabetic polyneuropathy. Early intervention, including proper insulin therapy, a specific antibiotic, and topical treatment, leads to a favorable treatment outcome in the treatment of burns in patients with diabetic neuropathy.

Keywords: burn, burn treatment, burn wound, diabetic neuropathy, skin graft.

1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease prevalent in modern civilization, characterized by abnormal insulin secretion or action in the body. Elevated blood sugar level (hyperglycemia), which is a typical result of uncontrolled DM, leads to severe damage to numerous body systems, especially the circulatory and nervous systems. The impact on the nervous system can result in Diabetic Peripheral Neuropathy (DPN), characterized by loss of sensation in touch, vibration, pain, and temperature, which can directly contribute to the development of burns (Sanaye and Kavishwar, 2023).

***Diabetes Epidemic*:** In 2022, the number of people suffering from DM reached 830 million, while in 1990, the number of patients was estimated at 200 million. In 2021,

DM was the direct cause of 1.6 million deaths, while almost 50 percent of all deaths caused by DM occurred before the age of 70 (World Health Organization, 2024).

We diagnosed DM in patients using the listed criteria:

- Random blood glucose (measured at any time of day) ≥11.1 mmol/l (200 mg/dl) with typical symptoms of hyperglycemia (increased thirst, polyuria, weight loss, frequent urination, weakness),
- Fasting glucose concentration measured twice ≥7.0 mmol/l (126 mg/dl),
- Blood glucose concentration ≥11.1 mmol/l (200 mg/dl) in the oral glucose tolerance test (OGTT) at 120 minutes
- When the measurement of glycated hemoglobin (HbA1c) is ≥ 6.5% (48 mmol/mol)

The leading causes of diabetic neuropathy

Consistent hyperglycemia during DM causes activation/inhibition of various pathways playing an important role in the homeostasis of neurons and other cells. Chronic hyperglycemia is associated with progressive damage, dysfunction, and eventual failure of multiple organ systems, including the eyes, kidneys, nervous system, heart, and vascular structures. DPN is the most common diabetic complication faced by a significant percentage of people with diabetes. One of the causes of DPN is elevated blood glucose levels, which result in the formation of so-called glycation, apoptosis, and mitochondrial dysfunctions (Sanaye and Kavishwar, 2023). Products of glycation cause changes in nerves, such as atrophy of nerve sheaths (demyelination) or changes in the nerve fibers themselves. Some people may be genetically predisposed to developing DPN. Other metabolic factors, such as long-standing diabetes, low insulin levels, an unhealthy diet, high cholesterol, high blood pressure, alcohol consumption, smoking, and certain health conditions, such as renal diseases, can also contribute to diabetic neuropathy.

In the course of DPN, there is a loss of sensation of touch, vibration, pain, and temperature, which can directly contribute to burns (Jones et al., 2014).

The severity of burns

Various scales determine the severity of burns. The most common of them are the rule of nines, where specific body segments occupy approximately 9% of the body surface area, and the hand rule – the area of the burned person's hand corresponds to 1% of the total area of his body. It is also crucial to assess the depth of the burn. A first-degree burn is superficial and involves the epidermis. It involves slight swelling, redness, and the presence of pain. Second-degree burns are clinically divided into two types. Type IIA burns are characterized by no damage to the deeper layers of the skin. Thereby, they do not cause damage to sweat glands and hair follicles. Local soreness of the burned tissues and the appearance of blisters are typical. In type IIB burns, in contrast, superficial necrosis of the epidermis, as well as deeper layers of the skin, is evident (Strużyna et al., 2024). The burn damages blood vessels. The wounds are devoid of blisters, pinkish-egg-colored, or intensely pale (gray). Sometimes there is a lack of sensation in the center of the wound. In a third-degree burn, nerve endings may be damaged, making the burned area less painful. It involves the entire thickness of the skin and subcutaneous tissue. Burned areas can be snow-white, brown, or black in color. Fourth-degree burns involve the full thickness of the skin along with muscle, fascia, and bone. Complete charring of the affected areas is observable. Depending on the depth and extent of the burn, a distinction is made between mild, moderate, and severe burns (Strużyna et al., 2024).

2. CASE PRESENTATION

In this publication, we present a clinical case of a 74-year-old male patient. We admitted him to the Department of Plastic Surgery and Burn Treatment with second and third-degree burns located on both feet, affecting approximately 3% of the total body surface area (TBSA). Suffering from DM type II for ten years, the patient did not take his medication systematically and did not follow his diet. It is known from his history that he suffers from hypertension, does not smoke cigarettes, and drinks alcohol occasionally. To lower his sugar levels, he takes Metformin 850 mg in the morning and afternoon and Amaryl 2 mg in the evening. The blood glucose level on admission was 343mg/dl. We administered insulin therapy and gradually decreased blood glucose levels, as shown in Table 1.

The burn occurred five days before his hospitalization while bathing his feet – the patient did not feel the temperature of the water, and added boiling water. In the initial phase, we started insulin and antibiotic therapy. Conservative treatment of burns included disinfection, the application of ointments, and specialized dressings. With the above-mentioned treatment, we revealed the demarcation zone. Figure 1 shows preoperative photographs of burn deepening and necrotic tissues.

Figure 1. Preoperative photographs demonstrating the deepening of the burn and necrotic tissues of the distal phalanges of the fifth toes of the right and left feet at admission (A, B) and 14 days later (C, D).

Table 1. Measurements of the patient's blood glucose concentration during the first 48 hours after admission to the hospital.

Date	Time	Blood glucose level (mg/dL)
16.06.2025	20:00:00	343,00
16.06.2025	22:00:00	342,00
17.06.2025	07:00:00	248,00
17.06.2025	13:00:00	320,00
17.06.2025	17:00:00	220,00
17.06.2025	22:00:00	103,00
18.06.2025	08:00:00	191,00
18.06.2025	12:00:00	228,00

We performed a necrosectomy of the toes, dorsal and plantar surfaces of both feet, and covered defects with free skin grafts. Gradual local improvement was observed. Blood glucose levels were stabilized. Additionally, we have implemented a treatment for diabetic polyneuropathy using alpha-lipoic acid, benfotiamine, and B vitamins. Alpha-lipoic acid was initially administered as an intravenous infusion, followed by oral treatment in tablet form. Benfotiamine is also taken orally for 3 months. All of the above methods were used to treat our patient.

After the surgery, we continued antibiotic therapy, insulin therapy, and treatment of polyneuropathy (figure 2). Considering the depth of the burn and the patient's diabetes, we decided to continue conservative treatment using specialized dressings for residual wounds. After the surgery, the patient did not report any pain. His blood glucose level did not exceed 132 mg/dl.

After the procedure, we observed good skin graft survival and routine healing of the graft donor site. We applied specialized dressings to toes 2-5 and cleaned them of dead tissue. In blood tests, procalcitonin level was not elevated, blood cultures were sterile, and contamination was seen in wound cultures. The patient moisturized the well-adapted skin grafts and other healed post-burn areas, and participated in physiotherapy treatments to promote scar mobilization (figure 3).

Subsequently, we placed the patient under outpatient care, recommending moisturizing of the skin grafts and protection from sun exposure and trauma. The patient was taken into care by a diabetes clinic.

3. DISCUSSION

Each year in Poland, nearly 1% of the population suffers burns. The cause of burns in adults is accidents at work and at home, and they are mostly thermal burns. The treatment of burns in a specialized center involves the comprehensive management of the patient. Severely burned patients require intensive care, nutritional treatment, renal replacement therapy, and numerous surgical procedures. Surgical treatment consists of excision of necrotic tissue and supplying wounds with free skin grafts of intermediate thickness. Wound treatment also includes ointments and specialized dressings containing silver ions with antiseptic properties. The length of hospitalization for burn patients is influenced by several factors, such as the patient's general condition prior to the accident, comorbidities, the severity of the burns, the quality of surgical and nursing care, and access to early rehabilitation, which reduces the risk of contractures. These factors influence the treatment outcomes (Chrzanowska-Wąsik et al., 2014).

In the course of DM, the central nervous system can be damaged, resulting in abnormal pain and temperature sensation, which can interfere with correct diagnosis. Due to the reduced sensitivity to pain, injury, or burns can very easily occur. Damage to nerve fibers also causes excessive dryness of the skin, which increases the risk of deep-seated burns (Jones et al., 2014).

Circulatory disorders can accompany DM. People with diabetes have a high risk of developing atherosclerosis of the lower arteries. Atherosclerotic ischemia of the lower extremities leads to narrowing or closure of the arteries that supply blood to the tissues. Insufficient blood flow to the lower extremities is a contributing factor in the progression of burn depth. Patients with DM often experience protein deficiencies. This fact can lead to impaired blood flow, which may result in ischemia. This given correlation is critical in the wound healing process and has a significant impact on graft acceptance (Roczniak et al., 2017).

For people with DM, treatment of burns is challenging. It requires consultation with specialists in other medical fields and additional preventive measures. Novel studies have proposed that the use of antioxidants, such as alpha-lipoic acid, may result in a beneficial intervention in the course of treatment of the neuropathic pain in patients with DM (Abubaker et al., 2022).

Figure 2. Postoperative photographs demonstrating the condition of the burn wounds after surgical debridement and skin grafting 2 days (A, B) and 12 days (C, D) after surgery.

Figure 3. Postoperative photographs demonstrating the condition of the burn wounds after healing and skin grafting 22 days (A, B) and 1,5 months (C, D) after surgery.

Regular monitoring of the patient's blood sugar level is critical. Maintaining normal glucose levels prevents cardiovascular disorders and reduces diabetic neuropathy. Local ischemia interferes with the mechanisms of tissue cleansing and regeneration. It is also recommended to implement a balanced diabetic diet enriched with protein, which reduces the risk of glucose fluctuations and helps wounds to heal. It is also necessary to maintain recommended blood cholesterol levels, ensure proper blood pressure control, and stop smoking and drinking alcohol (Rotman et al., 2022). Symptomatic treatment consists of relieving the patient's discomfort with analgesics, antidepressants, and sometimes anticonvulsants. Physical therapy and acupuncture may also be used.

4. CONCLUSION

This case highlights the importance of timely diagnosis and comprehensive treatment of burns. Proper insulin and antibiotic therapy, combined with a multifaceted approach and surgical treatment, lead to the desired results in the course of burn treatment in patients suffering from diabetic polyneuropathy. Early intervention and appropriate treatment methods are vital.

Acknowledgments
We thank the participant who took part in our research.

Author contributions
Conceptualization: Żanna Gawrysz,
Methodology: Żanna Gawrysz,
Software: Żanna Gawrysz, Stanisław Derewjanko
Check: Żanna Gawrysz, Stanisław Derewjanko
Formal analysis: Żanna Gawrysz, Stanisław Derewjanko
Investigation: Żanna Gawrysz, Stanisław Derewjanko
Resources: Żanna Gawrysz
Writing-rough preparation: Żanna Gawrysz
Writing review and editing: Żanna Gawrysz, Stanisław Derewjanko
Data curation: Żanna Gawrysz
Visualization: Żanna Gawrysz, Stanisław Derewjanko
Supervision: Żanna Gawrysz, Stanisław Derewjanko
Project administration: Żanna Gawrysz
All authors have read and agreed with the published version of the manuscript.

Informed consent
Written & Oral informed consent was obtained from the participant included in the study.

Ethical approval
Not applicable.

Funding
This research did not receive any external funding like specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Conflict of interest
The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability
All data associated with this study will be available based on the reasonable request to corresponding author.

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