Case study

Multidisciplinary team cooperative management of a case of severely infected diabetic foot ulcers

ABSTRACT

Objective This case study summarises nurses' experiences in managing a case of severely infected wounds from bilateral extensive Wagner Scale Grade 4 diabetic foot ulcers (DFU) in conjunction with multidisciplinary team cooperation (MDT).

Methods MDT consultation was conducted to establish a clear diagnosis and focus on systemic comprehensive treatment. The treatment plan was adjusted over time according to the results of the wound cultures and antibiotic tests to effectively control the infection. Lipid hydrocolloid foam dressings and negative pressure wound treatment were applied based on evidence to effectively manage the exudate.

Results The patient's left foot healed in 59 days and the right foot healed in 38 days. In the following three years, Wechat follow-up was conducted and the patient did not develop recurrent DFUs or infections in either foot.

Conclusion MDT cooperation in determining the differential diagnosis, developing a clear treatment plan comprehensive treatment of Grade 4 severe infected diabetic foot ulcers can accelerate wound healing, relieve the patient pain and reduce the financial burden to the patient and their family.

Keywords Wagner Grade 4 diabetic foot ulcer, severe infection, lipid hydrocolloid foam dressings, negative pressure wound treatment, multidisciplinary cooperation

For referencing Zhang M, Liang W, Zhao W. Multidisciplinary team cooperative management of a case of severely infected diabetic foot ulcers. WCET® Journal. 2025;45(3)37-43.

DOI https://doi.org/10.33235/wcet.45.3.37-43

INTRODUCTION

The term diabetic foot refers to a foot that is at risk of lower limb infection, ulcer formation or deep tissue injury in diabetic patients due to neuropathy and different degrees of vascular lesions.[1] The degree of diabetic foot disease can be divided into 6 levels according to the Wagner scale. At Grade 0 there are risk factors for foot ulcer, but no ulcer at present; Grade 1 denotes a superficial foot ulcer, with no signs of infection, or prominent neurological ulcer; Grade 2 is a deep ulcer, often combined with soft tissue infection, no osteomyelitis or deep abscess; Grade 3 is a deep ulcer, with abscess or osteomyelitis; Grade 4 has localised gangrene (toe, heel, or dorsal forefoot), characterised by ischemic gangrene, often accompanied by neuropathy; Grade 5 has total foot gangrene.[2]

Mengmeng Zhang[1]
Enterostomal Therapist

Wenxuan Liang[2]
Master of Nursing
Shandong First Medical University, Jinan, Shandong, China

Wenxing Zhao[1]*
Master of Public Health, Enterostomal Therapist
E-mail: 915527304@qq.com
[1]Department of Burns and Plastic Surgery, Central Hospital affiliated to Shandong First Medical University, Jinan, Shandong, China

** Corresponding author*

Diabetic foot ulcer (DFU) is a serious complication of diabetic patients. The global prevalence of DFU is 5–10%, the incidence is 6.3%, and the annual incidence is 1–4%. In China, the incidence of DFU is 4.1%, and it is a common cause of hospitalisation for diabetes.[3] Diabetic Foot Infections (DFIs) remain the most frequent diabetes-related complications requiring hospitalisation and the most common precipitating events leading to lower extremity amputations.[4,5] Once the clinical diagnosis of DFI is established, documentation of the severity of the infection is recommended using the International Working Group on the Diabetic Foot (IWGDF)/IDSA classification system.[6] The IWGDF/IDSA[7] scale of diabetic foot infection is divided into four levels (Table 1).

Systemic symptoms (such as fever or chills), significant leukocytosis, or severe metabolic disorders are uncommon in people with DFI, but their presence indicates a more serious infection that can be limb-threatening (even life-threatening). If not diagnosed promptly and treated correctly, DFI often progresses, sometimes rapidly.[8] The rapid progression of diabetic foot can lead to local tissue necrosis, the spread of infection causing sepsis, and the deterioration of limb ischemia, forming a vicious cycle. Eventually, amputation may be forced, and even life may be threatened due to multi-organ damage, seriously reducing the quality of life.

Table 1. IWGDF/IDSA classification[7]

DFI clinical classification of infection, definitions	IWGDF classification
No infection: No signs or symptoms of local or systemic infection.	1 (no infection)
Infection: There are at least two of the following: ① erythema >0.5 cm[a]; ② local swelling or induration; ③ local fever; ④ local tenderness or pain; ⑤ purulent discharge. Other causes of the skin inflammatory response, such as trauma, fracture, gout, acute neuro-osteoarthropathy (Charcot-foot), thrombosis, or venous congestion, are excluded.	
Only skin or subcutaneous tissue was involved, peritraumatic erythema was not >2cm[b], and there was no manifestation of systemic infection.	2 (mild infection)
Involvement extends beyond the skin and subcutaneous tissues, such as tendons, muscles, joints, and bones, and/or peritraumatic erythema ≥2cm[c], with no manifestations of systemic infection.	3 (moderate infection)
In addition to local infection, there were two or more of the following manifestations of systemic inflammatory response syndrome (SIRS) : ① Body temperature >38˚C or <36˚C; Heart rate >90 beats/min; ③ Respiratory rate >20 times/min, or $PaCO_2$<32mmHg; ④ White blood cell count >12,000/mm^3, or <4000/mm^3, or immature white blood cell count >10%.	4 (severe infection)
The infection involves bone tissue (osteomyelitis).	Add "(0)" after 3 or 4
Note: [a] refers to infection of any part of the foot, not just wounds or ulcers; [b] refers to the size of the erythema in any direction around the wound; [c] refers to 3(0) if less than 2 SIRS manifestations and 4(0) if ≥2 symptoms or signs of local or systemic infection are identified, and if osteomyelitis is diagnosed. Clinically, severe ischemia of the foot makes the diagnosis and treatment of infection more difficult.	

On June 24, 2021, the wound ostomy incontinence nurse specialist for the outpatient clinic of our hospital treated a patient with bilateral extensive DFUs categorised as Grade 4 severe infection using the Wagner Scale. With multidisciplinary cooperation, the left foot healed in 59 days and the right foot healed in 38 days. The case history and wound management interventions, nursing and multidisciplinary are reported as follows.

CASE INTRODUCTION

An unemployed 47 year-old-male presented with bipedal DFUs on June 24, 2021, to the wound ostomy continence nurse (WOCN) specialist clinic of our hospital. His previous medical history was as follows: Diabetes history for more than 10 years without regular treatment and monitoring of blood sugar. The current course of the illness, which resulted in his presentation to the hospital, was a fever of three days and his body temperature was up to 38.5˚C, with associated rigors. Foot assessment showed that the skin of entire dorsum, toe and sole of his left foot, and part of the back and toe of his right foot, were severely ulcerated and compromised by necrotic tissue, with a large amount of exudate. His personal hygiene was poor and the wounds were found to be crawling with maggots. An MDT consultation was requested to assist the WOCN to confirm the diagnosis and guide comprehensive systemic treatment and ongoing timely adjustment of the agreed upon a treatment plan according to wound cultures and drug sensitivity test results, effective control of infection, and effective exudate management through evidence-based application of lipid water glue foam dressing and pressure therapy. After comprehensive nursing intervention, the left foot healed in 59 days and the right foot healed in 38 days, and during the three years of follow-up the condition of his feet remained stable.

WOCN NURSE AND MDT ASSESSMENTS

Whole body assessment:

Upon admission a whole of body assessment was undertaken the results of which were:

1. Elevated infection index:
   a. Body temperature was 38.5˚C (normal axillary temperature is 36˚–37˚C)
   b. White blood cell (WCC) count was 14.9×10^9/L (normal WCC is (4–10) ×10^9/L]
   c. C-reactive protein (CRP) was 220mg/L (normal CRP is <5mg/L)
   d. Procalcitonin (PCT) was 8.41ng/mL (normal PCT is <0.05ng/Ml)
2. Nutritional status
   a. Poor systemic nutritional status was identified due to
      i. mild anemia, hemoglobin 95g/L
      ii. Hypoproteinemia: albumin 20.9g/L
3. Metabolic disorders
   a. His Blood glucose level (BGL) was 28.6mmol/L
      This is abnormal elevation of blood glucose.
   b. Blood sodium 123.8mmol/L (normal Blood sodium is 135–145mmol/L)
   c. Body Mass Index (BMI): 20.7 (normal BMI is 18.5–23.9)
   d. NRS score: 6, unable to walk, affecting normal life

The numerical rating scale is divided into four levels (Table 2)

   e. Hamiton Anxiety Scale (HAMA): Psychological status anxiety, fear.
   f. Lower limb oedema: Pitting or depressed edema of both lower limbs; Red, swollen, hot pain in the left leg, and a feeling of tramping snow.

Table 2. NRS classification[9]

Pain rating	Rating	Clinical picture	
Painlessness	0	No pain	
Mild pain (Does not interfere with sleep)	1–3	Pain when lying quietly, pain when turning over, coughing, deep breathing	1 point: Quiet flat, no pain, turn over, coughing pain 2 points: Cough pain, deep breathing does not hurt 3 points: Quiet lying flat without pain, cough deep breathing pain
Moderate pain (sleeping shallow)	4–6	Quiet flat when in pain, affects sleep	4 points: Quiet lying gap pain 5 points: Continuous pain while lying still 6 points: The pain is more severe when lying still
Severe pain (severely disturbed sleep)	7–10	Flipping restlessness, inability to sleep, sweating all over the body, unbearable	7 points: Severe pain, upset, fatigue, unable to sleep 8 points: Persistent pain, sweating all over 9 points: Severe pain is unbearable 10 points: The most pain, life is worse than death

4. Arterial-venous results:

    a. Arteriovenous ultrasonography of both lower limbs: Atherosclerosis and plaque formation in both lower limbs

    b. Left lower extremity saphenous femoral valvular insufficiency

Local low limb evaluation:

When the patient was admitted to the hospital, post cleansing of the left foot, the wounds were identified as Wagner Grade 1, diabetic foot infection Grade 4 (Figures 1 and 2). Assessment of the wound bed and peri-wound skin identified the wound bed measured approximately 13×15cm. The wound bed comprised of approximately 50% red granulation tissue and 50% yellow-green necrotic tissue. Wound exudate was heavy. According to the description of wound odor by Grocotl et al[10] in 2006, the odor of the affected area was evaluated by 6 grades (0–5 grades). Wound odor was evaluated as odor Grade 0: Odor can be detected in a single room/ward/consultation room, the wound edge was impregnated with exudate, and the skin around the wound was impregnated with exudate.

Similarly, the right foot (Figures 3 and 4) was assessed as being Wagner Grade 1, diabetic infection Grade 4 on admission. The wound bed measured approximately 10×12cm. A prior blister had ruptured exposing a red base to the wound bed. A large amount of fluid was coming from the wound and odor was evaluated[10] as grade 0, exudate macerated the edge of the wound, and skin around the wound. For both feet a 10g nylon thread (Semmes Weinstein monofilament) tactile examination showed protective anesthesia; the pain test was positive.

MULTI-DISCIPLINARY TEAM COOPERATION

After reviewing this case, the WOCN felt that it was difficult to treat this patient's wound because of the overall impact of the wounds on the patient's health status; the severity of the wounds, the extensive tissue destruction, the appearance and smell and the associated complicated systemic conditions. It would be difficult to promote wound healing with the application of a dressing and a single wound dressing change. For this case it was considered that multidisciplinary cooperation was most likely required to resolve the problem. The multi-disciplinary cooperation model, as advocated in China, is patient-centered and relevant medical staff from different specialties-pool their wisdom to jointly develop targeted and safe medical treatment and nursing plans for patients.[11] In addition to local wound dressing changes, infectious diseases, endocrinology, orthopedics and vascular surgeons also participate in daily rounds and check the patient's condition. First, in addition to the local wound infection, the patient showed systemic symptoms with a body temperature >38˚C and a white blood cell count >12x10^9/L, which was consistent with a severe Grade 4 diabetic foot

Figure 1. June 24, front view of left foot

Figure 2 . June 24, right view of left foot

Figure 3. June 24, front view of right foot

Figure 4 .June 24, left view of right foot

infection. A bacterial culture of the patient's wound processed by the Department of Infectious Diseases showed thr presence of Escherichia coli (E. coli) with Extended-Spectrum Beta-Lactamase (ESBL) ++. The drug sensitivity test was sensitive to Meronem, and so treatment was adjusted to include antibiotic application of Meronem by intravenous infusion of 1g, every 8 hours. The patient's temperature was controlled and the infection index gradually decreased. On July 2, the patient's body temperature fluctuated, with a maximum of 38.5˚C, and Tigecycline was added as an intravenous infusion of 100g, every 12 hours. The wound bacterial culture showed Acinetobacter baumannii +CR-AB (Carbapenem-resistant Acinetobacter baumannii) multi-drug resistant bacteria. Considering that Meronem and Tigecycline were already being administered, the antibiotics regimes were not adjusted. The drug sensitivity test showed that CR-AB was sensitive to the antibiotic Polymyxin B and the WOCN applied a smear of Polymyxin to the wound.

Due to the patient's severe metabolic disorders, the endocrinology department's consultant was invited to review the patient and as a result treatment was recommended to regulate blood sugar levels. An insulin aspartate injection micropump was used to pump the basic amount of 16U, and the insulin micropump pumped 6U into the patient before each meal. The orthopaedic surgeon, having ruled out the presence of osteomyelitis, and with further consideration of the patients age, general condition and financial status determined not to proceed with bilateral foot amputations at this point. The WOCNs were requested to manage the DFUs. Further, the vascular surgeons, in combination with the results of color ultrasound of both lower limbs, recommend treatment with drugs to improve the circulation of lower limbs. Through multi-disciplinary team cooperation, the patient's abnormal conditions were found and dealt with in time to provide comprehensive treatment.

Figure 5. Silver ion antibacterial dressing

Figure 6. UrgoTul lipid hydrogel foam dressing

Figure 7. June 28, left of right foot

WOUND CLEANSING AND DRESSING SELECTION

The patient was admitted to hospital on June 24 for the first treatment. The wound was thoroughly cleaned with 2% hydrogen peroxide solution, iodophor, and normal saline at first, according to the wound TIME principle. Due to serious wound infection, silver ion antibacterial dressing (Figure 5) was selected as the primary dressing to control infection and stimulate autolytic debridement. The patient had a large amount of fluid exudate from the wound, and UrgoTul lipid hydrogel foam dressing (Figure 6) was selected as the

Figure 8. Silver alginate ion dressing

Figure 9. UrgoTul lipid hydrogel foam dressing

secondary dressing to absorb the fluid. This dressing has a low-viscosity lipid water adhesive mesh surface, which improves the dressings ability to conform to the wound and creates a wet healing environment. Polyimide foam pad thickness 4mm, has strong absorption capacity and non-woven polyimide backing with high permeability. It can be used for infected wounds and was suitable for this patient. Using this method, the dressing was changed every other day.

For the third dressing change on June 28, the infection was controlled. The wound was washed with normal saline. After wiping, there was a small amount of bleeding in the wound on the right foot (Figure 7), but there was still a large amount of exudate. The primary dressing was replaced with silver alginate ion dressing[12] (Figure 8) to assist with haemostasis, autolytic debridement, control infection and absorb exudate. The secondary dressing was still applied with UrgoTul lipid hydrogel foam dressing (Figure 9) to absorb exudate. This method was used to change the dressing twice a week.

EXUDATE MANAGEMENT

The wound surface of both feet of the patient was large, accompanied by insufficiency of lower limb saphenous femoral vein valve closure and a large amount of exudate from the wound surface, which soaked the surrounding skin on the one hand and aggravated the loss of nutrients in the whole body on the other. A lipid water glue foam dressing was used to absorb the exudate. Lower limb venous color ultrasound showed atherosclerosis but no ischemia or occlusion of lower limb vein vessels. The ankle-brachial index was measured at 0.9. Based on patient compliance and the principle that multi-component, high-pressure, elastic bandages are better than single-component, low-pressure, non-elastic bandages in the treatment of diabetic foot with venous valve insufficiency of lower extremities, double-layer non-elastic bandages plus double-layer elastic bandages were selected. In this way, non-elastic bandages provide high pressure when standing and low pressure when resting, while elastic bandages provide continuous pressure,[13] effectively controlling exudate. At the end of treatment, the exudate was significantly reduced, the infection was gradually controlled, and gradient elastic socks were used after compliance was improved. The pressure of the gradient elastic socks gradually decreases from the bottom up to promote the blood flow back to the heart at the far end of the limb, thereby preventing, relieving and treating venous lesions of the lower extremities.

WOUND INFECTION AND WOUND DEBRIDEMENT

In the early stage of acute infection, the patient's condition was systemically poor. He was not deemed suitable for surgical sharp wound debridement. In addition, there was excessive wound exudate. Silver ion antibacterial dressing and silver alginate ion dressing were applied for autolytic debridement, which could alleviate the pain caused by dressing change and reduce bleeding. On July 12, after the yellow-green necrotic tissue of the left foot (Figure 10, Figure 11) was separated from the normal tissue, the burn orthopedic surgeon administered sharp debridement to promote wound healing. The right foot dressing was renewed only.

RESULTS

In this case, the patient was admitted on June 24. On July 22, The patient was discharged (Figure 12, Figure 13) and went to a local hospital for dressing changes. The left foot of the patient healed in 59 days (Figure 14) and the right foot wound healed in 38 days (Figure 15). Over the following three years, the multidisciplinary team conducted telemedicine follow-up and health education guidance on Wechat. There were several small blisters and ruptures during the period, which were treated and recovered in time without large fluctuations. The patient and his families were very satisfied and grateful.

DISCUSSION

In recent years, with the increasing number of DFU patients, the prevention and treatment of DFI has been very important. In this case, on admission the patient had large areas of ulceration-on both feet accompanied by Grade 4 severe infection, poor systemic condition, complex pathogenesis and diverse clinical manifestations. His management required involving multiple medical disciplines to assist with his treatment. By using a consultative collaborative MDT approach involving infectious diseases, endocrinology, orthopedics, vascular surgery, and wound specialist nurses who cooperated

Figure 10. July 12, front view of left foot

Figure 11. July 12, right view of left foot

Figure 12. July 22, front view of left foot

Figure 13. July 22, front view of right foot

with each other to detect the patients' abnormalities and treat them appropriately in a timely manner, effectively reduced the occurrence of further necrosis, halted the spread of infection and avoided the need for amputation. Overall, an MDT approach has been shown to decrease the development of DFU, improve the cure rate, and reduce the amputation rate and medical costs.[14]

Dressing selection for patients with large-scale foot ulcers accompanied by Grade 4 severe infection, is based on the patient's condition and economic situation. Lipid water glue foam dressing can be used to create a wet healing environment while absorbing a large amount of exudate. This dressing can be used for infected wounds with high permeability.

Some patients with diabetic foot infection with venous valve insufficiency can be treated with pressure to control wound exudate. After ultrasound examination, patients with no arterial occlusion and ankle-brachial index greater than 0.7 can be treated with compression. For patients with poor compliance, a double-layer non-crepe bandage plus a double-layer crepe bandage can be used to effectively control fluid exudate.

Although this has been examined in only a few studies, patients with a history of chronic hyperglycemia are more likely to develop DFI, and severe hyperglycemia may indicate a rapidly progressive or destructive (necrotic) infection.[8] Clinical attention should be paid to such patients. The progress of DFI should be closely observed and abnormal clinical parameters treated promptly.

Figure 14. August 22, left foot return visit

Figure 15. August 2, right foot return visit

This patient with Grade 4 severe diabetic foot infection was fully healed through MDT cooperation, comprehensive systemic treatment and wound care, and personalised health guidance throughout the course of his disease. This included education during follow-up after discharge, especially about the care of his feet. It is particularly important, that patients try to use soft, cotton socks with good permeability to avoid foot moisture and reduce foot infection. He was also encouraged to choose shoes with soft thick soles, to reduce internal foot pressure.[15] During the three-year follow-up, no diabetic foot ulcers or infections occurred on either of the patient's feet.

SUMMARY

For patients with grade 4 severe diabetic foot infections, timely initiation of multidisciplinary cooperation and active comprehensive systemic treatment in conjunction with local wound care is conducive to rehabilitation. For patients with low educational level, it is particularly important to provide necessary health guidance and follow-up. In this case, Wechat, an online real-time communication software, was adopted to conduct telemedicine follow-up, overcoming regional barriers, saving the patient time and money, and effectively preventing recurrence.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

The authors received no funding for this study.

REFERENCES

1. Hu Yin, Zhu Dalong. Expert consensus on preventing and treating diabetic foot under multidisciplinary cooperation (2020 edition). Chinese Journal of Burn. 2019,36(8):637–646.
2. Wagner FW Jr. The dysvascular foot: a system for diagnosis and treatment. Foot Ankle. 1981:2(2):64–122.
3. Zhang P, LU J, Jing Y, et al. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Ann Med. 2017;49(2):106–116.
4. Ndosi M, Wright-Hughes A, Brown S, et al. Prognosis of the infected diabetic foot ulcer: A 12-month prospective observational study. Diabet Med. 2018;35:78–88.
5. Tan TW, Shih CD, Concha-Moore KC, et al. Disparities in outcomes of patients admitted with diabetic foot infections. PLoS One. 2019; 14:e0211481.
6. Schaper NC, van Netten JJ , Apelqvist J ,et al. Practical Guidelines on the Prevention and Management of diabetic foot disease (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;4(Sup1):e3266.
7. Xu J, Xu ZR. Interpretation and progress of "Guidelines for the Diagnosis and Treatment of Diabetic Foot Infection": diagnostic part. Chinese Journal of Diabetes.2019;16(01):48–51.

8. Schaper NC, van Netten JJ, Apelqvist J, et al. Practical guidelines on the prevention and management of diabetes-related foot diseases (2023 update IWGDF). Diabetes Metab Res Rev. 2023: e3657.
9. Senneville E, Albalawi Z, van Asten SA, et al. Guidelines for the Diagnosis and Treatment of Foot Infections in Diabetic Patients (IWGDF/IDSA 2023 edition) — part of the International Diabetic Foot Working Group: Guidelines for the Prevention and Management of Diabetes-related Foot Diseases (2023). J Infect, Inflam Repair. 2019;24(4):187–211.
10. Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. Pain. 1986; 27(2):117–126.
11. He Zhenhua, Sun Xiaofen, Xu Min. Evaluation and management of wound effusion in malignant tumors. J Nurs Admin. 2019;19(02):119–124.
12. Wang C, Chang Y, Zheng Y, et al. The application of the multidisciplinary medical cooperation model in the perioperative period of elderly hip fractures. Chinese Journal of Prosthoplastic and Reconstructive Surgery, 2019,33(10):1283–1286. (In Chinese).
13. Chinese Society of Endocrinology, Chinese Association of Endocrinology and Metabolic Diseases. Diabetic foot ulcer wound treatment expert consensus (2024). The Endocrine Metabolism. 2024;40(7):565–569.
14. Yan Chengcheng, Ju Shang, Huang Tianyi, et al. Clinical study of low pressure and negative pressure in the treatment of diabetic ischemic foot ulcer. Chinese Journal of Integrated Traditional and Western Medicine Surgery. 2019;25(05):771–774.
15. Chinese Society of Diabetes, Chinese Society of Infectious Diseases, Chinese Society of Tissue Repair and Regeneration. Chinese Guidelines for the Prevention and Treatment of diabetic foot (2019 edition). Chinese Journal of Diabetes. 2019;11(4): 92–108.
16. American Diabetes Association Professional Practice Committee. 16. Diabetes Care in the Hospital: Standards of Care in Diabetes-2024. Diabetes Care. 2024;47(Sup1):S295–306.