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Maggot Therapy for Treating Diabetic Foot Ulcers
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Introduction
Diabetes mellitus, Type 2 and Type 2, is an associated with numerous debilitating consequences. One of the most common and serious complication is diabetic foot ulcers (DFUs) (Battist, Elferichaud, and Venes, 2014, p.837).
- DFUs are by loss of glycemic control, peripheral neuropathy, peripheral vascular disease, and immunosuppression and account for greater than 80,000 amputations per year in the United States (Amuiller, Dehollain, 2015, p.12).
- Approximately 15% of people with diabetes have diabetic foot ulcers (Amuiller & Dehollain, 2013, p.28) and studies demonstrate that 45% to 55% of patients presenting with neuropathy and ischemia diabetic foot ulcers will die within 5 years (Snyder, 2010, p.191).

Presentation of Process/Signs and Symptoms
All important factor to be aware of is that 60% of patients with diabetic foot ulcers present with diabetic neuropathy (Ven, Santos, & Gamba, 2013, p.18). According to the American Podiatric Medical Association within the neuropathy, pain will not be a common symptom observed by patients, discharge from the area will typically be the first aspect they will notice. On inspection, there would be no open wound with:
- Redness
- Swelling
- Foul odor (ulcer has progressed)
- Increased temperature
- Pain on touch

Due to the nature of these ulcers the risk of infection is high, so understanding the signs and symptoms of diabetic foot ulcers are considered necessary especially with all the risks and symptoms of an infections foot ulcer are:
- abnormal/disposition of tissue
- increase in pain
- increased edematate
- increased wound size
- increased paresthesia to peripheral neuropathy
- mid to mild halitosis (Stoic, Santos, & Gamba, 2013, p.40)
- fever
- tachycardia
- tachypnea

(Dehollain, & Amuiller, 2015, p.20)

Underlying Pathophysiology
Diabetic foot ulcers form as a consequence of the negative mechanisms associated with diabetes: neuropathy, peripheral vascular disease, and reduced infection to tissue (Dinh, 2012, p.297).
- Neuropathy, a result of the oxidative stress on nerve cells secondary to hyperglycemia, has a key role in the development of diabetic ulcers.
- Sensory nerve dysfunction leads to a decrease ability to feel trauma or notice wounds on feet that may progress to an ulcer.
- Motor nerve dysfunction to the muscle of the foot can lead to deformities, which may cause areas of increased pressure and ultimately ulcers.
- Autonomic nerve dysfunction impacts sweat glands, decreasing foot’s ability to moisture, leading to cracks and skin breakdown (Amuiller, Dehollain, 2015, p.29).

Hypertension has been found in vascular changes by providing alterations of endothelial cells in the peripheral arterioles... (Harris, Nigam, Sawyer, Mack, & Pritchard, 2013, p.1393).

Motor Microbial burden or “bioburden” has three dimensions: microbial load (total quantity of microbes); microbial diversity (number of different bacterial populations present); and pathogenicity (Staphylococcus, Streptococcus, Proteusbacteria, and anaerobic species) (Veves, Price, Neal, & Harding, 2014, p.43).

A correlation was found between ulcer depth and duration microbial diversity and pathogenicity, with deep ulcers having longer durations having more diverse microflora and higher levels of anaerobes and Proteobacteria.

- Individuals with poor glycemic control had a higher abundance of Staphylococcus and Streptococcus (Shander, Hills, Heilmann, Segre, & Grice, 2013, p.927-928).

Maggot Debridement Therapy (MDT)
Maggot therapy is “an application low fly larvae to wounds in order to aid in wound debridement (cleaning), disinfection, and/or healing” (Sherman, 2014, p.1). MDT is used to treat “severe, infected acute and chronic wounds” (Casender et al., 2012, p.870) and is used as a combination with conventional treatments including systemic antibiotics and chemotherapy (Peck & Kirlis, 2012, p.1137).

MDT was approved by the US Food and Drug Administration for use in partial thickness diabetic ulcers (Price, Neal, & Harding, 2014) for use in wound debridement (Opletalova et al., 2012, p.42).

- Implemented for centuries to treat chronic wounds (Harris, Nigam, Sawyer, Mack, & Pritchard, 2013, p.1203).
- Introduced into clinical practice in the 1990s by Dr. William S. Baer, Baer, an orthopedic surgeon at Johns Hopkins Hospital, used MDT to heal osteomyelitis in children with great success (Casender et al., 2012, p.870).

- Research on maggot therapy has shown that there are numerous mechanisms involved beyond necrotic tissue debridement:
  - wound healing (excavations and bacterial secretions)
  - migration of wound organisms (infection and antibacterial secretions)
  - maturation of wound bioremediation (remodeling and stimulating cellular responses)

- MDT has also been shown to increase the hepcidin growth factor (HGF), which is an important factor involved in cutaneous wound healing (Horton, et al., 2011, p.1433).

- The most common used species is the Lucilia sericata secondary to the fact that it only consumes necrotic tissue (Campbell, N. & Campbell, D. 2014, p.178).

- The maggots produce proteolytic enzymes which transform necrotic tissue into a semi-liquid and debridement occurs when they consume the digested liquid of organs and wound debris (Campbell, N. & Campbell, D. 2014, p.17).

- The excretions and secretions of the maggots stimulate fibrous tissue more specifically through remodeling the extracellular matrix and stimulating cellular responses (Dinh, T., Tecliaficz, F., & Dinh, T. 2014). Therefore, health care providers must be cognizant of the following:
  - The importance of doing a thorough assessment on all patients, but particularly known diabetic and their feet.
  - The likelihood of the one to discover a diabetic foot ulcer, or the early signs of one, are very gross.
  - That neuropathy, vascular changes, and immune impairment are only a few of the ramifications of diabetes.
  - The primary goal would be the prevention or reversal of hyperglycemia.

- The patient, unable or unwilling to meet that goal, must be educated on the importance of glucose control and good foot care for the prevention of diabetic foot ulcers.

Significance of Pathophysiology
- The pathophysiology of the development of diabetic foot ulcers might provide insight and a direction for intervention.
- Understanding the underlying pathophysiology will help to determine an individualized educational plan for diabetes education for diabetic patients.
- Hyperglycemia and necrotic thighs, uncontrolled glucose, has detrimental effect on numerous systems of the body. The significance of knowing what those effects are how and how they originated gives the medical professional a knowledge base to educate patients.
- Knowing what faciliated a particular ulcer may possibly provide better treatment approaches.

Implications for Nursing Care
Diabetic foot ulcers can negatively impact one’s quality of life, can be an omen for death. Combating DFUs requires "multidisciplinary management, patient education, control, debridement, offloading, infection control, and adequate perfusion" (Braun, Fisk, Lev, Drozan, & Isseroff, 2014, p.267). Therefore, health care providers must be cognizant of the following:

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Conclusions
- Diabetes is a devastating disease with numerous complications such as: high blood pressure, heart symptoms of arterial disease, blindness, and kidney disease.
- In the United States, diabetes is the 7th leading cause of death, although the Centers for Disease Control and Prevention documents that deaths related to diabetes complications may only account for an estimated $245 billion per year (CDC, 2014).
- The estimated cost per diabetic foot ulcer, secondary to difficulty to treat, they are to treat, is between $7,000-$10,000; amputation of a limb can cost up to $50,000 (Metha, Herrington, Swener, & Swift, 2011, p.121).

These statistics show how imperative, physically and financially, prevention and education are to patients. Diabetes can not only be prevented, but a proactive education, resources, and awareness. We may not be able to amputations, but our job is to provide the education and resources.

Additional Resources