How a Multidisciplinary Approach Can Affect the Rate of Amputation in Patients with Diabetic Foot Disease

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How a Multidisciplinary Approach Can Affect the Rate of Amputation in Patients with Diabetic Foot Disease

Abstract

Background: At least 60% of nontraumatic lower limb amputations are due to diabetic foot disease. Furthermore, this carries a five-year mortality risk of 50% after one major amputation. A foot ulcer precedes the majority of amputations. One strategy for the management of patients with diabetic foot disease is to introduce a multidisciplinary approach and address the multifactorial processes involved in diabetic foot ulcers. The purpose of this review is to examine how a multidisciplinary approach can affect the rate of amputation in patients with diabetic foot disease.

Methods: An exhaustive search was made available using medical literature via Medline-OVID, CINAHL, Web of Science and Google Scholar using the keywords diabetic foot, amputation and patient care team. Relevant articles were assessed for quality using the Grading of Recommendations, Assessment, Development and Evaluation criteria.

Results: Two studies met the inclusion criteria and were included in this systematic review. The first study was a retrospective observational study that reviewed medical records of 74 patients who were hospitalized and treated in a multidisciplinary foot clinic at a university hospital in Turkey between January 1, 2002 and December 31, 2007. From 2002 through 2007, the overall amputation rate was 21.6%, which was lower than the prior rates from 1992 to 1996 and 2000 to 2002, 36.7% and 39.4% respectively. The second study was a retrospective observational study that reviewed 574 patients who were admitted to a university hospital in Turkey between January 1999 and January 2008. A multidisciplinary diabetic foot clinic was established in January 2002. There was a statistically significant reduction in major amputations after initiating the diabetic foot clinic (20.4% vs. 12.6%, p=0.026). However, there was no statistical significance in overall or minor amputations.

Conclusion: A multidisciplinary approach to treat patients with diabetic foot disease delays the rate of amputations via early identification and intervention. The studies in the United States are limited, as are studies with diverse populations; however, based on the above results, it may not be necessary to conduct further studies if all patients with diabetic foot disease are treated aggressively with a multidisciplinary approach.

Keywords: diabetic foot, amputation and patient care team

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A Clinical Graduate Project Submitted to the Faculty of the
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Biography

Grace Sevilla is a native of Maryland and graduated from the University of Delaware with a Bachelor of Science in Exercise Science and a concentration in Exercise Physiology. After moving to Washington, DC, she worked as a pharmaceutical sales associate with Sanofi-Aventis for six years promoting products used in both primary and specialty care settings. Prior to her entrance into Pacific University’s Physician Assistant program, Grace worked as a medical scribe for an emergency department in Alexandria, VA. After graduation she hopes to practice in the fields of Internal Medicine and Infectious Disease.
Abstract

Background: At least 60% of nontraumatic lower limb amputations are due to diabetic foot disease. Furthermore, this carries a five-year mortality risk of 50% after one major amputation. A foot ulcer precedes the majority of amputations. One strategy for the management of patients with diabetic foot disease is to introduce a multidisciplinary approach and address the multifactorial processes involved in diabetic foot ulcers. The purpose of this review is to examine how a multidisciplinary approach can affect the rate of amputation in patients with diabetic foot disease.

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Conclusion: A multidisciplinary approach to treat patients with diabetic foot disease delays the rate of amputations via early identification and intervention. The studies in the United States are limited, as are studies with diverse populations; however, based on the above results, it may not be necessary to conduct further studies if all patients with diabetic foot disease are treated aggressively with a multidisciplinary approach.

Keywords: diabetic foot, amputation and patient care team
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To *my parents and my friends*: Thank you for helping me to succeed and for reminding me why I was putting myself through this much work. It was worth it.

To *David*: I would not have arrived at this point if not for you. Thank you.
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BACKGROUND

Diabetes is a public health dilemma that has unfortunately grown. In 2012, 1.7 million Americans were newly diagnosed with diabetes, increasing its prevalence in the United States from 8.3% in 2010 to 9.3% of the population. As the number of new cases continues to rise, the new challenge clinicians face is how to prevent the debilitating and chronic complications associated with diabetes, such as lower limb amputations.

It is estimated that 60% of nontraumatic lower limb amputations occur in diabetic patients over 20 years of age. Amputations are not only costly because of extended hospitalization, rehabilitation, and disability services, there is a five-year mortality rate of 50% after the first major amputation. Amputations can also alter patients’ qualities of life through physical dysfunction and psycho-emotional stress. Preventing this complication can reduce costs, maintain patients' well-being and delay premature death.

*Diabetic foot disease* is described as an infection, ulceration and/or destruction of deep tissues with neurologic and vascular changes in the lower limb. Of amputations, 85% are preceded by foot ulcers. A strategy for the management of patients with diabetic foot disease is to introduce a multidisciplinary approach to foot ulcers for early detection and intervention. The multidisciplinary approach addresses the multifactorial processes involved in diabetic foot ulcers: peripheral vascular disease and neuropathy progressing to ischemia and infection. A multidisciplinary team can consist of specialists in vascular surgery to treat blocked arteries, infectious disease to prescribe appropriate antibiotic...
therapy and orthopedics to excise infected bone. Other factors such as optimizing glucose control with an endocrinologist, effective wound care and debridement with a podiatrist, proper foot wear and off-loading techniques, and adequate patient and staff education also play important roles in the success of patients' treatment. In the U.S., it may be difficult to coordinate a multidisciplinary treatment in rural or underserved areas; however, there are options if a clinician understands what is needed for an effective approach and can gather a team. This systematic review examines how a multidisciplinary approach can affect the rate of amputation in patients with diabetic foot disease.

METHODS

An exhaustive literature search was performed using Medline-OVID, CINAHL, Web of Science and Google Scholar. Keywords included diabetic foot, amputation and patient care team. Studies were required to compare the rate of amputation in patients with diabetic foot disease seen before and after multidisciplinary approaches were instituted. References cited within the studies were searched as additional sources. Studies were excluded from research if there was no emphasis on clinical medicine. Articles were assessed for quality using the Grading of Recommendations, Assessment, Development and Evaluation criteria (GRADE).[^9]

RESULTS

The initial search using the previously mentioned keywords yielded 12 studies. One study conducted by Aydin et al[^4] fit the inclusion criteria. A second study by Yesil et al[^5] was found by searching the reference list of the Aydin et al study. An additional
study\textsuperscript{6} did compare the rate of amputation before and after a diabetic foot clinic was implemented but was excluded from this review due to its emphasis on patient education. A fourth study\textsuperscript{7} evaluated the rate of amputation from the clinic in the U.S. but was also excluded as it did not compare the rate prior to when the multidisciplinary approach was started (see Table).

\textit{Aydin et al}

In this retrospective observational study\textsuperscript{4} medical records of 74 patients were reviewed who were hospitalized and treated in a multidisciplinary foot clinic at Hacettepe University Hospital in Turkey between January 1, 2002 and December 31, 2007. The researchers had two primary outcomes: to determine the risk factors for developing diabetic foot disease and to compare frequency of amputations in this population before and after the diabetic foot clinic was instituted. The rate of amputation was compared to data collected from 1992 to 1996 and from 2000 to 2002.\textsuperscript{4}

Patients in the study were similar in prognostic risk factors. History of smoking was defined as smoking more than one pack per year. Hypertension was present if the patient was on an antihypertensive medication or had a blood pressure over systolic 140 or diastolic 90 mmHg. Retinopathy was specified if retinal hemorrhages, exudates or microaneurysms were present on fundoscopic exam. Nephropathy was defined as more than 30mg/day of albuminuria. Peripheral neuropathy was present if there was a decrease or loss of sensations (vibration, light touch, pain, temperature discrimination) in a glove and stocking distribution and a decrease or loss of deep tendon reflexes. Peripheral vascular impairments were defined as classic intermittent claudication with at least one
nonpalpable major lower limb arterial pulse and cold extremities. In addition, peripheral vascular disease was confirmed with Doppler studies. Wound lesions were classified according to the Wagner's Grading System for diabetic foot infections and microorganisms were isolated and cultured. Osteomyelitis was established based on the basis of magnetic resonance imaging. All patients were hospitalized and given instruction for bed rest to reduce pressure of ulcers.4

In 2000, when the diabetic foot clinic was developed, a team of specialists evaluated all patients. The multidisciplinary team consisted of an endocrinologist to optimize glucose control with dietary changes, insulin or oral antihyperglycemic agents; an orthopedic, plastic and reconstructive surgeon to remove infected bone; a cardiovascular surgeon to address tissue perfusion impairment; an infectious disease specialist to address antibiotic therapy; and a diabetic foot nurse for local wound care. From 2002 through 2007, the overall amputation rate in the current study was 21.6%. This was lower than the rates from 1992 to 1996 and 2000 to 2002, 36.7 and 39.4% respectively.4

Yesil et al

In this retrospective observational study, Yesil et al5 reviewed the medical records of 574 patients who were admitted to Dokuz Eylul University Hospital between January 1999 and January 2008. A multidisciplinary diabetic foot clinic was established in January 2002. Prior to the diabetic foot clinic, a patient's physician arranged management and consultation of the foot ulcer. The primary objective of this study was to compare amputation rates before and after the multidisciplinary approach was started.
Patients included in the study were similar in prognostic risk factors while 99 patients were excluded due to the inability to go to the hospital regularly. Patients seen by the diabetic foot clinic were evaluated at presentation. A thorough medical history was obtained including patients' characteristics, smoking habits and physical examination. A photograph of the ulcer was taken, characteristics of the ulcer were noted with inspection and depth was obtained with a sterile probe. Foot lesions were classified according to the Wagner's Grading System for diabetic foot infections. Plain x-ray films were obtained and magnetic resonance imaging were taken on the consensus of the diabetic foot team. Limb ischemia was established by palpating peripheral pulses and obtaining ankle brachial pressure index (ABI) with a handheld Doppler. A conventional Doppler was used if pedal pulses were reduced or nonpalpable or the ABI was less than 0.9. Peripheral neuropathy was determined with a monofilament test and loss of vibration was assessed with a biothesiometer on the pulp of the hallux. Patients were evaluated for retinopathy and seen by an ophthalmologist if macular edema, nonproliferative or proliferative retinopathy was present on the fundoscopic exam. Baseline hemoglobin A1c levels were collected (normal A1c=4-5.7%). Nephropathy was examined with 24-hour urinary albumin excretion and serum creatinine levels. Microalbuminuria was defined between 30 and 299mg/day of albuminuria.

The diabetic foot team, who met on a weekly basis, was comprised of an endocrinologist; orthopedist; plastic and vascular surgeon; infectious disease specialist; radiologist; diabetes educator; rehabilitation specialist; wound-care specialist and footwear specialist. Established treatment included wound care, bed rest, off-loading instruction, parenteral antibiotics and debridement or amputation. Major amputation was
defined as amputation performed above the ankle; whereas minor amputation was defined as amputation involving partial removal of the foot. At least six months after the foot ulcers were completely healed, the multidisciplinary team continued to follow up with the patients seen by the foot clinic.

In short, there was a statistically significant reduction in major amputations after initiating the diabetic foot clinic (20.4% vs. 12.6%, \( p=0.026 \)). However, there was no statistical significance in overall or minor amputations.

**DISCUSSION**

The results of the above-described studies\(^4,5\) indicate that a multidisciplinary approach would be effective in reducing the rates of amputation in patients with diabetic foot disease. Both studies showed a decrease in amputations. Aydin et al\(^4\) demonstrated an overall amputation rate reduction of about 15.1 to 17.8% and Yesil at al\(^5\) demonstrated a major amputation rate reduction of 7.8%. This second study\(^5\) is of particular interest when considering that there is a 50% mortality rate after the first major amputation and although they saw no effect in minor amputations in the Yesil et al study, the researchers concluded that averting this type of procedure with the correct care is impossible.

As previously noted, two studies\(^6,7\) excluded from this review also included amputation rates that were consistent with the above studies. Karakoc et al\(^6\) conducted a study evaluating a multidisciplinary approach with the addition and emphasis on diabetes education in an outpatient clinic. The researchers saw a decrease in amputation from 21% to 9.4% (\( p<0.001 \)) after the development of a multidisciplinary team consisting of endocrinologists, orthopedics, infectious disease specialists, plastic and reconstructive
surgeons, dermatologists and a diabetes educator to inform patients about diabetes mellitus and its complications with diabetic foot disease. Another related study conducted by Driver et al that took place in the U.S. had an 82% decrease in lower limb amputations over a five-year retrospective evaluation with a similar multidisciplinary approach and emphasis on patient and staff education. This decrease was in spite of a 48% increase in patients newly diagnosed with diabetes.

Furthermore, the use of a multidisciplinary approach to diabetic foot disease has been shown to be effective in the United Kingdom since the 1980s, when one study demonstrated a 50% reduction in amputations with this initiative. Since then, a number of hospitals in the UK with dedicated clinics have increased, as has the access to clinics by patients.

In the U.S., similar studies evaluating the amputation rates with and without a multidisciplinary approach have been limited; however, in 2012 the Infectious Disease Society of America (IDSA) revised the guidelines regarding the management of diabetic foot disease. The IDSA recognized the benefit of a coordinated effort for treatment and recommended physicians who did not have access to a multidisciplinary team to attempt to arrange coordinated care with the appropriate specialists.

It should also be noted, however, that the research explored in this review had several limitations. Aydin et al, for instance, reviewed the files of Caucasian patients only and Yesil et al made no mention of the ethnicities or races included in their study. As both studies took place in Turkey, it is possible that the researchers were unable to fill the studied groups with a diverse population. This resulted in a very low level of quality of evidence.
In the US, non-Hispanic Whites make up the smallest group diagnosed with diabetes (7.6%), followed by Asian Americans (9.0%), Hispanics (12.8%), non-Hispanic blacks (13.2%) and American Indian/Alaskan Natives (15.9%). Research on the effects of a multidisciplinary approach on populations that are more representative of a diverse population could be useful information for developing more diabetic foot clinics in the US.

Another limitation to the research is that Turkey has a nationalized health care system; therefore, patients potentially had no challenges accessing healthcare before and after a multidisciplinary clinic was initiated. The severity of the groups' potential risk factors may have already been low because care was more accessible. Access to proper health care in the U.S. has been a challenge. It would be difficult to expand on what Turkey and the UK has developed in areas that are rural and underserved in the U.S. because of the limited specialists available for consultations. Therefore, it would be the primary clinician's responsibility to coordinate the appropriate specialists and ensure that the patient is seen.

CONCLUSION

The evidence supports that the use of a multidisciplinary approach to treat patients with diabetic foot disease delays the rate of major amputations via early identification and intervention. If the multidisciplinary specialties are not accessible as one team, it is crucial that the primary clinician arrange them so that a common strategy can be developed with a systematic follow-up to offset the amputation.

Although it is difficult to determine which multidisciplinary team is best suited to treat because of the multifactorial aspects of the disease, a combined effort of
revascularization, infection control, metabolic control, proper wound care and off-loading techniques is the foundation of a diabetic foot team (see Figure). Further studies evaluating the effect on diverse populations should be conducted to compare the rates of amputation but it may not be necessary if all patients with diabetic foot disease are treated aggressively with a multidisciplinary approach.
References


Table. Characteristics of Reviewed Studies

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<th>Downgrade Criteria</th>
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<td>Study Design Limitations Indirectness Imprecision Inconsistency Publication bias likely</td>
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<td>Amputation Rate</td>
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<td>Aydin et al⁴</td>
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<td>Yesil et al⁵</td>
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GRADE: Grading of Recommendations, Assessments, Development and Education.

⁴All the patients included into the study were Caucasians.
⁵No mention of ethnicities or races of the patients included into the study.
Figure. Prevention of Diabetes-Related Amputations