Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation

Podiatry impact on high-low amputation ratio characteristics: A 16-year retrospective study

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ARTICLE INFO

Article history:
Received 11 July 2016
Accepted 7 February 2017
Available online 21 February 2017

Keywords:
Podiatry
High:Low ratio
Amputation
Diabetic foot

ABSTRACT

Purpose: Complications from diabetes mellitus including major lower extremity amputation may have significant impact on a patient's mortality. This study determined what impact the addition of a limb salvage and diabetic foot program involving podiatry had at an academic institution over 16 years by analyzing high-low amputation ratio data.

Methods: The high-low amputation ratio in the diabetic population who underwent non-traumatic amputation of the lower extremity was retrospectively evaluated at an academic institution via cohort discovery of the electronic medical record and analysis of billing over 16 years.

Results: We directly compared two eras, one without podiatry and one with a podiatry presence. It was found that with the addition of a podiatry program, limb salvage rates significantly increased (R^2 (without podiatry) = 0.45, R^2 (with podiatry) = 0.26), with a significant change in both the rate of limb salvage per year (−0.11% per year versus −0.36% per year; $p < 0.01$) and an overall decrease in high-low amputation ratio (0.89 without podiatry to 0.60 with podiatry). Of note, approximately 40 major lower extremity amputations were avoided per year with the addition of a podiatry program ($p < 0.05$).

Conclusions: Our findings signify the importance of podiatric care in the diabetic population. With an established podiatry program present at an academic institution, major lower extremity amputations can be avoided and more limbs can be salvaged, thus preventing some of the moribund complications from this condition.

1. Introduction

Diabetes mellitus can be wrought with complications and amputation of the lower extremity has association with significant morbidity [1–4]. It is well understood that a diabetes-related amputation can lead to poor quality of life, increased risk of contralateral limb amputation, and increased mortality rates [3,5]. Mortality approaches 40% at one year and up to 80% at five years following amputation [3,5]. Following below-knee amputation a 30-day mortality of 6.3% has been reported whilst above knee amputation have a reported 30-day mortality rate of 13.3% [6].

Major lower extremity amputations (LEA), including both below-knee and above-knee amputation, were disproportionately high worldwide during the 1990s [7,8] but are beginning to decline [9,10]. For example, Denmark saw an 80% decrease

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http://dx.doi.org/10.1016/j.diabres.2017.02.008
0168-8227/

in rates of lower extremity amputations and a decline in the incidence of major LEA from 2000–2011 [11]. In Ireland, the incidence of lower extremity amputations demonstrated a diabetic was 22.3 times more likely to undergo a non-traumatic LEA than a non-diabetic; this did not change significantly between 2005 and 2009 [12]. A study from Spain in 2015 showed a national decrease in major and minor amputation incidence in patients with type 1 diabetes from 2001–2012, and a decrease incidence in patients with type 2 diabetes from 2004–2012 after the introduction of a diabetic foot unit in hospitals [13]. In the United States Veteran Affairs system, since the implementation of the Prevention of Amputation in Veterans Everywhere (PAVE) program, amputation rates declined from 10.2% in 2000 to 4% in 2010. The PAVE program is a podiatry inclusive limb salvage program [14].

When considering a treatment algorithm for a diabetic who will require an amputation, distal amputations are preferred as they are associated with less morbidity and mortality [15]. For example, the 30-day postoperative mortality following a transmetatarsal amputation is 3% [16]. Another recent study demonstrated that minor amputations are not significant predictors of mortality [17]. The research signified that limb salvage contributes to better patient outcomes, including functional ability and survival, and utilizing all resources available to the physician, will potentially lead to better outcomes in this patient cohort [18,19].

Previous literature has demonstrated the value of primary podiatric care as a strategy for complication prevention. Podiatrists are an integral part of the multidisciplinary team focused on lower extremity complications from diabetes [20,21]. Visiting a foot specialist was protective of undergoing lower extremity amputation [20]. Another study demonstrated that visiting a podiatrist in the year prior to a diabetic foot ulcer revealed a lower hazard of lower extremity amputation, major amputation, and hospitalizations in both non-Medicare eligible commercially insured and Medicare-eligible patient populations [22].

Economic value has been realized by patients with diabetes who visit with a podiatrist. Driver et al. in 2011 demonstrated that patients with ulcers who visited a podiatric physician had $13,474 lower costs in commercial plans and $3,624 lower costs in Medicare plans during 2-year-follow-up ($p < 0.01$ for both) [23]. In terms of amputation costs, in 2012, the cost of toe, foot, below-knee amputation, and above-knee amputation were $79,000, $244,000, $175,000, and $119000, respectively in the United States [24]. Limb salvage has cost savings as well as benefitting the patient's overall health.

It has been previously published that a high to low amputation ratio (Hi-Lo) is a measurement of limb salvage rates in a given population [25]. The ratio is the rate of major LEA divided by the total number of minor LEA. Wrobel et al. described distal foot amputations as minor LEA and below-knee and above-knee amputations as major LEA. Therefore, in theory, if the ratio is larger than one, where the numerator is equal to or greater than the denominator, then limb salvage efforts are not sufficient. On the contrary, when limb salvage efforts increase and major LEA are being avoided, the ratio is often less than one. As the ratio nears the asymptote of zero, greater limb salvage is occurring. This is beneficial because of the mortality and morbidity associated with higher level amputations [6].

We retrospectively examined the counts and rates of major and minor amputation in addition to the Hi-Lo ratio from 2000–2016 at our institution in the diabetic population. Prior to 2006, our institution did not have podiatric physicians on staff, nor a comprehensive diabetic foot program.

2. Methods

2.1. Study design

A retrospective cohort analysis was performed at our institution of lower extremity amputation from 2000–2016 by any provider at our tertiary care hospital. All patients who had type 1 or type 2 diabetes mellitus and underwent a non-traumatic lower extremity amputation were included.

2.2. Settings

The University Hospital System is an integrated, tertiary care facility. As of 2016 there are 1059 adult and pediatric beds and over 40 outpatient facilities with approximately 3100 physicians. Encounters described below were overall encounters seen at the University's health system from 2006–2016 and included all inpatient, outpatient, and emergency encounters with any physician. An encounter included a visit with a physician where a note is documented in the patient's chart. We analyzed encounter data at the hospital for all providers for patients with diabetes mellitus, type 1 or type 2. Distinctly, we also analyzed the encounters at our institution whereby a patient with diabetes mellitus, type 1 or type 2, was seen by a University Podiatry Faculty member. An average 134,681 encounters per year (134,681 ± 49,501 encounters per year) resulted.

2.3. Participants

Diabetic patients were identified by having a diagnosis code (ICD—DM 357.2x, 362.x, 648.0x, 250.xx, or 366.41) on at least two outpatient visits or one emergency department visit or one inpatient stay evaluation and management (E/M) codes [26]. We excluded traumatic amputations [18]. We defined major LEA as transtibial or transfemoral (CPT 27880, 27590, 27882 respectively). Minor amputations were defined as toe, ray resection, transmetatarsal, and Chopart's amputation (CPT 28820, 28825, 28810, 28805, 28800 respectively). We evaluated the numerators, which described the total number (n) of major amputations at our institution. The denominator described the total number (n) of minor amputations, for a given period at our institution. The numerator was divided by the denominator for a given period to create a ratio of major LEA to minor LEA. This number was then evaluated for change over the course of included dates.

The first source to determine numerator and denominator values was DataDirect. The second source was from our billing department at the facility. DataDirect, software developed by the University Of Michigan Medical School Office Of Research facilitates cohort discovery. It is a self-serve tool that