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Declines in Lower Extremity Amputation in the US Medicare Population, 2000-2010

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Abstract

Background: Despite evidence that improved outcomes are associated with more distal lower extremity amputations (LEA), the impact of recent advances in the orthopedic approach to diabetic foot ulcer (DFU) on the use and anatomic level of LEAs is unknown.
Methods: We queried the complete Medicare Part B claims database (2000-2010) for volume and reimbursement of all codes designating LEAs (hip and below) as well as a selection representing orthopedic treatments for DFU. Procedures were grouped for analysis; utilization rates per 100,000 Medicare enrollees and compound annual growth rates (CAGRs) of payments were calculated. Data are presented in the context of national health care spending trends.
Results: LEA utilization rates declined from 282.5 to 201.0 per 10^5 enrollees (–28.8%) over the decade. In general, declines were greatest for the most proximal levels and smallest for the most distal sites. Use of orthopedic treatments for DFUs, including Achilles tendon release and total contact casting, rose from 26.0 to 63.3 per 10^5 enrollees (+143.3%). Payment trends mirrored utilization data. During this period, total health care spending in the United States increased at a CAGR of 6.5%, whereas total Medicare payments rose at a CAGR of 8.9%.
Conclusion: The last decade saw a marked decline in the use of LEA in the Medicare population, despite unfavorable demographic changes. Furthermore, it became more likely for LEAs to occur at distal, limb-conserving locations. Over the same period, use of orthopedic treatments for DFU increased sharply.
Level of Evidence: Level III, retrospective comparative database analysis.

Keywords: statistical analysis, diabetes, outcome studies, tendon disorders, biomechanics

Lower extremity amputation (LEA) can be a life-saving procedure, performed to remove a tumor or nonsalvageable tissue damaged by trauma or peripheral artery disease. In 2005, an estimated 1.6 million Americans were living with a lost limb, 54% as a result of complications of vascular disease. Of those who had lost a limb to vascular disease, two-thirds had diabetes mellitus.[37] Many risk factors associated with LEA—high blood pressure, lipid, and glycemic levels, for instance—can be modulated with proper medication and lifestyle changes.[24,27] Recognizing this fact, many authors have attempted to track trends in LEA as a proxy to gauge the success of preventive care programs in various populations. Tantalizingly, many have reported a downward trend over the past 25 years.[2,10,29-31] Others, however, have attributed this decline to improvements in vascular interventions.[12] No studies have yet investigated the impact of improvements in the orthopedic approach to diabetic foot ulcer (DFU) on LEA incidence, and especially on the level of amputation.

While the overall decline in LEA is well known, it is poorly characterized. Very little work has been done on tracking changes in amputation level. The level of amputation is a crucial factor, as studies have shown better functional outcomes and gait in distal amputations compared with proximal ones.[7,9,19,32] We sought to address these shortcomings through a comprehensive analysis of LEA and orthopedic treatment for DFU in the entire US Medicare population over the period 2000-2010. As Medicare was primary payer on a full 26% of orthopedic office visits in 2009, we believe that this was an important and appropriate population to study.[4] Utilization rates per 100,000 Medicare enrollees and compound annual growth of payments were the primary outcomes assessed. Our objectives were to demonstrate that the decline in LEA observed by other authors could be better understood when broken down to specific anatomic levels and that advances in orthopedic treatment could be partially responsible. We hypothesized that greater declines would be observed for more drastic, proximal amputations.

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Table 1. *Current Procedural Terminology (CPT-4)* Codes for Procedures Included in This Study.

Group	*CPT* Code	Description
Amputations		
Hip	27290, 27595	Hip disarticulation
Femur	27590-27596	Transfemoral amputation
Knee	27598	Knee disarticulation
Lower leg	27880-27886	Transtibial amputation
Ankle	27888	Amputation, ankle, through malleoli of tibia and fibula (eg, Syme, Pirogoff type procedures)
	27889	Ankle disarticulation
Midfoot	28800	Midfoot amputation
Metatarsal	28805, 28810	Transmetatarsal amputation
Toe	28820	Metatarsophalangeal disarticulation
Partial toe	28825	Partial toe amputation
Orthopedic interventions		
Achilles tendon release	27605	Tenotomy, percutaneous, Achilles (separate procedure), local anesthesia
	27606	Tenotomy, percutaneous, Achilles (separate procedure), general anesthesia
	27612	Arthrotomy, posterior capsular release, ankle, with or without Achilles tendon lengthening
Gastrocnemius recession	27687	Gastrocnemius recession (eg, Strayer procedure)
Tenotomy, other tendons	27685	Lengthening or shortening of tendon, leg or ankle; single tendon (separate procedure)
	27686	Lengthening or shortening of tendon, leg or ankle; multiple tendons, each
Total contact casting	29445	Application of rigid total contact leg cast

Methods

We queried the Medicare Part B National Summary Data Files for years 2000-2010. Each file included information on 100% of Medicare payments made for Part B expenses (outpatient care and physicians' services) within a single fiscal year. Medicare provided coverage for 46.5 million individuals in 2010; 27.8% had diabetes mellitus and 1.8% had received an amputation.[26] While the median age of beneficiaries was 73 years in 2005, 14% were under age 65 and qualified through permanent disability.[8] This information is deidentified and made freely available to the public by the Centers for Medicare & Medicaid Services (CMS), and so this study was exempt from review by the institutional review board.[5]

We selected for analysis all *Current Procedural Terminology (CPT)* codes pertaining to lower limb amputation at or below the hip and a selection of codes pertaining to orthopedic treatment of DFU. Only appropriate modifier codes were included; those billed by an assistant or ambulatory surgical center in conjunction with a procedure were excluded from estimates of volume to avoid double counting. For each procedure, annual volume, reimbursement, and average reimbursement per procedure were recorded. For simplicity in presentation, each code was placed into 1 of 14 categories based on procedure type and anatomic location (Table 1). Utilization rates per 100,000 Medicare enrollees were calculated by dividing the volume of procedures in each group by the number of 10^5 Medicare enrollees in that year.[18] To allow a more accurate representation of annualized growth, compound annual growth rate (CAGR) of payments were also calculated for each group with the formula [(Ending Value/Beginning Value)^(1/No. of Years)] – 1. Payment trends were then compared against national inflation and health care spending data compiled by CMS and the US Bureau of Labor Statistics.[6,35] Data analysis was carried out using Microsoft Excel software (Redmond, WA). Statistical tests were used to ensure that inferences made based on samples were valid for entire populations. As our results presented conclusions based on the entire Medicare population, and not inferences to larger populations, statistical tests were not necessary to confirm them.

Results

Total reimbursement and volume for each anatomic level of amputation in each of the years 2000-2010 are presented in Table 2. In 2000, Medicare reimbursed a total of 111,520 LEAs. While the trend was not constant, over the 10-year period the number fell 16.3%, to 93,640 in 2010. Total

Table 2. Number and Medicare Reimbursement of Lower Extremity Amputations.

	2000		2001		2002	
Subset	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement
Hip	389	$383,624	360	$367,698	323	$312,770
Femur	29,049	$18,873,538	29,378	$20,975,608	31,348	$19,682,889
Knee	855	$508,324	894	$577,604	982	$496,165
Lower leg	26,705	$16,321,474	27,681	$18,574,154	26,564	$17,566,659
Ankle	432	$239,741	408	$244,252	391	$233,700
Midfoot	1124	$475,402	1305	$563,229	1055	$486,829
Metatarsal	25,509	$8,585,087	26,197	$10,078,019	25,502	$9,953,009
Toe	19,890	$4,615,397	20,874	$5,876,348	20,770	$6,387,573
Partial toe	7567	$1,580,701	8432	$2,232,597	8600	$2,528,404
Total	111,520	51,583,288	115,529	59,489,509	115,535	57,647,998

	2003		2004		2005	
Subset	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement
Hip	398	$374,297	363	$334,225	348	$318,710
Femur	29,675	$18,852,662	26,806	$15,523,913	24,853	$14,340,209
Knee	871	$472,738	782	$425,927	709	$385,769
Lower leg	26,059	$17,579,932	25,680	$14,782,244	23,889	$13,753,112
Ankle	456	$273,830	399	$203,079	388	$204,550
Midfoot	1054	$494,454	1127	$460,542	1046	$429,786
Metatarsal	25,322	$10,078,883	25,847	$8,562,477	24,845	$8,185,183
Toe	21,632	$6,841,926	21,983	$5,513,257	21,424	$5,318,882
Partial toe	9050	$2,732,867	9190	$2,171,013	9210	$2,137,137
Total	114,517	57,701,588	112,177	47,976,678	106,712	45,073,338

	2006		2007		2008	
Subset	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement
Hip	284	$265,883	286	$255,047	340	$245,542
Femur	22,046	$12,832,480	19,986	$11,479,797	20,381	$10,269,617
Knee	656	$360,624	574	$305,905	658	$301,940
Lower leg	21,745	$12,496,514	19,837	$12,175,042	20,829	$11,274,708
Ankle	341	$180,478	331	$164,091	305	$134,936
Midfoot	1000	$412,329	983	$386,659	952	$338,113
Metatarsal	23,927	$7,953,348	22,393	$7,840,696	21,944	$7,416,044
Toe	20,433	$5,123,401	20,091	$5,075,545	21,826	$5,152,180
Partial toe	9145	$2,159,116	8719	$1,998,965	10,324	$2,162,259
Total	99,577	41,784,173	93,200	39,681,747	97,559	37,295,339

	2009		2010		Overall change, 2000 vs. 2010	
Subset	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement	No. of Procedures	Reimbursement
Hip	303	$271,465	283	$263,835	–27.25%	–31.23%
Femur	17,359	$9,982,974	16,961	$10,273,513	–41.61%	–45.57%
Knee	533	$279,914	538	$296,017	–37.08%	–41.77%
Lower leg	17,967	$11,120,395	18,150	$11,905,041	–32.04%	–27.06%
Ankle	266	$129,696	261	$135,207	–39.58%	–43.60%
Midfoot	913	$353,643	856	$338,224	–23.84%	–28.86%
Metatarsal	21,880	$7,706,338	22,478	$8,353,710	–11.88%	–2.70%
Toe	21,821	$5,406,806	23,053	$5,980,210	15.90%	29.57%
Partial toe	10,513	$3,072,146	11,060	$3,493,369	46.16%	121.00%
Total	91,555	38,323,378	93,640	41,039,127	–16.03%	–20.44%

Table 3. Changes in Medicare Utilization Rates per 100,000 Beneficiaries.

Subset	2000 Rate	2010 Rate	Percentage Change
Hip	0.99	0.61	–38.4%
Femur	73.58	36.41	–50.5%
Knee	2.17	1.15	–46.7%
Lower leg	67.64	38.96	–42.4%
More proximal	144.38	77.13	–46.6%
Ankle	1.09	0.56	–48.8%
Midfoot	2.85	1.84	–35.5%
Metatarsal	64.61	48.25	–25.3%
Toe	50.38	49.48	–1.8%
Partial toe	19.17	23.74	23.9%
More distal	138.10	123.87	–10.3%
Total	282.48	200.99	–28.8%

reimbursement also fell—from $51.6 million in 2000 to $41.0 million in 2010, a 20.4% drop. Thus, on average, reimbursement per LEA procedure declined 5.3% over the study period, from $462.55 to $438.26. Amputations were most prevalent at the transfemoral level from 2000 until 2006, when transmetatarsal amputations surpassed them. By 2008, transfemoral amputations had fallen to fourth place in Medicare volume, behind transmetatarsal amputations, metatarsophalangeal disarticulations, and transtibial amputations.

The Medicare population grew by 18% over the last decade, from 39.5 to 46.6 million individuals.[21] Presenting procedure volumes per 10^5 Medicare beneficiaries, as is done numerically in Table 3 and graphically in Figure 1, takes this growth into account. Overall, the utilization rate for LEA fell from 282.5 to 201.0 per 10^5 beneficiaries (–28.8%). This decline was observed to vary widely by anatomic level of amputation, however, ranging from a 50.5% decline at the transfemoral level to a 1.8% decline at the metatarsophalangeal level. Partial toe amputations were the only area to see an increase in use for the period, rising by 23.9%. While some prior studies group amputations into "major" and "minor" categories, we found that these terms were used inconsistently, and we so opted to divide our own results into "more proximal" (above the ankle) and "more distal" (ankle and below) groups. Utilization rates for more proximal amputations declined from 144.4 to 77.1 per 10^5 (–46.6%), while more distal amputations saw a much smaller reduction, 138.1 to 123.9 (–10.3%).

Declines in amputation were almost matched by increases in the use of selected orthopedic treatments of DFU over the decade, as shown in Figure 2. In total, the utilization rate for these procedures increased 143.3% (from 26.0 to 63.3 per 10^5). The largest portion of this increase can be attributed to total contact casting, which saw its use increase from 16.0 to 36.7 per 10^5 (+130.1%), although the highest growth was actually seen for gastrocnemius recession (+574.8%; 1.4 to 9.4 per 10^5). Use of Achilles tendon releases also rose, although not as dramatically (+88.5%; 3.04 to 5.7 per 10^5). Due to limitations in the way procedures were coded, we were unable to present results for other specific muscles or tendons of the lower limb (Figure 3).

Rather than correcting for inflation or growth in the Medicare population, we elected to present our unadjusted payment data in the context of broader trends in health care spending. To do so on an annualized basis, we calculated CAGRs for overall consumer inflation, health care spending, and total Medicare spending, as well as for each of the study groups. As is visible in Figure 4, payments at all LEA levels lagged considerably behind the sustained growth seen in national health care spending (+13.38% CAGR) and total Medicare spending (+8.87% CAGR) over the decade.[5,35] Trends for payment mirrored utilization, with declines, in general, being greatest for more proximal amputations. Payments for the orthopedic DFU interventions that we included grew at a CAGR of 9.76%.

Discussion

Our data clearly demonstrate that LEAs have become less frequent since the turn of the century, despite unfavorable changes in demographics. The absolute number of LEAs in the US Medicare population declined by 16% in the decade following the year 2000, despite an 18% increase in the number of individuals receiving Medicare coverage. Many of these individuals were also in poor health. An analysis of the 2007 National Health and Nutrition Examination Survey revealed the high prevalence of diagnosed comorbidities in the Medicare population, including 70% for hypertension, 49% for hypercholesterolemia, 22% for coronary heart disease, and 16% for diabetes.[28] Studies that include allowances for undiagnosed cases report estimates of diabetes prevalence as high as 27.8%, which may explain why the CMS attributed 32% of its spending to the diabetic population in 2006.[26,37] In this context, the absolute decline in LEA appears particularly remarkable. In effect, decreased use of LEA has helped Medicare to care for a greater number of high-risk patients with less money spent.

The shift in amputation level observed in the Medicare population is also quite striking. At the decade's start, the overall Medicare utilization rate for LEA was around 140 per 10^5. While utilization declined over the course of the decade at most individual levels, the 10.5% drop seen in more distal amputations pales in comparison with the 47.6% decline achieved for more proximal amputations. This study uniquely demonstrated that this trend also could be seen when more specific anatomic levels of amputation are considered. Even within the foot, for example, more proximal levels saw greater declines: While amputations at the midfoot declined by 35.5%, those at the transmetatarsal level decreased by 25.3%, while metatarsophalangeal disarticulations only

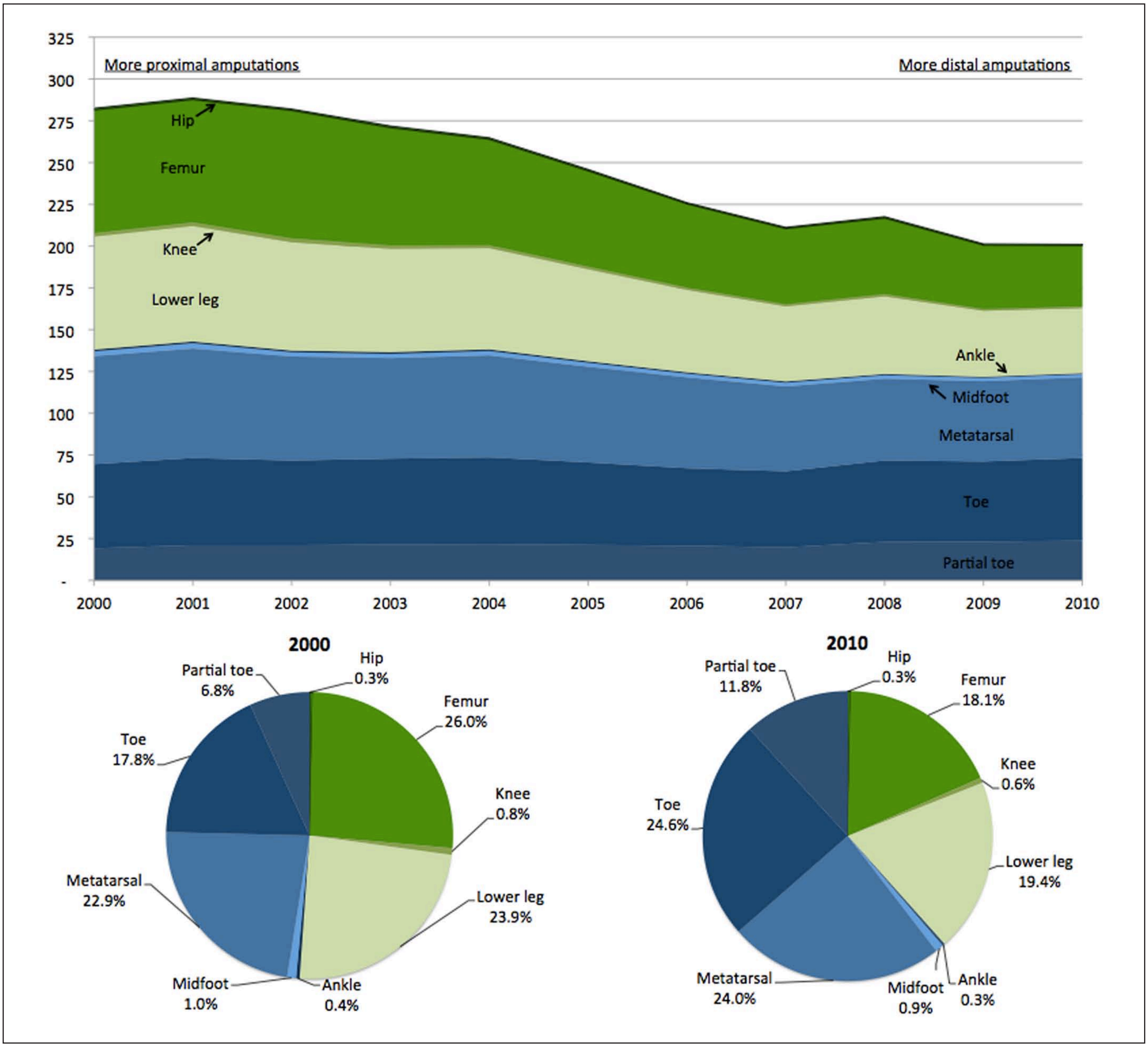

Figure 1. Overall decline in lower extremity amputation (LEA), 2000-2010. The top panel presents both the overall decline in utilization rate, 2000-2010, as well as general trends by anatomic level of amputation. More proximal amputations are represented by shades of green; more distal amputations by shades of blue. The lower pie charts present the composition of LEA in 2000 and 2010. Note the decrease in more proximal amputations.

shrank by 1.8%. The most distal amputation site possible—partial toe—was also the only level to see growth over the study period, a very substantial 23.9% increase in utilization. Previous work has validated what common sense indicates: the more distal the amputation site, the better the outcome for the patient. Advantages include increased mobility, and success in maintaining an independent living situation, as well as higher 1- and 2-year survival rates.[1,9,27,34] There is some concern about the higher rate of revision observed for more distal amputations, particularly in diabetic populations. In one study of 277 diabetic patients, the 5-year ipsilateral reamputation rate was 52% for toe amputations but only 13% for more proximal (above the ankle) amputations.[18] Our data seem to indicate, however, that revision to a higher level is not required for a large percentage of more distal amputees.

While few previous studies have attempted to track amputation level in any great detail, many have reported the general downward trend in utilization. For example, Li et al[24] investigated hospitalization rates for LEA via samples from national inpatient surveys and also demonstrated a

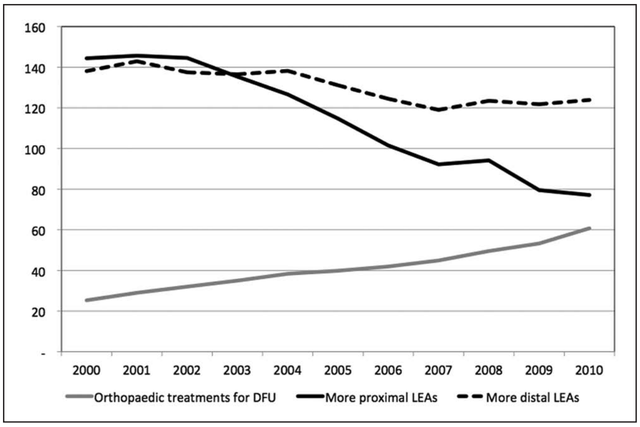

Figure 2. Utilization rates presented per 10^5 Medicare enrollees. DFU, diabetic foot ulcer; LEA, lower extremity amputation.

general decline since 1988.[24] Several explanations for this trend are possible. Perhaps the most optimistic attributes the decline to improved preventive care in the diabetic population. At least some studies indicate that glycemic control appears to be improving in recent years in individuals with diabetes, while the Centers for Disease Control and Prevention has reported declines in other cardiovascular risk factors, including hypercholesterolemia, hypertension, and smoking levels.[14-16] Multiple studies have confirmed that coordinated interdisciplinary foot care programs can reduce diabetic amputation rates considerably, although no such program exists at the national level.[10,36] It is thus uncertain to what degree improved preventative care has affected the overall Medicare population.

Others have observed a sharp rise in revascularization interventions in recent years and have pointed to improved access to vascular surgery as a causative factor of the decline in LEA. This is easier to demonstrate at the national level, as was done by Goodney et al,[11] who also used the Medicare Part B database to track trends in LEA and revascularization. They similarly observed a decrease in LEA from 1996 to 2006 (although they only considered amputations above the ankle and did not present trends for level of amputation), alongside a 3-fold increase in use of endovascular interventions and a 42% decline in bypass surgery. Another study used detailed Medicare claims data to demonstrate that increasing the supply of vascular surgeons in a region by 1 standard deviation was associated with a 1.4% reduction in amputation rate.[13] These are observational studies, like our own, and so their authors are careful to avoid making direct claims to causality.

The orthopedic approach to the management of DFU has evolved notably over the last decade and may share some of the credit for the decline in LEA. Our data reveal that exceptional growth has occurred in the use of both total contact casting (TCC) and tendon lengthening procedures. DFU is one of the most important indications for tendon lengthening and virtually the only indication for TCC. Both approaches attempt to promote healing and prevent recurrence by relieving pressure at the ulcer site. While neither is a novel tactic, both received considerable support from research published during the decade we analyzed. In 2000, the first year included in our study, a Cochrane review found only 1 randomized controlled trial on TCC and criticized the "small amount of poor quality research" in the area.[33] By 2008, another systematic review was able to conclude in favor of TCC based on 21 high-quality controlled studies.[3] Similarly, the first papers supporting the use of Achilles tendon lengthening in the prevention of diabetic foot ulcer recurrence began appearing in the late 1990s.[12,25] In a randomized controlled trial published in 2003, Mueller et al[30] demonstrated that using Achilles tendon lengthening plus TCC resulted in a 52% lower ulcer recurrence rate than achieved through treatment with TCC alone. More recently, other techniques to relieve pressure have gained prominence, including gastrocnemius recession and tenotomy of the flexor digitorum longus, peroneus longus, and tibialis posterior.[20,22,23] Our study seems to demonstrate the impact of this line of research.

Our analysis is limited our study's observational design and its reliance on the Medicare Part B database. Our payment data do not include this 20% or any other amounts paid out by individuals, employers, or supplemental insurance companies. We were also unable to assess the diagnosis associated with each procedure, so we cannot report the proportion of cases due to diabetes or other causes. The utilization rates we calculated were valid only for the population from which they were derived, Medicare beneficiaries, and it is possible that some of the trends we reported may differ in other populations, including the general American population. While we believe that utilization and payment trends together provide a useful economic perspective, this study is not equivalent to a full analysis of the economic impact of LEA, which would require consideration of associated indirect costs, such as work loss and prosthetic costs. Finally, while the trends we observed were real, we were unable to identify with certainty the causal relationships between the decline in amputation and orthopedic interventions through this observational study. It is likely that a combination of factors, including those highlighted above, has resulted in these hopeful developments.

Despite the favorable information we present, the burdens of diabetic complications are still tremendous for both patients and society; joint efforts from clinicians, researchers, and the government are necessary to continue this positive momentum. The number of Americans living with diabetes is forecast to nearly double in the next 2 decades, totaling perhaps 44.1 million individuals by 2034.[15] Studies indicate that diabetic patients currently face up to a 25% lifetime risk of

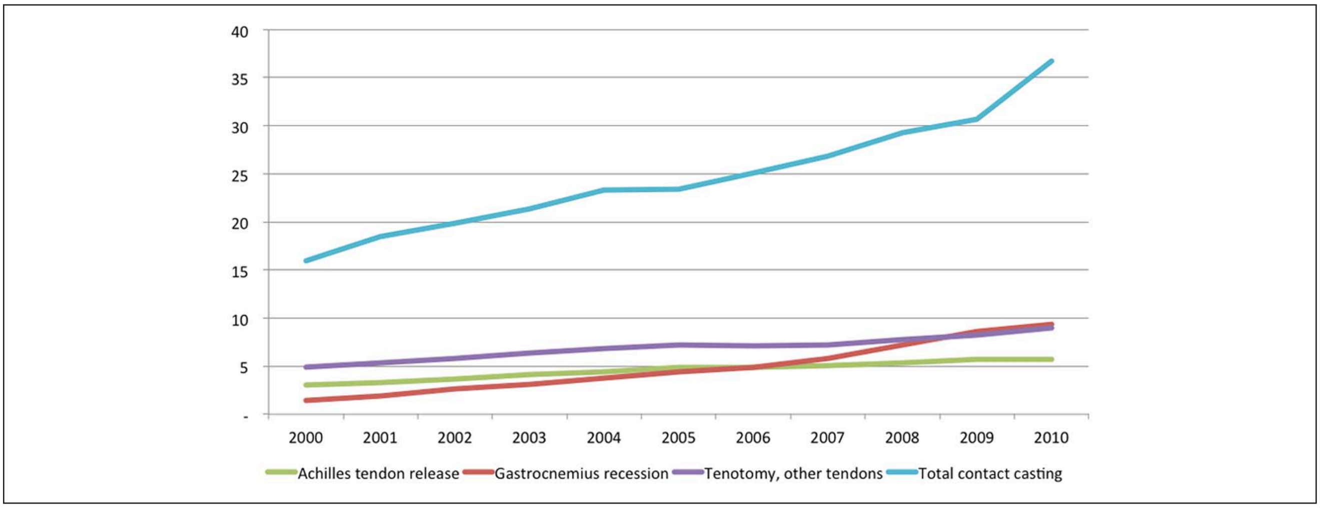

Figure 3. Utilization rates presented per 10^5 Medicare enrollees.

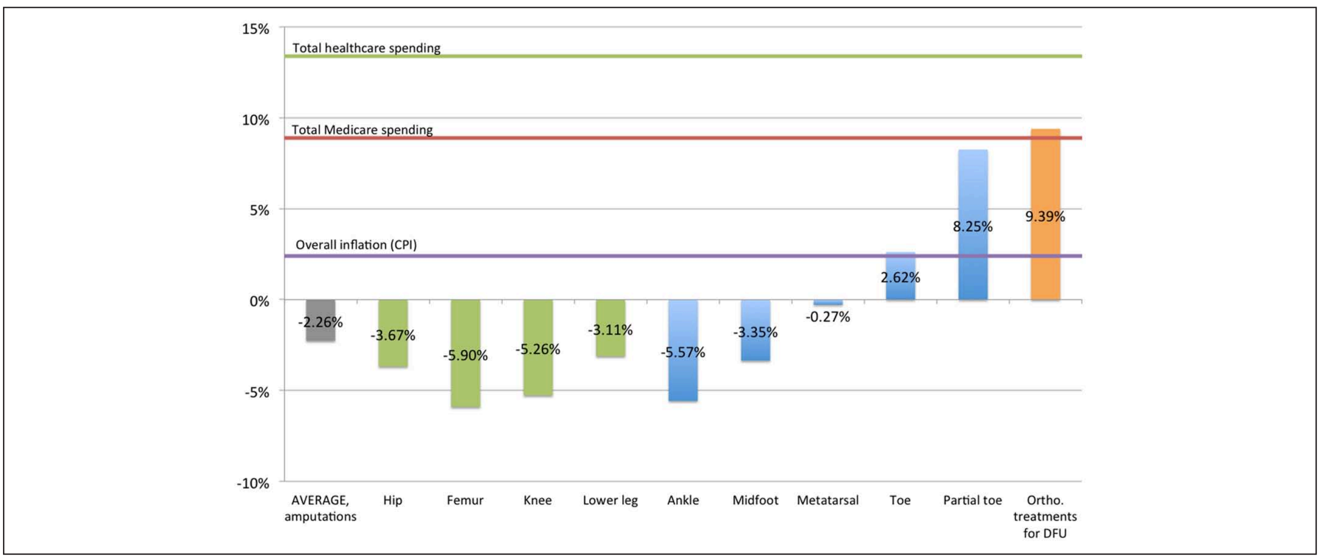

Figure 4. Compound annual growth rate, 2000-2010, included procedures. Major amputations are represented by the green; minor, by blue; orthopedic treatments for diabetic foot ulcer (DFU) orange.

amputation.[17,24] Clearly, continued success in preventing lower limb amputations, and limiting those that do occur to more distal levels, will be an uphill battle. Future work is needed to rigorously demonstrate best practices in preventing LEA and to identify definitively the causes behind recent declines. The rewards—both fiscal and intangible—for answering these questions should motivate policy makers to devote resources to this important area of research.

Declaration of Conflicting Interests

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