Disease Burden of Medial Epicondylitis in the USA Is Increasing: An Analysis of 19,856 Patients From 2007 to 2014

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Abstract *Background:* Medial epicondylitis (ME), or “golfer’s elbow,” is often treated initially by conservative means. Up to 15% of recalcitrant cases require surgical intervention, according to small sample populations, but no national study has determined the incidence of the diagnosis or corroborated the rate of surgical intervention. *Purpose/Question:* We sought to review the annual incidence of ME, surgical rates, and health care costs in a population setting. *Methods:* A national database was queried for ME from 2007 to 2014. Annual rates and the percentage of diagnosed cases subjected to surgical intervention were recorded. Epidemiologic data was reported with descriptive statistics, and the significant trends over time were analyzed using linear regression. *Results:* We identified 19,856 cases of ME in the study period. There was a significant increase in the annual incidence and overall incidence per 10,000 patients. The proportion of diagnoses in patients under 65 years of age decreased significantly, while the proportion in those 65 years of age or

older significantly increased. The annual number of surgical interventions significantly increased over the study period, although the annual proportion of diagnosed cases proceeding to surgery remained constant. The proportion of patients 65 years of age or older undergoing surgery significantly increased. Total reimbursement for the management of ME during the study period was \$1,877,189. While there was a significant increase in the total annual reimbursement, annual per-patient reimbursement did not change significantly. *Conclusions:* While the annual incidence of ME and surgical treatment of ME increased significantly from 2007 to 2014, the proportion of cases treated surgically did not. Notably, the proportion of patients 65 years of age or older diagnosed with and being surgically treated for ME has increased in recent years. Total reimbursement for ME has steadily risen, although per-patient reimbursement rates have not significantly changed.

Keywords medial epicondylitis · epidemiology · surgical treatment · health care costs

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Introduction

Medial epicondylitis (ME), or “golfer’s elbow,” is a degenerative process affecting a convergence of muscles in the forearm that are involved in wrist flexion and forearm pronation [1, 13]. Specifically, the pronator teres, flexor carpi radialis, flexor carpi ulnaris, palmaris longus, and flexor digitorum superficialis join to form a common flexor tendon (CFT), which inserts onto the medial epicondyle of the humerus [1, 9, 13]. Chronic tendinosis involving the CFT is thought to be responsible for ME symptoms [2, 5, 9]. ME prevalence is estimated to be less than 1% in the general population [8], although the incidence and prevalence in occupational settings have been reported as high as 1.5 and 8.2%, respectively [4, 7, 12, 15]. Furthermore, one study reported that the highest rate of prevalence was observed in

subjects between the ages of 45 and 54 years in both genders [14]. Despite the high incidence and prevalence described in these sampled populations, there remains limited evidence from a national sample to corroborate these rates and to provide comparative population-based data.

Treatment of ME typically begins with conservative, non-invasive measures [8]. The mainstays of initial management include activity modification, ice, non-steroidal anti-inflammatory medications (NSAIDs), orthotics (including counter-force bracing), and physical therapy focused on eccentric strengthening [1, 2, 6, 9]. After failure of such conservative treatments, corticosteroid injections are often recommended. While uncommon, recalcitrant cases do occur, sometimes requiring surgical intervention [1]. Arthroscopic, open, and percutaneous approaches have all been described [5, 6, 13]. While previous estimates based on small sample populations suggest that between 5 and 15% of recalcitrant cases ultimately require surgical intervention [2, 5], no current literature draws from a national sample to corroborate these rates. Furthermore, health care costs associated with the management of ME have not been well characterized.

With the identified limitations in the current literature, we sought to study the national trends in the diagnosis, treatment, and health expenditures associated with ME. The chief goal of this study was to review the annual incidence of ME from 2007 to 2014 in a large population setting. We also sought to analyze annual surgical intervention rates and the financial impact of ME on the health care system. We hypothesized that the annual incidence of ME diagnoses, rates of surgical intervention, and associated health care costs would all increase over the study period.

Materials and Methods

An insurance-based database of patient records, the PearlDiver patient records database (www.pearliverinc.com, Fort Wayne, IN, USA), was used for this study. All data is de-identified and anonymous and thus exempt from institutional review board approval. The database in its present form contains data from two different insurers, Medicare and Humana, a private insurer. The patients from the present study were all taken from this Humana database, chosen because it contains patients of all ages, not just those largely above age 65, as would be found in the Medicare database. The most typical age of presentation for ME is between 30 and 40 years, making the use of a database containing patients in this age group vital to the study.

The database contains procedural volumes, basic patient demographics, laboratory data, and prescription drug information, among numerous other data for patients, with International Classification of Diseases, 9th Revision (ICD-9) diagnoses and procedures or Current Procedural Terminology (CPT) codes. The database covers patients insured from 2007 through 2014, and patients can be tracked across all settings (inpatient, outpatient). Overall, the database contains approximately 20 million patients in all US states and territories, including commercially insured patients and

group and individual Medicare Advantage patients through Humana (www.pearliverinc.com/researchinfo.html). The database, on a password-protected server maintained by PearlDiver, was accessed by the senior author, who performed all data queries.

The PearlDiver patient records database was queried for patients carrying a diagnosis of ME using ICD-9 code 726.31 from 2007 to 2014. To prevent duplicative results, patients with multiple diagnoses of ME were counted only once when the diagnostic code first appeared in their record. Further analysis of this cohort included identification of surgically treated cases of ME using CPT codes 24350, 24351, 24352, 24354, 24356, 24358, and 24359, with an associated ICD-9 code for ME. For all diagnosed cases, patient demographics were recorded and analyzed, including age, gender, and US region. For surgical cases, annual rates and the percentage of diagnosed cases treated surgically were recorded. Epidemiologic data was reported with descriptive statistics including number, percentage, mean, median, and ranges, as appropriate. The significance of trends over time was determined using linear regression.

The financial burden of ME was determined using the reimbursement for the Diagnosis-Related Group (DRG) for each procedure. PearlDiver provided the reimbursement for the DRG directly from the private insurer, Humana. This reflects the amount the insurer reimbursed for the episode of care, including surgical costs, surgeon costs, and global period expenses. It does not necessarily include fees for providers or products not associated with the surgical procedure, such as braces or physical therapy. The reimbursement values provided represent the amount the insurer paid and not the amount the provider/hospital billed. This allows for a more accurate assessment of the financial burden to the healthcare system.

Epidemiologic data was then analyzed to report descriptive statistics including number, percentage, mean, median, and ranges where appropriate. The significance of trends in annual procedural rates over time was determined using linear regression. For all statistical comparisons, $p < 0.05$ was considered to represent statistical significance.

Results

We identified 19,856 patients with a diagnosis of ME over the study period. There was a significant increase in the annual incidence ($R^2 = 0.857$, $p = 0.001$), as well as the overall incidence per 10,000 patients ($R^2 = 0.864$, $p = 0.001$) (Table 1). The proportion of male and female patients diagnosed did not significantly change ($R^2 = 0.045$, $p = 0.646$). Interestingly, the annual proportion of diagnoses in patients under age 65 significantly decreased ($R^2 \geq 0.643$, $p \leq 0.017$), while the proportion in those 65 years or older significantly increased ($R^2 = 0.941$, $p < 0.001$). Geographically, there was a significant increase in the incidence of ME per 10,000 patients in the Northeast ($R^2 = 0.747$, $p = 0.006$) and South ($R^2 = 0.979$, $p < 0.001$) (Table 1).

Table 1 Trends in diagnosis of medial epicondylitis from 2007 to 2014

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p</i> value
Overall									
<i>N</i>	1799	1950	2119	2115	2115	2620	3002	3847	0.001
Incidence per 10k patients	2.9	2.8	3.4	3.6	3.6	3.6	3.8	4.0	0.001
Gender									
Female	868	900	1012	1135	1241	1442	1442	1809	0.616
Male	931	1050	1208	1249	1379	1580	1580	2038	(47.0%) (53.0%)
Age, years									
<25	135	130	174	151	138	154	187	183	(4.8%) 0.017
25–39	201	220	194	175	177	193	213	237	(6.2%) <0.001
40–64	1007	1048	1148	1057	1163	1245	1357	1833	(47.6%) 0.001
≥65	456	552	603	732	906	1028	1265	1594	(41.4%) <0.001
Region (incidence per 10k patients)									
Northeast	0.4	0.6	0.8	1.0	0.8	1.0	1.2	1.0	0.006
Midwest	3.6	3.3	3.9	4.0	4.2	3.8	4.0	4.0	0.088
West	2.3	2.4	3.2	2.9	2.7	2.7	2.9	2.7	0.372
South	3.0	3.1	3.4	3.8	4.0	4.1	4.3	4.7	<0.001

Of the diagnosed cases, 426 (2.1%) required operative treatment. The annual number of procedures performed significantly increased ($R^2 = 0.902$, $p < 0.001$) over the study period; however, the annual proportion of diagnosed cases proceeding to surgery remained constant ($R^2 = 0.013$, $p = 0.785$) (Table 2). The proportion of male and female patients undergoing surgical intervention did not significantly change ($R^2 = 0.156$, $p = 0.333$). Similar to the diagnosis trends, the proportion of patients undergoing surgical intervention represented by patients 65 years of age or older significantly increased ($R^2 = 0.636$, $p = 0.018$) (Table 2). There were no significant changes in regional procedural rates ($R^2 < 0.292$, $p > 0.167$) (Table 2).

Reviewing the associated procedural cost and health care burden, we found a total reimbursement of \$1,877,189 during the study period. There was a significant increase in annual total reimbursement ($R^2 = 0.888$, $p < 0.001$); however, annual per-patient reimbursement rates did not significantly change ($R^2 = 0.471$, $p = 0.060$) (Fig. 1).

Discussion

ME is a commonly encountered condition in both general and subspecialty orthopedic settings, particularly among certain occupational populations. However, national incidence remains ill defined, as are rates of surgical intervention and associated health care costs. In our review of over 19,500 cases of ME from a national database, we identified significant increases in both annual and overall incidence of ME per 10,000 patients. The number of cases requiring surgical intervention also increased significantly during the study period. However, contrary to our hypothesis, the proportion of surgical cases remained consistently low, at roughly 2%. Finally, while the total annual associated procedural costs and health care burden increased significantly, per-patient reimbursement rates did not.

There are several limitations of this study, most of which arise inevitably with the application of a large-scale national administrative database. For instance, the purported power of the database analysis relies on the accuracy of its procedure coding. Thus, providers' miscoding and noncoding are conceivable sources of error, potentially compromising the validity of our results. It is important to note that although conservative measures, including physical and occupational therapy, remain the mainstay of initial treatment for ME, they are not well captured in this database. The financial burden described in our study solely represents surgical patients. Additional study, potentially from a different database or institutional cohort, would be necessary to ascertain the financial burden of conservative management of this condition. Furthermore, while this study aims to provide a representative cross-sectional US analysis, data was taken from a single insurer, and therefore the results may not reflect national trends. Despite this limitation, we chose this database specifically because it covers the younger age demographic that is typically affected by ME and because it includes insured patients in all US states, as well as both commercial and Medicare Advantage customers, representing a large and

Table 2 Trends in surgery for medial epicondylitis from 2007 to 2014

	2007	2008	2009	2010	2011	2012	2013	2014	<i>p</i> value
Overall									
<i>N</i>	31	43	49	44	59	63	70	67	<0.001
Percentage of diagnosed	1.7%	2.2%	2.3%	2.1%	2.5%	2.4%	2.3%	1.7%	0.785
Gender									
Female	9 (29.0%)	17 (39.5%)	22 (44.9%)	15 (34.1%)	37 (62.7%)	30 (47.6%)	29 (41.4%)	28 (41.8%)	0.333
Male	22 (71.0%)	26 (60.5%)	27 (55.1%)	29 (65.9%)	22 (37.3%)	33 (52.4%)	41 (58.6%)	39 (58.2%)	
Age, years									
<40	6 (19.4%)	9 (20.9%)	3 (6.1%)	7 (15.9%)	4 (6.8%)	3 (4.8%)	6 (8.6%)	6 (9.0%)	0.065
40–64	21 (67.7%)	24 (55.8%)	41 (83.7%)	26 (59.1%)	40 (67.8%)	38 (60.3%)	43 (61.4%)	40 (59.7%)	0.477
≥65	4 (12.9%)	10 (23.3%)	5 (10.2%)	11 (25.0%)	15 (25.4%)	22 (34.9%)	21 (30.0%)	21 (31.3%)	0.018
Region (incidence per 10k patients)									
Northeast	2.3	3.3	4.1	3.8	5.7	4.8	5.0	2.8	0.323
Midwest	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.167
West	2.1	2.5	3.0	4.1	3.2	3.1	3.0	3.2	0.226
South	0.0	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.197

diverse sampling of the US health care system. Finally, diagnoses and procedures for epicondylitis lacking laterality coding were excluded, which could result in an underestimation of diagnostic and surgical rates of ME.

Reports on the epidemiology of ME remain scarce, with the vast majority focusing on point-prevalence within specific, high-risk occupational settings [4, 15]. While others have attempted to characterize prevalence within the general population, they have included populations outside the USA, and most did not attempt to identify incidence rates [9, 14]. The first study to take a longitudinal approach and report on incidence of ME alone, albeit in an occupational cohort, was performed by Descatha et al. in France [4]. They used results from a national survey to report on the prevalence and incidence of ME in 1757 workers between 1993 and 1997. Subjects were required to have ongoing exposure to repetitive work involving the wrists and hands. They identified an annual incidence rate of 1.5%, but were limited by their cross-sectional study design to comment on changes in annual incidence rates during that period [4]. Their reported rate is much greater than even the highest of those identified in our cohort (four cases per 10,000 patients; 0.04%), and the reasons for this are evident. Repetitive stress on the CFT is well known to predispose individuals to ME [1, 8]; therefore, this study is not generalizable to a larger population. In contrast, our study

is aimed at identifying the incidence of ME in a larger, national, non-occupational setting.

The rates of surgical intervention following ME diagnosis have not been well defined, and most studies have focused on identifying the percentage of recalcitrant cases requiring surgery. As previously mentioned, these estimates, based on small cohort studies, have ranged from 5 to 15% [2, 5]. Using a national database, we identified a 2.1% rate of surgical intervention, with a stable proportion of cases managed surgically each year. More recent studies have begun to report on surgical rates following specific conservative treatments. Degen et al. used a national database to determine the incidence of surgical interventions following failed therapeutic injections for ME [3]. They reviewed 1837 patients who received therapeutic injections for ME between 2005 and 2012. Of those, 52 (2.8%) ultimately underwent surgery on the ipsilateral elbow within 2 years. This represents a modestly greater proportion than we identified in our national cohort (2.1%). The likely factor underlying the difference in these rates is that cases failing to respond to conservative therapy would be expected to proceed to surgery at higher rates. Our study is the first to attempt to represent the rates of operative treatment of ME cases in the general population, including in patients who refused injection and opted for surgery after failed

Fig. 1. Total annual reimbursement for medial epicondylitis surgery from 2007 to 2014 and annual per-patient reimbursement for medial epicondylitis surgery from 2007 to 2014

conservative treatments. This information is valuable to patients and surgeons alike in predicting the need for surgical intervention for ME, irrespective of additional risk factors or failed therapies.

Lastly, the procedural costs associated with ME management were reviewed. An average per-patient cost of \$4319 was identified during the period. Silverstein et al. attempted to identify costs associated with epicondylitis via workers' compensation claims data but failed to separate data between lateral and medial subtypes [10]. They identified an average of \$6593 in accepted claims per person with epicondylitis. As workers' compensation encompasses more than medical costs, this value is higher than the one identified in our national cohort. In addition to identifying a per-person average, our study also discerned a significantly rising annual total reimbursement for ME. To our knowledge, this is the first study showing an increasing health care burden related to ME treatment. This emphasizes the need for ongoing research and future trials to compare management options and improve treatment algorithms in order to prevent unnecessary health expenditures. For example, studies comparing debridement vs. tenotomy for the treatment of recalcitrant lateral epicondylitis have shown similar improvements between groups, with shorter recovery times for those undergoing debridement [11]. As debridement is a more cost-effective option, it would be interesting to see if those findings held true for the treatment of ME, as well. This is an interesting area for future research.

In conclusion, the annual incidence of ME and surgical treatment of ME increased significantly from 2007 to 2014. However, the proportion of cases treated surgically did not significantly change during that time. Notably, the proportion of patients 65 years of age or older diagnosed with and treated surgically for ME has increased in recent years. Regional variations in diagnosis and treatment have been minimal. Over time, total reimbursement for ME has steadily risen, demonstrating an increasing burden on the healthcare system. Per-patient reimbursement rates, however, have not significantly changed. While further study is needed, the results from this study may aid in the optimization of treatment algorithms for ME, as well as help reduce the associated financial burden.

Compliance with Ethical Standards

Conflict of Interest: Anthony Wiggins, BA, Jourdan M. Cancienne, MD, Christopher L. Camp, MD, Ryan M. Degen, MD, David W. Altcheck, MD, and Brian C. Werner, MD, declare that they have no conflict of interest. Joshua S. Dines, MD, reports receiving grants and personal fees from Arthrex, personal fees and royalties from Linvatec, and royalties from Wolters Kluwer Health; acting as a paid consultant to Trice; holding editorial or governing board membership at American Journal of Orthopedics and Journal of Shoulder and Elbow Surgery and

board or committee membership at American Shoulder and Elbow Surgeons, all outside the submitted work.

Human/Animal Rights: N/A

Informed Consent: N/A

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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