INTRODUCTION

Chronic rhinosinusitis (CRS) is an inflammatory disease of the paranasal sinuses that affects up to 15% of the US population.1 CRS disease burden is high, with a national annual health-care cost estimated between $8 billion and $64.5 billion dollars, largely arising from outpatient services, prescription medication, ambulatory care, and emergency room treatment.2 For patients with CRS refractory to medical treatment, conventional functional endoscopic sinus surgery (FESS) has provided immediate and long-term relief in as many as 85% of patients.3,4 However, the procedure is associated with potential postoperative complications, including a low risk (<1%) of major complications such as cerebrospinal fluid leak, meningitis, hemorrhage, and orbital injuries.5 Furthermore, despite a high initial success rate, up to 10% to 15% of patients will require revision surgery.6

Controversy surrounds the ideal postoperative care regimen after FESS and largely falls to provider preference. In particular, recommendations for the timing and extent of postoperative debridement after FESS varies. Some suggest initial debridement days after the procedure followed by weekly or monthly follow-up visits.7 Regular debridement after sinus surgery has been shown to reduce adhesions when compared to saline irrigation alone.7 However, depending on debridement frequency, issues arise regarding patient compliance and comfort without substantial pro-healing benefits.8 Some providers have implemented alternative postoperative care strategies in adult patients to minimize debridement while still preventing adhesions and crustings, and maintaining rates of symptom improvement.9,10 As such, although aggressive debridement may aid in remucosalization and improve surgical success, patient discomfort and associated procedural costs also need to be taken into account. In a recent systematic review, Green et al11 analyzed 6 randomized controlled trials comparing postoperative debridement to no debridement. Their work demonstrated no clear evidence in long-term benefits based on symptom scores. Additional studies have revealed evidence for other postoperative care involving saline irrigation, topical and systemic corticosteroids, and antibiotics to alleviate short-term symptoms, prevent nasal poly recurrence, and improve ease of surgery and postoperative appearance.12-15

First introduced in the early 2000s, balloon sinuplasty (BSP) was approved for the treatment of CRS in 2005 by the Food and Drug Administration. Compared to traditional FESS, BSP is considered a minimally invasive...
procedure with the potential to preserve the nasal mucosa, shorten postoperative recovery, and minimize complications. Calitxo et al demonstrated the rapid replacement of traditional FESS with BSP procedures since the introduction of Current Procedure Terminology (CPT) codes specific for BSP in 2011. Given the less-invasive and mucosa-sparing nature of this new procedure, one would expect a lower need for postoperative debridement. However, rates of debridement utilization given the rise in BSP remain uncharacterized.

Since 2014, the Centers for Medicare and Medicaid Services has made available data on utilization, payment, CPT codes, and place of service information for fee-for-service beneficiaries enrolled in Medicare Part B. This information has made it possible to analyze the rates and utilization of procedures, and provide insight into epidemiologic and financial burdens of various diseases. The primary objective of this study was to analyze temporal and geographic trends in endoscopic debridement from 2000 to 2016 in the Medicare population. In addition, we aimed to correlate the use of endoscopic debridement with FESS and BSP given temporal shifts in procedure utilization.

**METHODS**

Medicare Part B National Summary data files were analyzed from 2000 to 2016 for temporal trends of endoscopic debridement, FESS, and BSP (see Table 1 for CPT codes). These data files include information about the number of services performed for a given CPT code as well as allowed charges and payments. Allowed charge is defined as the “amount Medicare determines to be reasonable payment for a provider or service covered under Part B [which] includes the coinsurance and deductible amounts.” Payment is the amount Medicare reimburses to providers.

The Medicare Physician and Other Supplier Public Use data files provide information on services and procedures provided to Medicare beneficiaries by physicians and other health-care professionals. Data files were collected for the years 2012 to 2016, which were the only years available at the time of analysis. Geographic information was obtained from 2016 and was summarized from provider information. Geographic results were organized using US Census Bureau designated regions: the West (including Mountain and Pacific states), Northeast (Mid-Atlantic and New England), Midwest (East North Central, West North Central), and South (West South Central, East South Central, South Atlantic). The West and East South Central regions were combined. The 2015 US Census population estimate was used to obtain regional populations of individuals ≥ 65 years old. These values were used to estimate procedures per 100,000 Medicare beneficiaries.

Linear regression was used to correlate endoscopic debridement, sinus surgery, and BSP procedures (Table 2). Providers who performed no procedures, including no balloon dilation and no endoscopic sinus surgery, were excluded from the regression analysis. We performed ordinary least-squares linear regression analysis, with the test of

<table>
<thead>
<tr>
<th>Rank</th>
<th>HCPCS description (HCPCS code)</th>
<th>Total allowed charges ($)</th>
<th>Total nonfacility volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nasal endoscopy dx (31231)</td>
<td>94,472,734</td>
<td>454,324</td>
</tr>
<tr>
<td>2</td>
<td>Diagnostic laryngoscopy (31575)</td>
<td>58,471,364</td>
<td>489,057</td>
</tr>
<tr>
<td>3</td>
<td>Remove impacted ear wax unilateral (69210)</td>
<td>37,124,601</td>
<td>726,043</td>
</tr>
<tr>
<td>4</td>
<td>Antigen therapy services (95165)</td>
<td>24,996,095</td>
<td>2,072,867</td>
</tr>
<tr>
<td>5</td>
<td>Nasal/sinus endoscopy surgery (31237)</td>
<td>24,409,484</td>
<td>80,453</td>
</tr>
<tr>
<td>6</td>
<td>Sinus endoscopy with balloon dilation of frontal sinus ostium (31296)</td>
<td>21,342,912</td>
<td>17,381</td>
</tr>
<tr>
<td>7</td>
<td>Sinus endoscopy with balloon dilation of maxillary sinus ostium (31295)</td>
<td>14,370,228</td>
<td>10,967</td>
</tr>
<tr>
<td>8</td>
<td>Comprehensive hearing test (92557)</td>
<td>14,208,909</td>
<td>333,378</td>
</tr>
<tr>
<td>9</td>
<td>Laryngoscopy telescopic (31579)</td>
<td>11,041,916</td>
<td>52,893</td>
</tr>
<tr>
<td>10</td>
<td>Create eardrum opening (69433)</td>
<td>7,977,471</td>
<td>36,688</td>
</tr>
</tbody>
</table>

dx = diagnostic; HCPCS = Healthcare Common Procedure Coding System.

<table>
<thead>
<tr>
<th>Type</th>
<th>Procedure name</th>
<th>CPT code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative endoscopy/debridement</td>
<td>31237</td>
<td></td>
</tr>
<tr>
<td>Endoscopic maxillary antrostomy + tissue</td>
<td>31267</td>
<td></td>
</tr>
<tr>
<td>Endoscopic frontal ± tissue</td>
<td>31276</td>
<td></td>
</tr>
<tr>
<td>Endoscopic sphenoid</td>
<td>31287</td>
<td></td>
</tr>
<tr>
<td>Endoscopic sphenoid + tissue</td>
<td>31288</td>
<td></td>
</tr>
<tr>
<td>Endoscopic anterior ethmoid</td>
<td>31254</td>
<td></td>
</tr>
<tr>
<td>Endoscopic total ethmoid</td>
<td>31255</td>
<td></td>
</tr>
<tr>
<td>Endoscopic maxillary antrostomy</td>
<td>31256</td>
<td></td>
</tr>
<tr>
<td>Balloon maxillary</td>
<td>31295</td>
<td></td>
</tr>
<tr>
<td>Balloon frontal</td>
<td>31296</td>
<td></td>
</tr>
<tr>
<td>Balloon sphenoid</td>
<td>31297</td>
<td></td>
</tr>
</tbody>
</table>
Pearson’s $r$ for bivariate correlations. Statistical analysis was performed using RStudio version 0.98.1091 (RStudio, Boston, MA) in R 3.1.2 (The R Foundation for Statistical Computing, Vienna, Austria). This study was exempt from institutional review board review at our institution.

**RESULTS**

Between 2000 and 2016, the number of allowed endoscopic debridement procedures increased from 31,579 to 79,762, with an annual average growth rate of +6.0% (Figure 1). During this time frame, annual growth rate trended downward from +13.3% in 2000 to 2001 to +5.5% in 2015 to 2016 (range, +1.0%–+14.5%). During this period, the number of allowed FESS procedures increased from 66,559 to 116,008, with an average annual growth rate of +3.6%. Upon the introduction of BSP CPT codes in 2011, the number of allowed BSP procedures from 2011 to 2016 increased from 7604 to 42,949, with an average annual growth rate of +44.2%.

The annual total reimbursement increased from $5,944,582 to $19,438,956, with an average annual increase of +8.4%. This annual change fluctuated over time without a notable trend, ranging from –16.9% in 2013 to 2014 to +50.3% in 2003 to 2004. The annual total allowed charges trended similarly, increasing from $7,596,575 to $25,443,892, with an average annual increase of +8.6%. Likewise, the annual change in allowed charges tracked similarly with annual change in total reimbursement, ranging from –16.5% from 2013 to 2014 to +49.8% from 2003 to 2004. The average allowed charge per procedure increased from $240.56 to $319.00, whereas the average payment per procedure increased from $188.24 to $243.71 (Figure 2). Of note, although the average allowed charges and payment per procedure increased over time, the proportion remained the same at 75% to 78% reimbursement of allowed charge.

The greatest and least numbers of total debridement procedures occurred in the South East (12,703) and New England (1810) regions, respectively (Figure 3). The number of procedures nationally totaled 47,841 and averaged 6834 per region. When adjusted for procedures per 100,000 Medicare beneficiaries, the South Atlantic had the greatest number at 137 procedures per 100,000 beneficiaries whereas the Midwest had the least at 70 procedures per 100,000 beneficiaries.

There was a positive correlation between the number of sinus surgeries performed by providers ($n = 752$) and the number of endoscopic debridements performed ($r = 0.31$, $P < 0.001$; Figure 4A). Similarly, there is also a positive correlation between the number of BSP procedures performed and the number of endoscopic debridements ($r = 0.29$, $P < 0.001$; Figure 4B). When the number of sinus surgeries and BSP procedures performed are combined, there is also a positive correlation to the number of endoscopic debridements performed ($r = 0.4$, $P < 0.001$; Figure 4C).

**DISCUSSION**

This is the first study to report trends of endoscopic debridement after sinus surgery in the Medicare population.
The primary goal was to use publicly available Medicare Part B data to analyze temporal and geographic trends in endoscopic debridement from 2000 to 2016. Furthermore, this study served to correlate the use of endoscopic debridement with FESS and BSP in light of changes in procedure utilization. Previous studies have assessed the shift from open to endoscopic approaches in sinus surgery, geographic variations in endoscopic sinus surgery utilization, and the transition from FESS to BSP using the same data source. By drawing on the evidence from previous work, this study seeks to add to the body of clinical knowledge, and describe postoperative care and practice following sinus surgery.

BSP is generally reserved for patients without extensive or complex sinus disease and is less invasive in nature, leading to improved recovery and a decreased need for postoperative debridement. Previous studies have demonstrated the safety and efficacy of BSP in treating a wide range of sinusitis patients with comparatively fewer complications and revisions, and greater symptom improvement and patient satisfaction rates compared to traditional FESS. Additional advantages of provider comfort level, ease of procedure, and increased reimbursement rates have likely contributed to the plateauing effect of non-BSP FESS procedures, with total sinus procedure numbers remaining relatively static whereas BSP procedures increased dramatically. Previous studies have demonstrated a lower rate of postoperative debridement in patients who underwent office BSP compared to FESS. As such, the expectation is that, as BSP practice expands and reduces the use of traditional FESS, associated postoperative debridement procedures should also decline in tandem.

However, nasal/sinus endoscopy with biopsy/polypectomy/debridement, or CPT code 31237, remains one of the top 10 most frequent and highest billed otolaryngology procedures among Medicare patients (Table 1). Our study shows that the number of allowed endoscopic debridement procedures has increased somewhat steadily over time. Although the rate of growth shows little correlation with the transition timeline for BSP—namely, remaining static despite the dramatically increased use of BSP after 2011 (Figure 1), the consistent positive trend seems incongruent with the shift in sinus procedure distribution. Furthermore, although the number of endoscopic debridement procedures correlates positively with the number of FESS procedures, there is also a positive correlation with the number of BSP procedures completed by physicians. This does not align with a key advantage of BSP needing fewer postoperative debridement procedures when compared to FESS. The body of evidence comparing the relative safety and efficacy of FESS and BSP, particularly in determining superiority as far as recovery and revision rate, is ample yet complex, with many sources citing strong yet opposing perspectives. Furthermore, the evidence directly associating improved recovery with fewer postoperative endoscopic debridement remains unclear.

In our study, the Midwest region had the greatest overall Medicare population but the least number of endoscopic debridement procedures per 100,000 beneficiaries. Meanwhile, the South Central and South Atlantic regions had
similar-size populations, but the greatest number of total procedures, resulting in the highest number of procedures per 100,000 beneficiaries. This correlates with previous studies that demonstrated that the South had the greatest overall increase in BSP procedures, the greatest total number of endoscopic procedures, the greatest number of endoscopic dacryocystorhinostomies, and the highest number of diagnoses of chronic rhinosinusitis. In particular, Texas, Florida, and Louisiana had notably the highest total BSP procedures and highest total BSP procedures per 100,000 beneficiaries. However, the definitive connection between diagnosis of CRS and performance of endoscopic sinus surgeries is unclear, as Venkatraman et al notably found no correlation between number of procedures performed and diagnosed Medicare beneficiaries, per capita number of otolaryngologists, or population density of beneficiaries. Instead, rates of sinus surgeries may be more guided by physician practice patterns, perhaps as a result of the controversy regarding the comparative efficacy of medical versus surgical interventions. Still, other studies assessing prevalence of total knee arthroplasty and other high-cost procedures such as bypass surgery and hip replacement in the Medicare population have demonstrated a direct correlation between increased number of enrolled beneficiaries and procedure utilization. Although the exact cause is still to be determined, variation in health-care access between US regions as defined by number of specialists per capita, distance to major medical centers, and population density may contribute to differences in utilization of postoperative procedures such as endoscopic debridement.

Recent reviews have found no clear evidence for frequent postoperative debridement and called for additional randomized controlled trials to establish benefit, optimal frequency, extent, and timing of debridement. Despite the lack of evidence, our study has demonstrated a consistent upward trend of endoscopic debridement procedures from 2000 to 2016 that is out of proportion with the overall increase in sinus procedures, with an average annual growth rate of +6.0% versus the +3.1% to +3.6% annual growth rate of total sinus procedures. Meanwhile, the annual total allowed charges and reimbursement also increased during this period, with BSP procedures reimbursement ranging from 2 to 10 times greater than non-BSP sinus surgeries, and providers became more accustomed to the technique, utilization increased dramatically. However, the overall comparative health-care cost to patients remains unclear given variations in relative operating time, recovery time, and postoperative care between BSP with FESS. In addition, the associated growing rate and cost of postoperative endoscopic debridement procedures may contribute to overall increased health-care burden on patients undergoing sinus surgery, regardless of method. Further assessment of cost-effectiveness and procedural efficacy is needed to prevent overuse of postoperative debridement, and to optimize patient-centered and evidence-based care.

Given the age restriction of Medicare beneficiaries, this study has limited generalizability. The study focused on the patient population older than 65 years, which does not fully represent the overall patient population requiring surgical treatment of CRS. Given the potential for the elderly population to present with disproportionately advanced sinus disease requiring greater postoperative care and debridement, the findings of this study may not be representative of patients undergoing sinus surgery at all ages. However, studies have shown that, although patient age may affect postoperative outcomes following endoscopic sinus surgery, patients in the over-65 age group typically have comparable or even superior postoperative outcomes when compared to pediatric and adult groups. Further analysis of postoperative debridement utilization relative to BSP utilization in the general population is needed to determine trends and efficacy of health-care use. Likewise, age-related considerations in procedural type and utilization as well as postoperative outcomes following BSP are necessary to optimize care and to guide clinical decision making. Despite these limitations, the Centers for Medicare and Medicaid Services remains the single largest payer for health care in the United States, making Medicare Part B information a valuable source of publicly available data.
that can provide insight into reimbursement incentives and health-care utilization trends.

CONCLUSION

Timing and frequency of endoscopic debridement remains a controversial part of postoperative care for sinus procedures in the absence of standard recommendations or evidence of long-term benefit. Although BSP procedures are associated with a reduced need for postoperative debridement, general trends toward BSP procedures over FESS have not decreased the practice of postoperative debridement from 2000 to 2016. Instead, both procedure use and reimbursement have increased over time at rates disproportionate to the overall increase in total sinus procedures and BSP utilization. The cause of the observed increase remains unclear, but could be attributed to changes in practice as physicians adapt to the relatively novel BSP technique, adjustment in patient preferences and expectations of postoperative outcomes, or financial incentives from increasing reimburments. Given the lack of consistent clinical evidence and associated procedural discomfort and complications, overuse of endoscopic debridement may represent a negotiable health and financial burden that calls for greater scrutiny. Further analysis is needed to determine current debridement utilization in the general population, evidence-based guidance for postoperative care after sinus surgery, and cost-effectiveness of sinus treatment regimens.

Disclosure Statement

The authors have no conflicts of interest to disclose.

Authors’ Contributions

Mulin Xiong, BA, and Rijul S Kshirsagar, MD, contributed equally to this article. Rijul S Kshirsagar, MD, and Jonathan Liang MD, FACS, FARS, participated in the study design, acquisition and analysis of data, and drafting and critical review of the final manuscript. Mulin Xiong, BA, participated in the analysis of data, drafting, critical review, and submission of the final manuscript. All authors have given final approval to the manuscript.

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References

Trends in Endoscopic Sinonasal Debridement in the Medicare Population


