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Meniere's Disease – A “CHEER” Database Study of Local and Regional Patient Encounter and Procedure Patterns

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Abstract

Objective—1) Integrate practice-based patient encounters using the Dartmouth Atlas Medicare database to understand practice treatments for Meniere's Disease (MD). 2) Describe differences in the practice patterns between academic and community providers for MD.

Study Design—Practice-based research database review.

Setting—“CHEER Network” academic and community providers.

Subjects and Methods—MD patient data were identified using ICD-9 and CPT codes. Demographics, unique visits, and procedures per patient were tabulated. The Dartmouth Atlas of Healthcare was used to reference regional healthcare utilization. Statistical analysis included one-way analyses of variance (ANOVA), bivariate linear regression, and Student's t-tests with significance set at p-values less than 0.05.

Results—2,071 unique patients with MD were identified from 8 academic and 10 community OHNS provider centers nationally. Average age was 56.5, 63.9% were female and 91.4% self-reported white ethnicity. There was an average of 3.2 visits per patient. Western providers had the

highest average visits per patient. Midwest providers had the highest average procedures per patient. Community providers had more visits per site and per patient than academic providers. Academic providers had significantly more operative procedures per patient ($p = 0.0002$), compared to community providers. Healthcare Service Areas with higher total Medicare reimbursements per enrollee did not report significantly more operative procedures being performed.

Conclusion—This is the first practice-based clinical research database study to describe MD practice patterns. We demonstrate that academic OHNS providers perform significantly more operative procedures than community providers for MD, and validate this data with an independent Medicare spending database.

Keywords

Meniere's disease; regional variability; endolymphatic sac surgery; intra-tympanic injection

Introduction

Meniere's Disease (MD) is among the more common and perplexing conditions encountered in otolaryngology, with a contemporary prevalence estimate of 190 cases per 100,000 people, or 0.20-0.27% of the population.¹⁻³ The most prominent symptoms include acute episodes of vertigo lasting longer than 20 minutes, as well as fluctuating hearing loss, tinnitus, and aural fullness.⁴ These symptoms can become so severe as to incapacitate the patient, and can recur in an unpredictable pattern. Risk factors identified include Caucasian ethnicity, female gender, age, and elevated body-mass index.^{1,3} The treatment for MD is comprised of both medical and surgical therapies. Medical management has historically consisted of maintenance or preventative therapy, as well as abortive therapy for acute attacks. Maintenance therapy consists of a low-salt diet and a diuretic. Abortive therapy includes benzodiazepines. Surgical management, which includes endolymphatic shunts, labyrinthectomy and/or vestibular neurectomy is reserved for medical treatment failures, often after attempt at control of vertigo with intratympanic gentamicin. Despite the pervasiveness of this condition, little has been published on possible geographic trends and healthcare resource utilization.

The Creating Healthcare Excellence through Education and Research (CHEER) is an NIH-funded national practice-based research network in Otolaryngology- Head & Neck Surgery comprised of 30 provider sites in 19 states totaling more than 200 otolaryngologists, 100 audiologists, and 50 Speech Language Pathologists. The goal of CHEER is to unite academic and community practices to facilitate practice-based research and quality improvement.

The objective of this study is to examine the CHEER network providers and their MD patients' encounters to investigate possible local and regional variations in healthcare resource utilization in both academic and community settings. Specifically, we aim to determine if there are significant differences in the practice patterns between academic and community OHNS providers in the management of MD. A dated practice guideline exists for the evaluation and treatment of MD,⁴ and we suspect there may considerable variability

in the surgical management employed in the treatment of MD. A national practice-based approach to these questions has yet to be attempted, and will offer a broader scope of investigation compared to a series from one center. These results would inform further research questions and studies on MD using a “big data” approach in conjunction with a practice-based network such as CHEER.

Methods

Provider Database and Patient Selection

This study was deemed research exempt by the Duke University School of Medicine Institutional Review Board (IRB). The Creating Healthcare Excellence through Education and Research (CHEER) network warehouses the Retrospective Data Collection (RDC) initiative that contains one year of de-identified patient-level data from contributing sites and represents more than 260,000 unique patients and over 650,000 unique encounters. All sites provided 1 year of patient data either from 2011-2012 or 2012-2013. A subset of MD patients from the RDC was created using ICD-9 and CPT code criteria developed by this study's authors. The ICD-9 codes utilized included 386.00 Meniere's disease, 386.01 Meniere's disease (cochleovestibular), 386.02 Meniere's disease (cochlear), 386.03 Meniere's disease (vestibular), and 386.04 inactive Meniere's disease/Meniere's disease in remission. The CPT codes utilized included 69801 trans-tympanic injection, 69805 endolymphatic sac decompression without shunt, 69806 endolymphatic sac decompression with shunt, 69910 labyrinthectomy with mastoidectomy, and 69915 vestibular nerve section. For patients identified as diagnosed with MD, patient demographics, unique visits, visits per patient, and procedures per patient were tabulated. Procedures were coded first as Meniere's related procedures, and procedures that required invasive surgery were recoded into an operative procedures sub-group. For regional comparisons, the CHEER site locations were recoded into conventional Northeast, South, Midwest, and West descriptors. Moreover, site locations were further classified as “academic” if the provider site was contained within a university, and as “community” if within a community or private clinic.

Dartmouth Atlas of Healthcare Cross-Reference

To integrate our patient-encounter level data with regional medical resource utilization metrics, each CHEER provider site was cross-referenced to a Hospital Service Area (HSA) utilized in The Dartmouth Atlas of Healthcare.^{5,6} The Dartmouth Atlas of Healthcare utilizes population-based small area analysis to present CMS Medicare data on a given population living in a defined geographic area or a specific hospital. For each healthcare service area, variables reported included total Medicare reimbursements per enrollee (2012 data), and surgeons per 100,000 HSA residents, by specialty (Otolaryngology, 2006 data).

Statistical Analysis

Statistical analysis including descriptive statistics, one-way analyses of variance (ANOVA), bivariate linear regression, and student's t-tests (two-tailed) were conducted using the JMP Pro 11.2.1 software suite (Cary, North Carolina, USA). Statistical significance was set at p-values less than 0.05.

Results

Patient Population and Procedures

Using MD ICD-9 codes, 2,071 unique patients and 6,669 unique visits were identified. Only CHEER sites with MD encounters were included in subsequent analyses (Table 1; n = 18). Eight (44.4%) sites were classified as “academic,” and 10 sites (55.6%) as “community.” The average age of patients was 56.5 years. In all patients, the frequency of female gender was 63.9%, and the self-reported white ethnicity was 91.4%. There was an average of 3.2 visits per patient. Two-hundred and seventy-eight MD related procedures were identified. The most common procedure reported was the CPT 69801, trans-tympanic injection (Table 2). We were unable to determine by CPT code if the trans-tympanic injection was delivery of steroid or aminoglycoside. For the purposes of analyses, operative procedures were classified as office-based (intra-tympanic injection) or occurring in the operating room (endolymphatic sac decompression, labyrinthectomy, and vestibular nerve section).

Academic and Community Site Trends

There was no significant difference in mean encounters per patient between community and academic sites (Table 3). There were no significant differences in academic and community sites with either the number of any type of procedure per patient (0.35 vs. 0.14; $p=0.14$) or intra-tympanic injection procedures per patient (0.08 vs. 0.10; $p=0.70$). However, academic sites had a significantly higher number of operative procedures per patient compared to community sites (5.2 vs. 0.63; $p=0.0002$). When comparing academic and community sites with the Dartmouth Atlas variables, no significant differences were observed when comparing total Medicare Reimbursements per enrollee, and the number of Medicare enrollees who visit a primary care clinician annually. Moreover, no significant differences between site types were observed when comparing healthcare physicians, surgeons, and otolaryngologists per 100,000 residents in each HSA.

Regional Site Variation

When the CHEER sites were re-coded into their corresponding regions, we observed that the western region providers had the highest average visits per patient (Table 4). Midwest providers had a significantly higher average procedures per patient compared to the next highest procedural region (0.72 vs. 0.09; $p=0.007$). There were no other significant differences between the regions when comparing the other variables in the table (not shown). The CHEER regions were cross-referenced with Dartmouth Atlas variables, including the 2012 total Medicare reimbursements per enrollee adjusted for price, age, sex & race, percent of Medicare enrollees with an annual primary care clinician, physicians per 100,000 residents, surgeons and OHNS surgeons per 100,000 residents (Figure 1). There were no other significant differences between the regions when comparing these variables of a region with the lowest value and the region with the next highest value (not shown).

Dartmouth Atlas Cross-Reference

Bivariate linear regressions were performed to assess for correlation between 2012 total Medicare reimbursements per enrollee adjusted for price, age, sex & race and operative

procedures, all procedures, and average visits per patient for all CHEER site HSAs (Table 5). Medicare reimbursement was not a statistically significant predictor of number of operating room procedures (data not shown), aggregate of both operative and procedures, and average visits per patient (data not shown).

Discussion

The management of MD is generally comprised of both medical and surgical interventions depending on the patient's severity of illness. To date, there are no formal clinical practice guidelines focused on management of these patients, as there are with other otologic conditions such as tinnitus,⁷ acute otitis externa,⁸ sudden sensorineural hearing loss,⁹ and Bell's palsy.¹⁰ For MD, there is only a committee document that provides guidance regarding the diagnosis and evaluation of MD patients has been published.⁴ Furthering our understanding of MD practice patterns may provide an opportunity for quality improvement that may inform the discussion for development of a guideline for the management of the MD patient. To be informative, a broad and generalizable analysis of Otolaryngology provider management patterns is needed. This is the first practice-based clinical research database study to describe trends in the practice patterns related to MD.

The patients reported in our database of 8 academic and 10 community provider sites had a similar demographic profile as previously published in other contemporary reports on MD as most being of non-Hispanic white race, and female gender.¹ Our academic and community sites did not differ in the self-reported ethnicity, the number of visits or tympanic injection procedures per patient. Community sites had a significantly older and higher proportion of female patients compared to academic sites. The clinical significance of these demographic differences is likely inconsequential.

We discovered that academic sites had a significantly higher mean number of operating room procedures per patient. Both gentamicin injection and surgical therapy for Meniere's disease has been shown to be very effective in the resolution of vertigo symptoms.¹¹⁻¹³ As such, insurance providers will reimburse gentamicin injections, endolymphatic sac decompression procedures, lateral semi-circular canal plugging, sacculotomy, vestibular nerve decompression, vestibular nerve section, and labyrinthectomy in the treatment of Meniere's Disease.¹⁴ Inclusion criteria that must be met include patients who have disabling vertigo, symptoms for two or more years, and have failed conservative medical therapy. Whilst most community otolaryngology practices have operating room privileges at an ambulatory surgery center or hospital, it is possible that this is not the case universally. It is also plausible that community providers may elect not to perform an endolymphatic sac decompression, labyrinthectomy, or vestibular nerve section, and refer patients into academic centers for these procedures, thus concentrating their prevalence at these sites. Our data does not furnish information on disease severity, so we cannot infer about the complexity of MD cases our community providers observed versus their academic counterparts. While we cannot specifically determine why the population is different on some constructs in these data, the differences support the need for guidelines that are unique to patients and also that address provider site type, capacity, as well as specialized training for providers performing more invasive surgical therapy. These findings may reinforce

emphasis of future studies of operative procedures toward academic settings, whilst the study of diagnoses and non-operative procedures is pertinent to both academic and community provider settings.

The Dartmouth Atlas of Healthcare is an innovative database that highlights regional trends in Medicare spending and healthcare utilization.^{5,6} In this new era of healthcare, analysis of healthcare utilization is prudent when considering priorities for resource allocation. As MD is a challenging condition with both effective non-invasive and invasive therapies, we sought to determine if healthcare regions of high spending are associated with a higher frequency of more expensive, and more invasive therapies. To our knowledge, our study is the first to attempt to cross-reference the Dartmouth Atlas dataset with an independent Otolaryngology dataset. When we coupled our database to the Dartmouth Atlas Data, we found that CHEER Sites who belong to HSAs with higher total Medicare reimbursements per enrollee did not report significantly more operative procedures being performed. There was also no significant relationship between the number of all procedures, and average number of visits with HSA total Medicare reimbursements. This may mean that either low-spending regions are performing as many operative procedures, and/or patients requiring operative intervention are not being preferentially referred to provider sites in higher spending regions. Considering our data and the widely accepted evidence for the efficacy of surgical therapy, it is unlikely that CHEER sites in high Medicare reimbursement HSAs are performing superfluous or “unnecessary” volumes of operative or office-based procedures.

This study has limitations that need to be considered. Our inferences on the provider sites' data are only as strong as the data itself. The RDC includes the most recently available year of data from each contributing site and the maximum number of diagnosis and procedure codes each site can provide. The earliest RDC year start date is January 2011 and the latest year-end date is May 2013. We made no attempt to balance academic and clinical sites within a region when constructing the CHEER network. Though our network covers all geographical regions of the United States, there is variability as regards clinical or academic practices within regions. The CHEER RDC database includes a year's worth of de-identified data from contributing sites in the CHEER network. We assume that the encounters, diagnoses, and procedures are only a subset of the total patient population. We are unable to describe the severity of MD by the ICD code identification, or whether or not they have sought prior treatment elsewhere. We must also note that we are limited to the description of the procedures by their representative CPT codes. As stated previously, we cannot determine the therapeutic ingredient used for trans-tympanic injections. Though the data is from limited sites within different geographical regions, the findings suggest that there may be a shift away from more invasive surgical procedures, such as transmastoid labyrinthectomy, to a more limited invasive procedure of a transtympanic injection.

For this given study, not all sites with data in the RDC had the appropriate patient population to be included. The CHEER RDC was not developed with the goal of regional representation for all conditions, which would be difficult in otolaryngology. Additionally, CHEER is both community and academic sites of various sizes. The sites in the Northeast and South constituted the majority of the sites included in the analysis (13 out of 18). The sample sizes of both sites and volumes are provided in the regional analysis. We are currently embarking

on updating the RDC with more recent data and expanding and enhancing the number of the fields collected. As “big data” and registries become integrated into performance and quality metrics, studies such as ours can help educate on the limitations and methodologic approaches for analyses. Ours is an administrative dataset without rigor in enforcing consistency in reporting, and provides an appropriate source for descriptive analyses and the basis for further investigation and research. This study is also informative as we move in healthcare towards performance, quality and reimbursement based on “big data”. This study appropriately identifies limitations of the database while describing potential opportunities for addressing variation in practice and treatment options for MD. As registries and other “big data” sources are being developed and utilized, limitations identified in studies like this one can be used in their development, as well as in supporting the need for multi-dimensional performance and reimbursement algorithms.

With regard to our healthcare utilization analyses, debate has been raised about the validity of the Dartmouth Atlas Data. The Dartmouth Atlas seeks to highlight high-spending hospital service area inferred from total Medicare reimbursements. One major argument is that certain hospital referral regions will accrue ‘sicker’ patients, thus justifying their higher care expenditure. The Dartmouth Atlas authors have tried to mitigate this potential bias by accounting for age, race, gender, and local price of care.¹⁵ An additional limitation is our ad hoc merge of the Dartmouth Atlas administrative dataset with our practice-based CHEER network data. As the Dartmouth Atlas data has not been explicitly designed to merge seamlessly with other datasets, this could introduce an element extrapolation to our conclusions. We also cannot assume that each CHEER site is representative of the hospital service area and larger hospital referral regions in which they are embedded. This limits our ability to generalize healthcare expenditure trends to the larger geographical sub-divisions we list.

This is the first practice-based clinical research database study to describe trends in the practice patterns in MD management. We demonstrate that academic OHNS providers perform significantly more operative procedures for MD patients than community providers. Reasons for this difference include possible operating room availability or access, Otolaryngologist training, severity of patient illness, or possible operative case referral. As these operative procedures are reported to be very effective in the management of refractory MD, more detailed investigation into the practice patterns of academic and community providers will be fruitful in further determining drivers for this difference. It is well understood that variation in health care often leads to inefficient health care utilization of resources and waste. In demonstrating that there is a degree of variation within the management of MD across different provider centers and types, we highlight an opportunity to improve care delivery while describing potential opportunities for addressing variation in practice and treatment options for MD. Specifically, we hope that this paper may inform discussion whether a national guideline for the management of MD patients would prove useful, as this often burdensome condition can be effectively treated with appropriate medical and surgical therapy.

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Figure 1.
Comparisons of regional designations of CHEER sites with cross-referenced Dartmouth Atlas Database variables. Error bars represent one measure of standard error.

Table 1

Academic and Community CHEER Network Provider Sites and Corresponding Hospital Service Area Included in Study.

CHEER Site	Hospital Service Area	Region
Academic		
Brigham & Women's Hospital	Boston, MA	Northeast
Duke University Medical Center	Durham, NC	South
Medical University of South Carolina	Charleston, SC	South
New York Eye & Ear	Manhattan, NY	Northeast
Oregon Health & Science University	Portland, OR	West
University of Michigan	Ann Arbor, MI	Midwest
University of Texas Southwestern	Dallas, TX	South
Weill-Cornell	Manhattan, NY	Northeast
Community		
Albany Ear, Nose, & Throat	Albany, NC	Northeast
Central Oregon	Bend, OR	West
Charlotte Ear, Nose, & Throat	Charlotte, NC	South
Coastal Ear, Nose, & Throat	New Brunswick, NJ	Northeast
Duke Regional Hospital	Durham, NC	South
Indiana Ear Clinic	Fort Wayne, IN	Midwest
Long Island Jewish Medical Center	Mineola, NY	Northeast
Low Country	Charleston, SC	South
Puget Sound Hearing & Balance	Seattle, WA	West
Western New England	Springfield, MA	Northeast

Abbreviation: CHEER: Creating Healthcare Excellence through Education and Research

Table 2

Most common MD-related procedures reported.

	n (% of column)
Meniere's disease-related Procedures	278
Trans-tympanic Injection (office-based)	249 (89.6)
Endolymphatic sac decompression without shunt (OR)	5 (1.8)
Endolymphatic sac decompression with shunt (OR)	17 (6.1)
Labryinthectomy with mastoidectomy (OR)	6 (2.2)
Vestibular nerve section (OR)	1 (0.36)

Table 3

One-way ANOVA comparisons of Academic and Community Provider Patient Encounters, Procedures and Dartmouth Atlas Database variables.

	Academic (n=8)	Community (n=10)	
<i>CHEER RDC Data</i>	<i>No.</i>	<i>No.</i>	
Unique Patients	722	1346	
Unique Encounters	1683	4983	
<i>CHEER RDC Data Variables</i>	<i>Mean (Std. Error)</i>	<i>Mean (Std. Error)</i>	P-value
Unique Patients, Per Site	90.6 (44.9)	134.6 (40.1)	0.48
Unique Encounters, Per Site	210.8 (188.5)	498.3 (168.6)	0.27
Unique Encounters, Per Patient	2.34 (0.60)	3.47 (0.5)	0.17
Average Age, Years	54.7 (1.7)	60.0 (1.5)	0.03
Female Gender, %	42.5 (7.35)	65.3 (6.2)	0.03
White Ethnicity, %	84.7 (5.1)	92.9 (4.1)	0.24
Any Procedure Type, N	27.2 (9.73)	17.8 (7.69)	0.46
Any Procedure Type, Per Patient	0.35 (0.11)	0.13 (0.087)	0.14
Operating Room Procedures, N	5.20 (0.67)	0.63 (0.53)	0.0002
Intra-tympanic Injection Procedures, N	22.0 (9.23)	17.4 (7.30)	0.70
Intra-tympanic Injection Procedures, Per Patient	0.08 (0.04)	0.10 (0.04)	0.70
<i>Dartmouth Atlas Data Applied to CHEER HSAs</i>			
Total Medicare Reimbursements per Enrollee, \$	9299.2 (373.9)	8619.8 (334.4)	0.19
Medicare Enrollees Having Annual Ambulatory Visit to a Primary Care Clinician, %	74.9 (2.64)	79.0 (2.36)	0.27
Physicians per 100,000 Residents	250.58 (15.9)	218.4 (14.2)	0.15
All Surgeons per 100,000 Residents	41.1 (3.97)	38.9 (3.5)	0.69
OHNS Surgeons per 100,000 Residents	2.76 (0.26)	2.48 (0.23)	0.43

Table 4

Descriptive statistics of regional designations of CHEER site patient encounters and procedures data.

	Midwest (n=2)	Northeast (n=7)	South (n=6)	West (n=3)
<i>CHEER RDC Data</i>				
Unique Patients, N	82	767	975	247
Unique Encounters, N	207	3191	2691	580
<i>CHEER RDC Data Variables</i>	<i>Mean (Std. Error)</i>	<i>Mean (Std. Error)</i>	<i>Mean (Std. Error)</i>	<i>Mean (Std. Error)</i>
Unique Patients, Per Site	41 (53.7)	109.6 (94.4)	162.5 (186.3)	82.3 (78.4)
Unique Encounters, Per Site	103.5 (405.0)	455.9 (216.5)	448.5 (233.8)	193.3 (330.7)
Unique Encounters, Per Patient	3.1 (1.3)	2.7 (0.69)	2.8 (0.75)	3.33 (1.1)
Any Procedure Type, Per Site	19.0 (15.0)	8.43 (8.0)	23.8 (8.7)	12.67 (12.3)
Any Procedure Type, Per Patient	0.72 (0.095)	0.044 (0.05)	0.094 (0.05)	0.15 (0.08)
Intra-tympanic Injection Procedures, Per Site	17.5 (13.9)	7.71 (7.4)	21.3 (8.04)	10.67 (11.4)
Intra-tympanic Injection Procedures, Per Patient	0.22 (0.08)	0.04 (0.04)	0.08 (0.05)	0.14 (0.06)

Table 5

Bivariate linear regression of operative procedures, all procedures, and average visits per patient against CHEER site Hospital Service Area 2012 total Medicare reimbursements per enrollee adjusted for price, age, sex & race.

Equation	R ²	RMSE	F-Ratio	P-Value
# of Operative Procedures = $-5.154342 + 0.0008493 \times \text{Total Medicare reimbursements per enrollee}^*$	0.14	2.64	1.73	0.21
# of All Meniere's Procedures = $-5.18914 + 0.0029937 \times \text{Total Medicare reimbursements per enrollee}^*$	0.027	22.0	0.31	0.59
Average Visits Per Patient = $8.290704 - 0.0005967 \times \text{Total Medicare reimbursements per enrollee}$	0.15	1.57	2.68	0.12

RMSE – root mean square error.

* CHEER sites not reporting operative procedure frequencies were excluded.