American Journal of Otolaryngology–Head and Neck Medicine and Surgery xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

American Journal of Otolaryngology–Head and Neck Medicine and Surgery

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

# Payer database and geospatial analysis to evaluate practice patterns in treating allergy in North Carolina

Matthew G. Crowson [a,*], Kristine Schulz [a], Alex Ulvila [b], David L. Witsell [a]

[a] Division of Head & Neck Surgery and Communication Sciences, Duke Voice Care Center, Duke University Medical Center, Durham, NC, USA
[b] SynGlyphX Holdings Inc., Arlington, VA, USA

ARTICLE INFO

*Article history:*
Received 11 May 2017
Available online xxxx

*Keywords:*
Allergy
Otolaryngology
Health services
Health care delivery

ABSTRACT

*Objective:* The objective of this study was to characterize the delivery of allergy care in North Carolina using a large payer charge database and visualization techniques.
*Study design:* Geospatial database analysis.
*Setting:* North Carolina State claims database.
*Subjects & methods:* Medical data from the 2013 FAIR Health National Private Insurance Claims (FH NPIC) database for North Carolina was mined for CPT codes and charges for allergy testing, and for the preparation and provision of allergen immunotherapy. Provider and patient variables were analyzed. Analyses were performed to compare differences in allergy care delivery. A visualization strategy complemented the analytic approach.
*Results:* 162,037 CPT charge entries were analyzed. Allergy-immunology specialists were the most common provider specialty to perform allergy immunotherapy treatments (68.9%, $p < 0.05$). Among other specialties, there were no significant differences between specialists performing immunotherapy when comparing otolaryngology, family practice, and internal medicine (16.3%; 4.6%; 2.6%; $p > 0.05$). Providers with an M.D. degree were the most common provider type. The three most commonly treated diagnoses were allergic rhinitis variants. Females were more likely to receive allergy treatments versus males (55.9% vs. 51.5%; $p < 0.001$), and were more likely to receive allergy testing (65.3% vs. 34.7%: $p < 0.005$). Internal medicine providers charged higher than any other specialist type ($p < 0.05$) for allergy immunotherapy.
*Conclusions:* Using a large payer database coupled with visualization techniques was an efficient approach to characterizing the state-wide provision patterns of allergy diagnostic and therapy services in North Carolina. This first tier approach to efficiently exploring questions and describing populations is valuable.


## 1. Introduction

Health care delivery is influenced by myriad local, regional, and national contexts, and the study of health care delivery issues is critical for both identifying barriers and expanding access to patients. This is easier said than done. As healthcare continues to move into an electronically-based environment, it is important to deploy approaches and strategies to efficiently and effectively use available data to characterize populations of interest. It can be challenging to navigate a large dataset to identify patterns or characteristics of interest, thus the advent of complementing traditional analytic approaches with visualization tools. Novel visualization techniques can be used to explore care provision patterns and specific concerns with access to care.

To explore the utility of using a large database coupled with geospatial imaging visualization, a topic was selected. Allergy and related conditions are often treated by otolaryngologists, thus the study of regional variation in allergy care may yield important insights into the care challenges and opportunities for otolaryngologists. The manifestations of allergy in the upper airway are a common reason for a patient consultation with an otolaryngologist. Allergy and immunology medical specialists have traditionally been a primary resource for the treatment of allergic patients. However, otolaryngologists have also provided this service for many years – some of the earliest English-language reports and treatise date back to the 1930s [1,2]. In contemporary practice, otolaryngology-head & neck surgery residency programs are now required to provide education and training in the treatment of allergic conditions [3,4].

When comparing the approach to work-up of nasal obstruction, allergists and otolaryngologists have been shown to evaluate nasal obstruction differently [5]. Otolaryngologists who are interested in allergy management utilize nasal endoscopy for evaluation of nasal anatomy and pathology. To the otolaryngologist, nasal endoscopy informs the decision regarding management of nasal allergy symptoms. Allergists have been shown to rely on allergy testing, whereas

* Corresponding author at: Duke University Medical Center, 2301 Erwin Road, Division of Otolaryngology-Head & Neck Surgery, Durham, NC 27710, USA.
*E-mail address:* matthew.crowson@dm.duke.edu (M.G. Crowson).

https://doi.org/10.1016/j.amjoto.2017.10.004
0196-0709/

**Table 1**
Three most common diagnoses associated with allergy injections and allergy testing.

| Treatment diagnosis | Total number of injections | Mean % (SD) | Testing diagnosis | Total number of tests | Mean % (SD) |
|---|---|---|---|---|---|
| Allergic rhinitis, pollen | 72,327 | 48.6 (6.41) | Irritable bowel syndrome | 2948 | 12.7 (9.40) |
| Allergic rhinitis, unspecified | 25,517 | 16.4 (14.2) | Allergy, unspecified | 2790 | 10.6 (3.58) |
| Allergic rhinitis, other | 20,372 | 16.9 (5.38) | Dermatitis, food related | 1967 | 8.70 (2.97) |

SD: standard deviation.

otolaryngologists more frequently use nasal endoscopy [5]. A recent survey of allergists, otolaryngologists, and primary care physicians also noted other allergy practice trends between specialties differ [6]. Specifically, otolaryngologists were more likely to perform intradermal testing, however there was no significant different in therapies prescribed including injection or sublingual immunotherapy between otolaryngologists and allergists. These studies underscore the potential for variation in the delivery of allergy care, and as of the writing of this manuscript little has been published that explores geospatial variability in allergy care between otolaryngologists and allergists.

The main objective of this study was to characterize the delivery of allergy care in North Carolina using a national procedure charge database to determine provision patterns, and the relative proportion of allergy care provided by otolaryngologists compared to other specialists. We also sought to demonstrate the utility of visualization techniques to complement traditional data analyses for analyzing patterns and trends in allergy care.

## 2. Methods

This study was reviewed by the Duke University Medical Center IRB and deemed exempt from formal review.

### 2.1. Database analysis

Medical data from the 2013 FAIR Health National Private Insurance Claims (FH NPIC) database for North Carolina was mined. The payers contributing to this database include health insurers from large national payers to small local and regional insurance companies. This database included records of CPT codes and charges for allergy testing (specific IgG, IgE quantitative or semi-quantitative), and for the preparation and provision of allergen immunotherapies (injections of allergic extract). Associated with each CPT code and charge entry, the database included variables for ordering specialty, provider credentials, diagnosis, patient gender, patient health insurance plan type, and care provision service zip code.

### 2.2. Statistical analysis

T-tests and ANOVA analyses were performed to compare differences in allergy care delivery between provider specialty type, provider credential, charge amounts, diagnosis incidence, and patient gender. Means and standard deviation (SD) were reported where appropriate. To control for multiple comparisons, Tukey's honest significant difference (HSD) was used when performing multiple pairwise comparisons. Statistical analysis significance was set at $p < 0.05$.

### 2.3. Geospatial analyses

Using proprietary data visualization and insight discovery software (SynGlyphX, Arlington, Virginia), geospatial analyses were completed to qualitatively describe differences in the above variables. SynGlyphX software creates visual 'glyph' icons with different components (rings, rods) that represent different variables for instance. The creation of these glyphs allows for the visualization of complex datasets in a geospatial context. For example, on one map of North Carolina, one is able to demonstrate the market share of allergy service by different provider types, the proportion of certain allergy CPT codes billed in a given population, and demographic variables for each city. The range of values in each variable are color-coded such that data extremes can be appreciated at-a-glance.

## 3. Results

### 3.1. Allergy care provision

162,037 CPT charge entries were analyzed comprising allergy testing and allergy injection therapy codes. The three most commonly treated diagnoses were allergic rhinitis variants (Table 1). Females were more likely to receive allergy treatments versus males (55.9% vs. 51.5%; SD 1.65 $p < 0.001$), and were more likely to receive allergy testing (65.3% vs. 34.7%; SD 6.4 $p < 0.005$). Providers with an M.D. degree were the most common provider type compared to physicians with doctor of osteopathy (D.O.) certification, nurse practitioners (NP), and physician assistants (PA) (96.4% SD 0.56%, 2.6% SD 0.69%, 0.2% SD 0.17%, and 0.3% SD 0.06% respectively; M.D. versus D.O. $p < 0.0001$, and D.O. vs. NP $p = 0.005$).

Allergy-immunology specialists were the most common provider specialty to perform allergy immunotherapy treatments (68.9% of total); when comparing allergy to otolaryngology ($p = 0.01$), family practice ($p = 0.001$), internal medicine ($p = 0.001$) (Table 2). Among other specialties, there were no significant differences between specialists performing immunotherapy when comparing otolaryngology, family practice, and internal medicine (16.3%; 4.6%; 2.6%; $p > 0.05$ for each combination). Allergy testing charges were billed by non-physician billers in this database, so we were unable to determine which specialty was more likely to refer patients for allergy testing.

Internal medicine providers charged higher than any other specialist type ($p < 0.05$) for allergy immunotherapy (Table 3). Allergy specialists charged the least amount, however this was not significantly different than family practice providers (allergy $20.20/claim SD 4.86, family practice $26.44/claim SD 12.25; $p > 0.05$).

### 3.2. Visual geospatial analyses

Using proprietary geospatial analysis software and the allergy treatment zip codes where the service was provided, we annotated a North Carolina state map with our variables (Fig. 1). In order to determine where in North Carolina otolaryngologists have a substantial market share, we filtered our data to highlight zip codes where the proportion

**Table 2**
Relative proportion of provider specialty types providing preparation and provision of injections of allergic extract.

| Specialty | Total number of procedures | Mean % (SD) |
|---|---|---|
| Allergy-immunology** | 93,210 | 68.9 (12.7) |
| Otolaryngology+ | 19,762 | 16.3 (15.6) |
| Family practice+ | 4766 | 4.6 (1.6) |
| Internal medicine+ | 2293 | 2.6 (1.4) |
| Pulmonology | 2284 | 2.5 (2.8) |
| Pediatric medicine | 2345 | 1.6 (0.4) |

SD: standard deviation.
** $p < 0.05$ for T-Tests comparing allergy to otolaryngology ($p = 0.01$), family practice ($p = 0.001$), internal medicine ($p = 0.001$).
+ No significant difference in T-Tests comparing each ($p > 0.05$ for each combination).

Please cite this article as: Crowson MG, et al, Payer database and geospatial analysis to evaluate practice patterns in treating allergy in North Carolina, American Journal of Otolaryngology–Head and Neck Medicine and Surgery (2017), https://doi.org/10.1016/j.amjoto.2017.10.004