Strabismus Surgical Subspecialization
A Population-Based Analysis

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IMPORTANCE The growing complexity of medical and surgical care has resulted in increasing subspecialization. To date, data have been lacking regarding the degree to which subspecialization has affected the provision of strabismus surgical services. This gap is important to address given the implications for health care human resources planning and educational programs.

OBJECTIVE To investigate the effect of subspecialization on the provision of strabismus surgery services.

DESIGN, SETTING, AND PARTICIPANTS Population-based study in Ontario, Canada, which provides universal health care coverage to the provincial population. Participants included all ophthalmologists in Ontario and the provincial population of approximately 12 million persons from January 1, 1994, through December 31, 2011.

MAIN OUTCOMES AND MEASURES Surgeon-level rates of strabismus surgery.

RESULTS From January 1, 1994, through December 31, 2011, the percentage of ophthalmologists who provided strabismus surgery decreased from 37.7% (156 of 414 surgeons) to 12.5% (54 of 432 surgeons; difference, 25.2%; 95% CI, 19.3%-30.9%; \( P < .001 \)), a 66.8% decline from the baseline level. Of ophthalmologists who provided strabismus surgery during the same period, the mean number of strabismus procedures per surgeon grew from 16.2 to 55.3 per year, a 241.4% increase (95% CI, 20.4%-461.6%; \( P < .001 \)). These trends occurred at all career stages.

CONCLUSIONS AND RELEVANCE Strabismus surgery has evolved into a subspecialized field of ophthalmology during the past 15 years. These findings may have important implications for health care professionals and health care system leaders, including the need to account for subspecialization in physician human resources decisions to ensure access to quality strabismus surgery across regions. Furthermore, residency education programs and their governing organizations may need to account for strabismus subspecialization when designing curriculum and accreditation requirements.
The growing complexity of medical and surgical care has resulted in an increasing focus on specialization and subspecialization.\(^1\) The American Board of Medical Specialties now recognizes more than 150 specialties and subspecialties.\(^6\) In ophthalmology, subspecialization has been a steadily growing phenomenon for many years, and an increasing number of ophthalmologic procedures have become the purview of high-volume subspecialists.\(^7\) Traditionally, strabismus surgery has been offered by a wide cross-section of ophthalmologists, including most comprehensive ophthalmologists. However, factors such as the relative lack of attention to strabismus in the ophthalmology literature and an increasing focus on cataract surgery among comprehensive ophthalmologists have the potential to drive strabismus surgery into the hands of fewer and fewer subspecialists.\(^8\)

Population-level data addressing this issue have been lacking, to our knowledge. This gap is important to address given the implications for health care human resources planning and educational programs. In particular, such data inform decisions regarding the curricula of residency and fellowship training programs as well as the criteria for the accreditation of training programs. In addition, given the evidence suggesting that surgeons’ surgical volumes may affect outcomes, subspecialization in strabismus surgery has the potential to affect surgical success and complication rates.\(^9\)\(^-\)\(^13\) Hence, we conducted a population-based study of strabismus surgical practice among all ophthalmologists in Ontario, Canada, from 1994 to 2011.

**Methods**

We conducted a population-based study to investigate subspecialization in strabismus surgery in Ontario from January 1, 1994, through December 31, 2011. Ontario is Canada’s most populous province, with a population of approximately 12 million during the study period. The Research Ethics Board at Queen’s University approved the study protocol.

Government-funded universal health care insurance is provided to all Ontario citizens through the Ontario Health Insurance Plan. It is the sole payor for all insured services, including strabismus surgical procedures. As a result, the Ontario Health Insurance Plan database, which has excellent accuracy, contains data for all strabismus operations and all Ontario physicians who performed the procedures in this study.\(^14\)

We included all strabismus operations in this study irrespective of the number of extraocular muscles operated on.

During the study period, the number of ophthalmologists who performed strabismus surgery each year and the number of operations provided by each surgeon were assessed. Early career, midcareer, and late career were defined as less than 15 years, 15 to 25 years, and more than 25 years since completion of medical school, respectively. Deidentified physician data were obtained from the Institute for Clinical Evaluative Sciences Physician Database.\(^7\)\(^,\)\(^15\)\(^,\)\(^16\) Interviews with all Ontario physicians are used to validate this database, which has been used in previous studies.\(^7\)\(^,\)\(^15\)\(^,\)\(^16\) Statistics Canada provided annual population estimates.\(^17\) Cochran-Armitage trend analyses and linear regression analyses were used to assess trends using SAS, version 9.2 (SAS Institute Inc).

**Results**

Between January 1, 1994, and December 31, 2011, the median number of ophthalmologists in Ontario was 414 (33 per 1 000 000 persons). During this period, the percentage of ophthalmologists who provided strabismus surgery decreased from 37.7% (156 of 414 ophthalmologists) to 12.5% (54 of 432 ophthalmologists; difference, 25.2%; 95% CI, 19.3%-30.9%; \(P < .001\)), a 66.8% decline from the baseline level (Figure 1). The decrease in the percentage of ophthalmologists who per-
formed strabismus surgery was consistent across all career-stage groups ($P < .001$) (Figure 2). Among the ophthalmologists who provided strabismus surgery during the same period, the mean number of strabismus procedures per surgeon grew from 16.2 to 55.3 per year, a 241.4% increase (95% CI, 20.4%–461.6%; $P < .001$) (Figure 1). Similarly, the 95th percentile for strabismus surgical volume also tripled during the study period (Figure 1). In contrast, the number of low-volume surgeons remained stable during the study period; in 2011, 25.0% of the ophthalmologists who provided strabismus surgery performed only 1 or 2 operations in the year (Figure 1). As a consequence of the shift to higher strabismus surgical volumes among a small fraction of ophthalmologists, the percentage of strabismus operations performed by higher-volume surgeons—those who perform 30 or more operations per year—increased from 64.9% to 90.4% (Figure 3).

**Discussion**

Subspecialization is a growing reality in many areas of medicine, including ophthalmology. In our population-based study, we observed a steady decrease in the proportion of ophthalmologists who provided strabismus surgery during an 18-year period. At the same time, strabismus surgical volumes increased significantly among a subset of ophthalmologists. Combined, these developments have resulted in a large increase in the proportion of strabismus surgery provided by
higher-volume surgeons. These trends were observed at all career stages, indicating that the tendency toward subspecialization has occurred across the career-stage spectrum. To our knowledge, ours is the first population-based study to investigate subspecialization in strabismus surgery.

Numerous factors may underlie the move toward subspecialization in strabismus surgery. The procedures are often lengthy and complex, and the skill set required is distinct from that of intraocular surgery, which generally forms the major component of comprehensive ophthalmologists’ surgical volumes. The requirements for preoperative and postoperative care in strabismus, with a large proportion of cases involving pediatric patients, are also distinct, and supportive infrastructure, such as orthoptist and specialized clinical equipment, are required. It is also possible that higher-volume strabismus surgeons are filling a void left by ophthalmologists who are shifting their focus to other procedures, such as cataract surgery and intravitreal injections.\(^{18,19}\) Finally, limited access to operating room time with general anesthetic coverage may also be a disincentive for some surgeons to perform strabismus surgery.

Our findings have implications at many levels. Human resources planning decisions made at regional or hospital levels must be cognizant of the move to subspecialization in strabismus surgery.\(^{20}\) Furthermore, our data will inform residency and fellowship programs and their accrediting bodies in establishing training standards that meet the evolving needs of new ophthalmologists and the communities they serve. The potential need for greater recognition and regulation of subspecialties has drawn significant attention from certification organizations, including the American Board of Medical Specialties, the American Board of Ophthalmology, and the Royal College of Physicians and Surgeons of Canada, as well as accreditation bodies, such as the Accreditation Council of Graduate Medical Education and the Royal College of Physicians and Surgeons of Canada.\(^{3,5,20-22}\) Nevertheless, the American Board of Ophthalmology remains one of the few US specialty boards that do not offer subspecialty certification.\(^{5}\)

Policy directions of these governing bodies, including the Accreditation Council of Graduate Medical Education and the Royal College of Physicians and Surgeons of Canada, will need to balance many factors. For instance, the need for general-ists across the spectrum of medical and surgical care has been highlighted recently, and the surgical skills learned through strabismus surgery are broadly applicable to other types of surgery, such as trauma, retinal, and glaucoma surgery.\(^{21}\) Reversing the declining role of comprehensive ophthalmologists in strabismus surgery may require greater attention to strabismus during residency training and better access to clinical resources, such as orthoptist services for practicing comprehensive ophthalmologists. However, if subspecialization in strabismus is an irreversible development, the devotion of significant training for all residents toward a procedure performed only by subspecialists may be an inefficient approach to education. Furthermore, for a number of procedural interventions, including cataract surgery, higher surgeon volumes have been associated with improved outcomes.\(^{9-13}\) Hence, given the lack of research in this area, further study will be needed to investigate the effect of surgeon experience, training, and surgical volume on strabismus surgical outcomes.

A major strength of this study was the incorporation of comprehensive data from all physicians and patients in a large well-defined population with universal health care insurance. There are some limitations to our study that warrant mention. Although the accuracy of the data sources is excellent, the potential for coding errors exists. In addition, although Ontario’s population demographics mirror those in the United States, our results may not be generalizable to all jurisdictions. However, while data from the United States are lacking, ophthalmology residency training is 1 year shorter in the United States than in Canada, potentially raising even further the likelihood of surgeons limiting their scope of practice.

Conclusions

In summary, using a population-based approach, we found that strabismus surgery has evolved into a more subspecialized area of ophthalmology. Strabismus surgery is increasingly provided by a small number of higher-volume surgeons. Our results may have important implications, not only for health care professionals and health system leaders but also for residency and fellowship education programs and their governing organizations.

ARTICLE INFORMATION

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REFERENCES