

# Effect of cataract surgery volume constraints on recently graduated ophthalmologists: a population-based cohort study

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## ABSTRACT

**Background:** Across Canada, graduates from several medical and surgical specialties have recently had difficulty securing practice opportunities, especially in specialties dependent upon limited resources. In most developed nations, cataract surgery is the most common operation performed, making practice opportunities sensitive to access to health system resources and making this procedure an exemplar of issues facing resource-intensive specialties.

**Methods:** We used population-based administrative data from Ontario for the period Jan. 1, 1994, to June 30, 2013, to compare health services provided by recent graduates and established ophthalmologists. The primary outcome was volume of cataract surgery, a resource-intensive service for which volume is controlled by the province.

**Results:** When cataract surgery volume in Ontario entered a period of government-mandated zero growth in 2007, the mean number of cataract operations performed by recent

graduates dropped significantly (−46.37 operations/quarter, 95% confidence interval [CI] −62.73 to −30.00 operations/quarter), whereas the mean rate for established ophthalmologists remained stable (+5.89 operations/quarter, 95% CI 95% CI −1.47 to +13.24 operations/quarter). Decreases in service provision among recent graduates did not occur for services without volume control. The proportion of recent graduates providing exclusively cataract surgery increased over the study period, and recent graduates in this group were 5.24 times (95% CI 2.15 to 12.76 times) more likely to fall within the lowest quartile for cataract surgical volume during the period of zero growth in provincial cataract volume (2007–2013) than in the preceding period (1996–2006).

**Interpretation:** Recent ophthalmology graduates performed many fewer cataract surgery procedures after volume controls were implemented in Ontario. Integrated initiatives involving multiple stakeholders are needed to address the issues facing recently graduated physicians in Canada.

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Despite the increasing need for health care services to meet the demands of Canada's aging population, reports suggest that graduates from several medical and surgical specialties have recently had difficulty securing practice opportunities.<sup>1–14</sup> The Royal College of Physicians and Surgeons of Canada (RCPSC) employment survey, published in 2013, indicated that recent graduates from a broad cross-section of specialties are experiencing increasing difficulty in accessing health system resources, with graduates from nuclear medicine, radiation oncology and cardiac surgery programs reporting the greatest difficulty.<sup>6</sup> The RCPSC survey results, in combination with National Physician Survey data, also indicate

that physician unemployment and underemployment are Canada-wide issues.<sup>6,12,15</sup>

The RCPSC survey was an important step in developing effective physician human resources policies and builds on previous reports identifying the need for research in this area, including those of the Commission on the Future of Health Care in Canada (Romanow Commission)<sup>16</sup> and the Physician Human Resource Strategy for Canada (Task Force Two).<sup>17</sup> The RCPSC employment survey identified a pressing need for quantitative analyses of physician human resource issues to first confirm the survey findings and then address the complex challenges facing recent graduates, particularly in specialties dependent upon limited and controlled resources, where the issues are

most acute.<sup>6</sup> Indeed, hospital resources have become increasingly strained across Canada, with hospital budget growth at its lowest level in almost 2 decades.<sup>18</sup>

In many nations, including Canada, cataract surgery, a highly technology-dependent procedure, is the most common operation performed.<sup>19–22</sup> Consequently, practice opportunities are sensitive to overall constraints on health system resources and serve as an exemplar of issues facing many resource-intensive specialties. Furthermore, Ontario has undertaken a process of health system funding reform, which incorporates direct government-controlled, patient-based funding to institutions for cataract surgical cases. The number of cataract operations is provincially controlled, which has resulted in volume caps at each institution. This provides a unique opportunity to identify and study the impact of resource constraint on the practice of recent graduates in a fashion not possible for areas of care where global budgeting precludes precise identification of resource constraints.

To investigate whether resource constraints in the health care system have a greater impact on recent graduates than on established physicians, we conducted a retrospective cohort study comparing the effect of access to health system resources on the practice profiles of recent ophthalmology graduates and established physicians.

## Methods

To investigate how access to clinical resources has altered the practice of recent ophthalmology graduates, we conducted a population-based, retrospective cohort study comparing the practice profiles of recent graduates with those of established ophthalmologists between Jan. 1, 1994, and June 30, 2013. We examined both resource-intensive, volume-controlled procedures and minimally resource-intensive, non-volume-controlled health services. The study protocol was approved by the Queen's University Health Sciences Research Ethics Board. Confidentiality was maintained via encrypted identification numbers and strict adherence to privacy protocols.

### Cohort definitions

We defined recent graduates as physicians in their first 2 years of independent practice, to allow for lags in the initiation of practice. Independent practice was defined as commencing on the date of the first independently performed clinical service (consultation, other office visit or procedural service). To allow for the possibility of postresidency fellowship training, we specified

that independent practice had to have commenced within 3 years of residency completion for the physician to be classified as a recent graduate. The comparison group of established physicians comprised all other ophthalmologists in Ontario who were in practice within each quarter, as defined by the provision of consultation, other office visit or procedural services. The cessation of clinical billing was used to assess physicians' retirement or departure from the province.

To investigate the potential effect of subspecialization among recent graduates in areas of ophthalmology focused on operations other than cataract surgery, we divided ophthalmologists into mutually exclusive categories based upon the number of subspecialized operations performed each year. The subspecialties were corneal surgery, glaucoma surgery, retina surgery, strabismus surgery and orbital surgery. Surgeons were classified as providing subspecialized surgery if they performed 10 or more operations in the year within one subspecialty. Surgeons meeting the criteria for more than one subspecialty were assigned to the one in which they performed the greatest number of operations. Exclusive cataract surgeons were defined as those who performed cataract surgery and none of the subspecialized ophthalmic operations.

### Data sources and clinical service definitions

Universal health care insurance is provided to all 13 million residents in the province of Ontario, and the health administrative data derived from the databases used for this insurance are population-based. The Ontario Health Insurance Plan (OHIP) database contains information on inpatient and outpatient physician services and has excellent reliability in recording medical procedures.<sup>23</sup> The Institute for Clinical Evaluative Sciences (ICES) Physician Database contains data on all physicians practising in Ontario, and incorporates information from the OHIP Corporate Provider database, the Ontario Physician Human Resource Data Centre database and the OHIP database. Telephone interviews with physicians practising in Ontario are used to validate the database, and the database has been used in previous studies of physician practice.<sup>24–26</sup>

Using the OHIP database, we examined cataract surgery as a representative operating room-based, resource-intensive, volume-controlled procedure. We identified all cataract surgery cases in each quarter during the study period and linked each operation to the individual attending surgeon using the ICES Physician Database. To evaluate whether observed effects were specific

to resource-intensive, volume-controlled procedures, we also evaluated clinic-based aspects of care that are not volume-controlled. Specifically, we evaluated all consultations provided by ophthalmologists, as well as laser iridotomy procedures. Laser iridotomy is performed routinely in ambulatory care office settings to prevent or treat angle-closure glaucoma.<sup>27</sup> Finally, operating room days were defined as days on which the surgeon provided any of the ophthalmic operations evaluated in the study (cataract surgery, corneal surgery, glaucoma surgery, retinal surgery, strabismus surgery or orbital surgery).

### Statistical analysis

We descriptively compared trends in the mean number of services per quarter for cataract surgery, consultations and laser iridotomy procedures among recent graduates and established ophthalmologists providing these services. We then compared differences between recent graduates and established ophthalmologists in rates of cataract surgery, consultations and laser iridotomy procedures using 2-sample *z*-tests.

To provide additional detail, we used segmented regression to evaluate individual physician cataract surgery rates within each group before and after cataract surgery volume limits led to the levelling-off of total provincial cataract surgery volumes at the end of 2006, controlling for the number of ophthalmologists serving the population.<sup>28</sup> Details of the segmented regression analysis are presented in Appendix 1 (available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1)). We also performed 2 sensitivity analyses for the segmented regression analysis. In the first, data from 2006, the final year of the expansion of resources, were excluded to assess the possibility that an outlier year caused an overestimation of the impact of subsequent resource constraint. In the second sensitivity analysis, to avoid having physicians belong to different groups, surgeons in the recent graduates group were not transitioned to the established surgeons group, but instead were excluded after their period as a recent graduate.

We further refined the analysis by using logistic regression models to evaluate the effect of recent graduate status and time period (period with steady growth in total provincial cataract surgery volume [1996–2006] versus period with no growth in total provincial cataract surgery volume [2007–2013]) on cataract surgery volume and operating room days among surgeons who exclusively performed cataract surgery. In these analyses, surgeons classified as recent graduates were not transi-

tioned to the established surgeon group at the end of their period as recent graduates.

To confirm that a trend toward subspecialization among recently graduated ophthalmologists did not confound the analysis, we used Cochran–Armitage tests to examine trends in the proportion of ophthalmologists providing subspecialized surgery.

Finally, we investigated regional variation by comparing the number of cataract operations performed by recent graduates and established ophthalmologists across time periods in each of Ontario's health care administrative regions (Local Health Integration Networks).

All analyses were performed with SAS software version 9.4 (SAS Institute).

## Results

Between 1994 and 2006, the total number of cataract operations performed in Ontario grew steadily, from about 12 000 to about 36 000 cases/quarter. During this period of steady growth in total provincial cataract surgery volume, the rate ratio for mean number of cataract operations performed by recent graduates relative to established ophthalmologists was 0.79 (95% confidence interval [CI] 0.71 to 0.89) (Figure 1). From 2007 onward, the total number of cataract operations performed in Ontario remained stable, at about 36 000 cases/quarter. During this period of zero growth in total provincial cataract surgery volume, the mean number of operations performed by recent graduates declined sharply, from a high of 147.3 cases/quarter in the preceding period to a low of 36.6 cases/quarter, and the rate ratio for mean num-

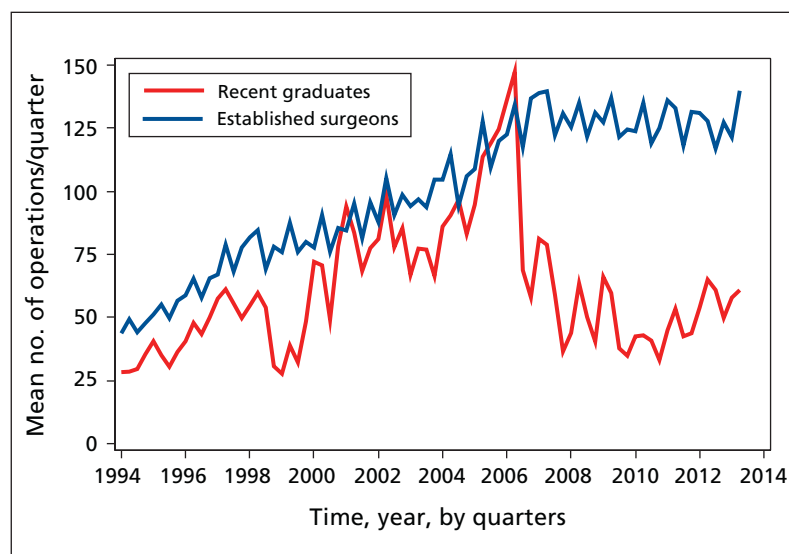


Figure 1: Mean quarterly number of cataract surgery procedures among recent graduates and established physicians, 1994–2013.

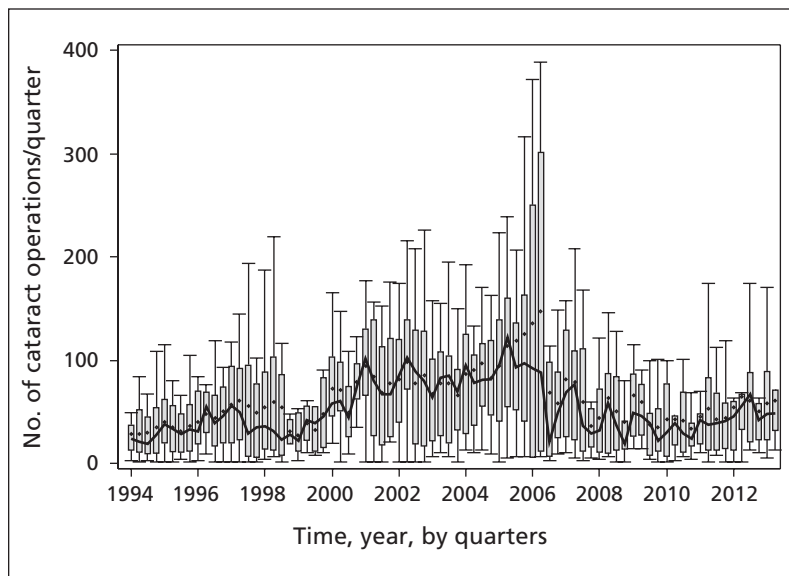
ber of cataract operations performed by recent graduates relative to established ophthalmologists dropped to 0.44 (95% CI 0.39 to 0.49) (Figure 1).

Among recent graduates commencing practice since 2007, the mean rate of cataract operations subsequently plateaued at a level below that of established ophthalmologists (Appendix 2, available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1)). The annual number of recent graduates, the number of established surgeons and the number of ophthal-

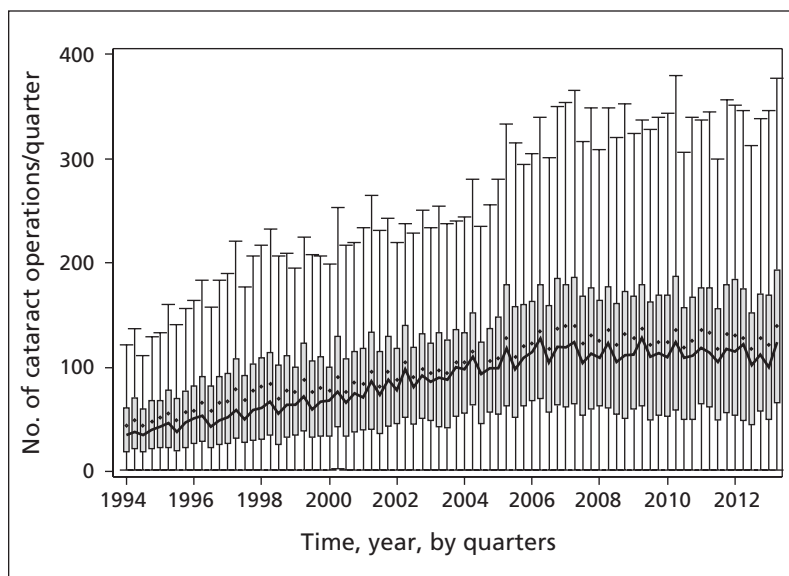
mologists ceasing practice remained approximately constant over the study period (Appendix 3, available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1)). Trends in the total number of cataract operations, consultations and laser iridotomy procedures performed by each group over the study period are shown in Appendix 4 (available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1)). Higher cataract surgical rates became very rare among recent graduates in the later years of the study, as evidenced by the substantial drop in the 95th percentile for surgeon-specific cataract surgery rate in this group (Figure 2). In contrast, among established physicians, there was a levelling-off of the 95th percentile for surgeon-specific cataract surgery rate, but a decline was not observed (Figure 3).

Segmented regression analysis of mean surgeon-specific cataract surgery rates provided detailed, supportive results. Before 2007, the mean rate of cataract operations increased by 1.39 (95% CI 1.04 to 1.74) operations/quarter in the recent graduate group and by 1.50 (95% CI 1.34 to 1.66) operations/quarter in the established ophthalmologist group (Table 1). However, when policy shifts led to a plateau in total provincial cataract surgery volume, beginning in January 2007, the mean number of cataract operations performed by recent graduates decreased by 46.37 (95% CI -62.73 to -30.00) operations/quarter (Table 1). Conversely, among established surgeons, a significant decline in mean procedure rates did not occur (+5.89 [95% CI -1.47 to +13.24] operations/quarter; Table 1). The trend in mean cataract surgical rates slowed from 2007 onward within both groups (-1.62 [95% CI -2.51 to -0.73] operations/quarter for recent graduates; -1.68 [95% CI -2.08 to -1.28] operations/quarter for established ophthalmologists; Table 1).

Logistic regression models incorporating surgeons who exclusively performed cataract surgery also showed a significant effect of recent graduate status on both cataract surgery volume and operating room days (Figure 4). In particular, recent graduates were 5.24 (95% CI 2.15 to 12.76) times more likely to fall within the lowest quartile for cataract surgery volume during the period of zero growth in total provincial cataract surgery volume (2007–2013) than in the preceding period, during which total provincial cataract surgery volume grew steadily (1996–2006). Similarly, recent graduates were 2.30 (95% CI 1.07 to 4.92) times more likely to fall within the lowest quartile for operating room days during the period of zero growth in total provincial cataract surgery vol-



**Figure 2:** Box and whisker plot showing the distribution of quarterly cataract surgery volumes among recent graduates, 1994–2013. Grey bars represent the 25th through 75th percentiles, and whiskers represent the 5th and 95th percentiles. Small diamonds indicate means, and the thick black line joins medians.



**Figure 3:** Box and whisker plot showing the distribution of quarterly cataract surgery volumes among established physicians, 1994–2013. Grey bars represent the 25th through 75th percentiles, and whiskers represent the 5th and 95th percentiles. Small diamonds indicate means, and the thick black line joins medians.



ume than in the preceding period of steady growth in total provincial cataract surgery volume. In contrast, time period had no effect on volumes for established surgeons (Figure 4).

We conducted multiple sensitivity analyses and additional investigations of comparator procedures (Appendix 5, available at [www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1](http://www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.150674/-/DC1)). Exclusion of data from 2006 (the final year before the plateau in total provincial cataract surgical volume) or censoring of data on surgeons after their 2-year recent graduate period yielded results similar to the main analysis. In contrast to cataract operations, surgeon-specific rates of consultations and laser iridotomy procedures did not decrease among recent graduates after 2007. No evidence of a shift toward subspecialization in areas other than cataract surgery was observed among either recent graduates or established surgeons.

## Interpretation

In this population-based study, we found that the clinical practice of ophthalmology graduates has recently changed significantly from patterns seen in prior periods. In particular, although recent graduates have continued to provide stable or increasing levels of consultations and clinic-based procedures, there have been substantial declines in cataract surgical rates and operating room days within this group. These declines coincided with policy shifts that led to a rapid transition from a period of resource expansion to one of resource constraint. The absence of central planning for many aspects of medical care hamper efforts to undertake similar analyses in other areas. However, many other specialties face similar resource constraints, and evidence suggests that similar events may be unfolding in many resource-intensive specialties across Canada.<sup>3,6,9,10,12-14</sup>

The finding that declining participation by recent graduates was specific to a resource-intensive procedure, and did not occur in comparison services that do not require access to controlled and limited resources, strongly suggests that such access is an important factor underpinning our findings. When overall provincial cataract surgical rates were growing, new surgeons could access added volumes without necessitating a concomitant decrease in volumes among established ophthalmologists. However, providing opportunities for recent graduates has proven difficult following the levelling-off of total and per-surgeon case loads. The end of mandatory surgeon retirement may also have added to resource constraints faced by new surgeons. Hence, our

results quantitatively support the view that resource allocation decisions effectively establish the demand for resource-intensive services.<sup>6</sup> Consequently, human resource planning and policy must account not only for population health needs, but also for health system fiscal realities.

Several Canadian health human resources evaluations and reports have shaped policies in recent decades.<sup>16,17,29-31</sup> These reports have emphasized the inherent link between physician human resources and overall health care system decision-making, and the need for integrated policies that reflect this link. More recently, surveys by the RCPSC and the National Physician Survey have drawn attention to the growth of underemployment and unemployment among physicians and surgeons from a wide variety of specialties across Canada.<sup>6,12,15</sup> Our results complement these surveys and will inform both short-term and long-term policy initiatives at several levels. In the short term, detailed, current data should improve the effectiveness of career counselling, a goal suggested in the RCPSC employment report.<sup>6</sup> In the long term, such data should inform broad policy directions, as called for by bodies including Task Force Two of the Canadian Medical Association (CMA) and the RCPSC.<sup>2,6,17</sup>

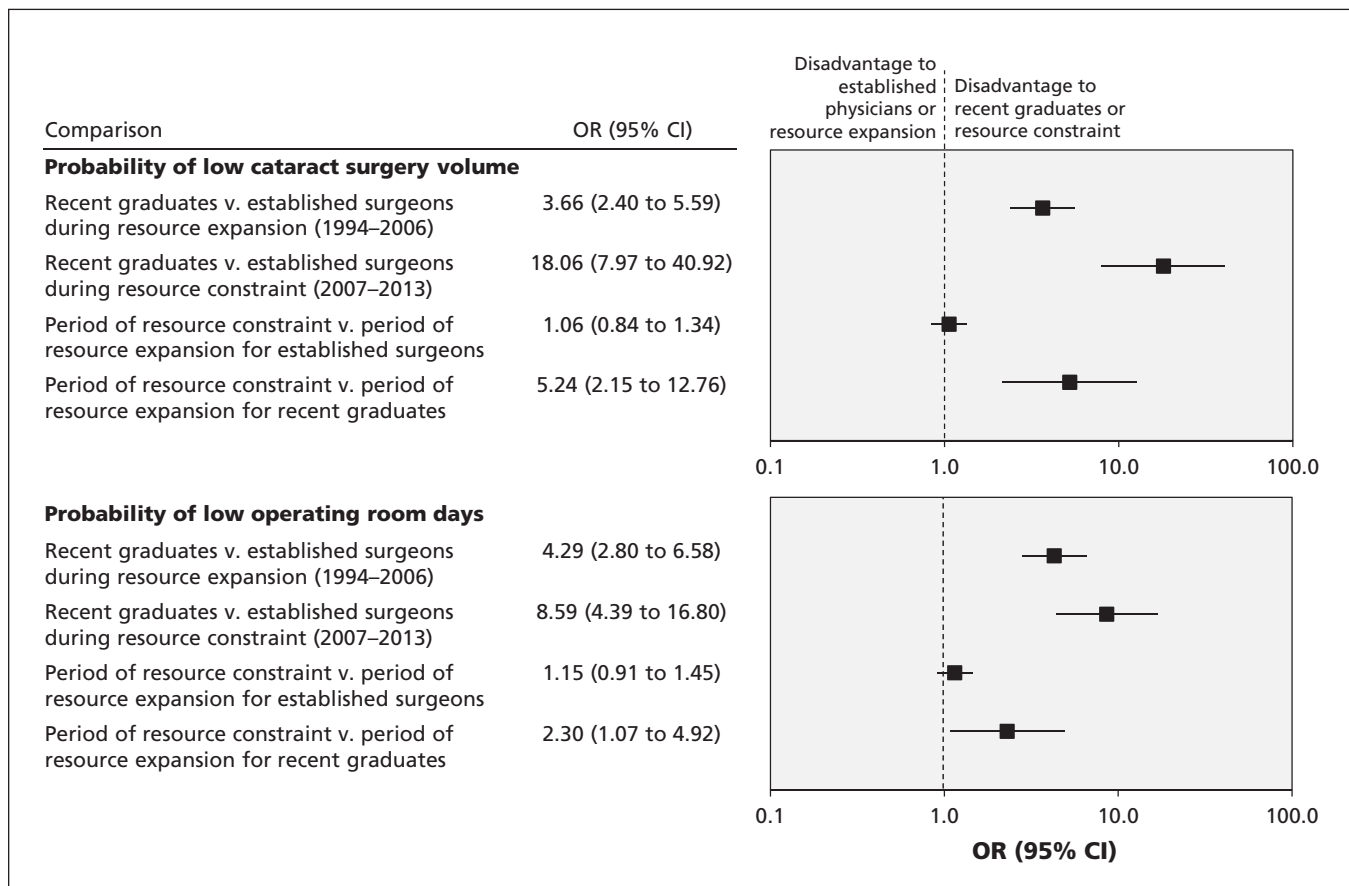
Of note, Ontario's Provincial Vision Strategy Task Force, a collaborative effort of clinical and government leaders that is charged with develop-

**Table 1:** Full segmented regression models predicting mean quarterly number of cataract operations

Variable*	Parameter estimate (95% CI)
<b>Recent graduates</b>	
Intercept, $\beta_0$	197.54 (8.7 to 386.33)
Baseline trend, $\beta_1$	1.39 (1.04 to 1.74)
Level change after Jan. 1, 2007, $\beta_2$	-46.37 (-62.73 to -30.00)
Trend change after Jan. 1, 2007, $\beta_3$	-1.62 (-2.51 to -0.73)
No. of ophthalmologists/100 000 population $\geq$ 18 yr of age, $\beta_4$	-27.98 (-58.86 to 2.89)
<b>Established ophthalmologists</b>	
Intercept, $\beta_0$	45.96 (-38.91 to 130.83)
Baseline trend, $\beta_1$	1.50 (1.34 to 1.66)
Level change after Jan. 1, 2007, $\beta_2$	5.89 (-1.47 to 13.24)
Trend change after Jan. 1, 2007, $\beta_3$	-1.68 (-2.08 to -1.28)
No. of ophthalmologists/100 000 population $\geq$ 18 yr of age, $\beta_4$	0.15 (-13.73 to 14.03)

Note: CI = confidence interval

\* $\beta_0$  = estimate of the adjusted quarterly cataract surgery rate at baseline (first quarter of 1994);  $\beta_1$  = estimate of the adjusted baseline slope parameter representing the change in the cataract surgery rate that occurred every quarter before January 2007;  $\beta_2$  = estimate of the adjusted immediate shift in the cataract surgery rate occurring as of January 2007;  $\beta_3$  = estimate of the adjusted change in the trend (slope) of the cataract surgery rate occurring as of January 2007;  $\beta_4$  = estimate of the effect of the number of ophthalmologists per population on the mean cataract surgical rate.



**Figure 4: Effect of career stage and time period on probability of low cataract surgery volume and low number of operating room days among cataract surgeons.** The figure represents an analysis of 233 established surgeons and 88 recent graduates who were exclusively cataract surgeons. Low cataract surgery volume = lowest quartile for annual number of cataract cases. Low number of operating room days = lowest quartile for annual number of operating room days. The plot uses a logarithmic scale.

ing a framework for transformation of the eye care system, recently highlighted the need to ensure reasonable allocation of publicly funded operating room resources among surgeons at all career stages, while recognizing the natural arc of volumes expected over a career.<sup>32</sup> Indeed, the problems identified do not stem from a glut of providers, as there remains unmet demand for ophthalmologic services, which is evidenced by access issues for many services, including eye exams for patients with diabetes.<sup>32</sup> Hence, the task force recommendation aims both to improve surgical opportunities for recent graduates (to ensure ongoing, sustainable access to surgery) and to promote the provision of vital nonsurgical aspects of eye care where access has been inadequate.<sup>33,34</sup> The magnitude of the results we report suggests a pressing need to evaluate similar policies across many resource-intensive specialties in Canada.

#### Strengths and limitations

Our study was strengthened by its population-based approach, long study period and the natural experiment created by policy shifts. Furthermore, the inclusion of health care services from across

the spectrum of resource intensity allowed us to evaluate the role of health system resource allocation and access in the developments that we observed.

The study had weaknesses that warrant mention. We analyzed data at provincial and regional levels, and it is possible that smaller subregional and hospital-level variations exist. Although such variations would not affect our overall conclusions, it will be important for leaders to examine local data where human resources decisions are regulated at a subregional or hospital level. In addition, our results may not be generalizable to other provinces and specialties, and further studies are warranted. Nevertheless, survey data from the RCPSC and the National Physician Survey suggest that the issue is indeed widespread. Hence, our results and previous surveys provide complementary data that together provide a foundation for the next steps in research and policy development.

#### Conclusion

We found that the practice of recent ophthalmology graduates has changed substantially,

with a significant decrease in the provision of cataract surgery, a resource-intensive, volume-controlled surgical procedure. The lack of access to health system resources for graduates specializing in resource-intensive areas of medicine is likely to worsen, given the large expansion of medical school enrolment and residency positions in recent years.<sup>35,36</sup> Given the threat to system sustainability, integrated initiatives involving multiple stakeholders, including provincial ministries of health, the CMA, the RCPSC, national specialty societies, residency programs and schools of medicine, will be required to address the issues facing recently graduated physicians in Canada.

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