Association of Cataract Surgical Outcomes With Late Surgeon Career Stages
A Population-Based Cohort Study

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IMPORTANCE Evidence suggests that the quality of some aspects of care provided by physicians may decrease during their late career stage. However, to our knowledge, data regarding the association of advancing surgeon career phase with cataract surgical outcomes have been lacking.

OBJECTIVE To investigate whether an increase in cataract surgical adverse events occurs during later surgeon career stages.

DESIGN, SETTING, AND PARTICIPANTS This population-based study of 499,650 cataract operations performed in Ontario, Canada, between January 1, 2009, and December 31, 2013, investigated the association between late surgeon career stage and the risk of surgical adverse events. Linked health care databases were used to study cataract surgical complications while controlling for patient-, surgeon-, and institution-level covariates. All ophthalmologists who performed cataract surgery in Ontario within the study period were included in the analysis.

EXPOSURES Isolated cataract surgery performed by surgeons at early, mid, and late career stages.

MAIN OUTCOMES AND MEASURES Four serious adverse events were evaluated: dropped lens fragments, posterior capsule rupture, suspected endophthalmitis, and retinal detachment.

RESULTS Of 416,502 participants, 244,670 (58.7%) were women, 90,429 (21.7%) were age 66 to 70 years, 111,530 (26.8%) were age 71 to 75 years, 90,809 (21.8%) were age 76 to 80 years, and 123,734 (29.7%) were 81 years or older. Late-career surgeons performed 143,108 of 499,650 cataract operations (28.6%) during the study period. Late surgeon career stage was not associated with an increased overall risk of surgical adverse events (odds ratio [OR] vs midcareer, 1.06; 95% CI, 0.85-1.32). In a sensitivity analysis with surgeon volume removed from the model, late career stage was still not associated with overall adverse surgical events (OR, 1.10; 95% CI, 0.88-1.38). Among individual complications, late surgeon career stage was associated with an increased risk of dropped lens fragment (OR, 2.30; 95% CI, 1.50-3.54) and suspected endophthalmitis (OR, 1.41; 95% CI, 1.01-1.98). These corresponded with small absolute risk differences of 0.11% (95% CI, 0.085%-0.130%) and 0.045% (95% CI, 0.028%-0.063%) for dropped lens fragment and suspected endophthalmitis, respectively.

CONCLUSIONS AND RELEVANCE These findings suggest that later-career surgeons are performing a substantial proportion of cataract operations with overall low surgical adverse event rates. Future studies might extend evaluations to the frequency of secondary surgical interventions as additional measures of surgical care quality.

Published online October 11, 2018.

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In recent years, efforts to improve health care outcomes have focused on the quality of care and avoiding medical and surgical errors.\(^4\)\(^-\)\(^9\) Evidence suggests that the quality of some aspects of care that is provided by physicians may decrease during their late-career phase, with the number of years since completing training and age suggested as underlying mediators.\(^4\)\(^-\)\(^9\) In particular, the technical proficiency of surgeons at later career stages has been questioned.\(^4\)\(^,\)\(^5\)\(^,\)\(^8\)\(^-\)\(^10\) Studies of neurophysiologic function have demonstrated deterioration in numerous domains among aging individuals, including surgeons, and lend biologic plausibility to the empirical evidence for declining surgeon performance.\(^11\)\(^-\)\(^13\) However, advancing surgeon career stage has not been universally associated with poorer surgical outcomes.\(^10\)\(^,\)\(^14\)\(^-\)\(^16\) Moreover, in many surgical fields, the study of technical skill in isolation is hampered by institutional-level confounders, particularly the quality of postoperative inpatient hospital care.

Cataract surgery is the most common operation in the majority of developed nations (excluding intravitreal injections) and, because of its technical demands, it is an excellent model in evaluating surgeon skill.\(^17\)\(^,\)\(^18\) Cataract surgery is performed primarily as an outpatient operation, thereby avoiding confounding that is caused by variations in the quality of patient postoperative care. Additionally, adverse event indicators have been established for cataract surgery and have been used in quality assurance programs and health systems research.\(^19\)\(^-\)\(^21\)

Despite an important potential association with the quality of care, to our knowledge, data assessing the influence of advancing surgeon career stage on cataract surgical outcomes have been lacking. A literature search that included the terms cataract/cataract surgery, intraoperative/surgical complications, aging/aging surgeon, and surgeon age did not identify any original investigations that evaluate this important clinical topic. Hence, we conducted a population-based study to investigate whether an increase in cataract surgical adverse events occurs during later surgeon career stages.

**Methods**

**Overview**

We conducted a population-based study to investigate the association between late surgeon career stage and the risk of cataract surgical adverse events. All isolated cataract operations performed in Ontario, Canada, between January 1, 2009, and December 31, 2013, were evaluated. We linked several health care databases to study 4 complications of cataract surgery: dropped lens fragment, posterior capsule rupture, retinal detachment, and suspected endophthalmitis. All analyses controlled for patient-, surgeon-, and institution-level covariates. The Queen's University Health Sciences Research ethics board approved the protocol and patient confidentiality was maintained via encrypted identification numbers and strict privacy protocols. The study used administrative health care data, and thus patient consent was not required.

**Data Sources**

Ontario provides universal health care insurance for the population of approximately 13 million, and data from the health care databases evaluated in this study are population based and have been used in previous studies.\(^19\)\(^,\)\(^22\)\(^-\)\(^25\) Several databases were linked for this study. The Ontario Health Insurance Plan database provides information on inpatient and outpatient physician services and is highly accurate in recording surgical procedures.\(^26\) The Ontario Drug Benefit database provides records of all prescriptions for drugs that are dispensed to outpatients 65 years or older with more than 99% accuracy.\(^27\) The Canadian Institute for Health Information discharge abstract database contains accurate information on all hospital admissions in Ontario.\(^28\) The Registered Persons Database contains demographic information on all persons in Ontario. The Ontario Diabetes Database provides validated data on citizens with diabetes.\(^29\) The Institute for Clinical Evaluative Sciences Physician database provides detailed data regarding all physicians in Ontario. Telephone interviews with physicians who practice in Ontario were used to verify the accuracy of the database, which has been used in previous studies of physician practices.\(^22\)\(^,\)\(^30\)\(^-\)\(^32\)

**Patient and Surgeon Inclusion Criteria**

We identified all isolated cataract operations performed in Ontario between January 1, 2009, and December 31, 2013. We limited the study to patients who were 66 years and older to provide a 1-year look-back period to identify potential drug-related confounders in the Ontario Drug Benefit database. More than 80% of cataract operations are performed on patients within this age range.\(^25\) We excluded cataract operations that were done in conjunction with other ocular procedures because the additional procedures may increase the risk of complications.\(^33\) Because previous ocular procedures may correlate with ocular comorbidity, we excluded patients who had undergone intraocular surgery or retinal laser therapy in the preceding 5 years. We also excluded patients who had received an intravitreal injection for retinal disease in the previous year because these procedures have been associated with an increased risk of adverse events during subsequent cataract surgery.\(^34\)\(^-\)\(^36\) Patients who underwent general anesthetic or bilateral surgery were excluded to avoid confounding because these approaches are not used in routine cataract surgery and systemic and ocular comorbidities that affect surgical outcomes may correlate with these approaches.

**Findings**

In this population-based study of 499,650 cataract operations, a late surgeon career stage was not associated with an increased overall risk of cataract surgical adverse events.

**Meaning**

These results suggest that cataract surgery can be performed by surgeons at later career stages without increasing the risk of surgical adverse events.
All ophthalmologists who performed cataract surgery in Ontario within the study period were included in the analysis. Because previous research has shown that early-career surgeons have higher adverse event rates than more experienced surgeons, we separated early-career surgeons from midcareer surgeons to create a midcareer reference group against which appropriate comparisons with late-career surgeons could be made.21 Hence, early, mid, and late career phases were defined as fewer than 15 years, 15 to 25 years, and more than 25 years since completing medical school, respectively. Only surgeons who belonged to a single career stage category throughout the study period were included. Surgeons who performed fewer than 25 cataract operations per year were excluded because of the potential that results among very low-volume surgeons are not generalizable.19

Adverse Cataract Surgical Outcomes

Four serious adverse events were evaluated: dropped lens fragments, posterior capsule rupture, suspected endophthalmitis, and retinal detachment. We used the outcome definitions published by the Ontario Ministry of Health and Long-Term Care as surgical quality indicators.20 The outcome definitions have been used in prior studies and coding details are provided in the eAppendix in the Supplement.19,21,25 Briefly, dropped lens fragment was identified as a case undergoing vitrectomy and retained lens extraction between 1 and 14 days after cataract surgery. Posterior capsule rupture was identified as cases requiring anterior vitrectomy on the same day as cataract surgery. Suspected endophthalmitis was identified as cases that required vitrectomy without air/fluid exchange or retained lens extraction or an intravitreal injection procedure that was not performed as part of a pneumatic retinopexy between 1 and 14 days following cataract surgery. Retinal detachment was defined as a case having vitrectomy or scleral buckle in combination with an air/fluoride exchange between 1 and 14 days following cataract surgery, or a case undergoing pneumatic retinopexy between 1 and 14 days following cataract surgery. Only the first adverse event was included for cases with more than 1 of these 4 complications.

Covariates

We adjusted for many potential confounders that have been identified as risk factors for cataract surgical adverse events.25,33,37-39 Patient-level covariates evaluated included sex, patient age on the date of surgery, socioeconomic status (neighborhood income quintile), topical glaucoma medication use in the preceding 90 days, ophthalmic medication use in the preceding 90 days, tamsulosin or antiviral use in the preceding year, and diabetes. As a measure of comorbidity, the total number of medications used by each patient in the previous year was evaluated.19 Surgeon cataract procedure volume was also included in the models and was defined as the number of cataract operations performed in the calendar year.25 Institutions were designated as academic or nonacademic centers based on the Ontario Ministry of Health and Long-Term Care classification of hospitals. We confirmed these designations through direct communication with all surgical training programs in Ontario.

Analysis

Multilevel random-effects logistic regression models were used to evaluate the association between late surgeon career stage and the risk of adverse events, controlling for both patient- and surgeon-level covariates as well as institution type.40 A secondary analysis was also performed in which surgeon age was used as the variable of interest. Analyses adjusted for secular trends by including the calendar year in all models. A parsimonious model was developed for overall complications (a composite of the 4 individual complications), with diabetes included because of evidence demonstrating its association with cataract surgical adverse events.33,37,41 The analyses of each adverse event used the same model to allow for comparisons.

Because decreasing surgical volume may occur at later career stages and mediate an increased risk of surgical complications, it is possible that including this potential mediator in the models could obscure an association between late career stage and outcomes. To evaluate this possibility, we conducted a sensitivity analysis in which surgical volume was not included in the models. A sensitivity analysis was also performed in which patients with a recent history of noncataract ocular surgery were included. Analyses were performed using SAS software, version 9.4 (SAS Institute).

Results

Over the study period, 499,650 cataract operations that met the study criteria were performed in Ontario. Among these cases, 83,148 (16.6%) were performed by 64 early-career surgeons, 273,394 (54.7%) were performed by 147 midcareer surgeons, and 143,108 (28.6%) were performed by 88 late-career surgeons. Among the 416,507 patients in the study, the median age was 76 years (interquartile range, 72-81 years) and 244,670 (58.7%) were women. Patients used a median of 9 prescription medications in the year prior to surgery (interquartile range, 6-13 medications) and 130,866 (31.5%) had diabetes. Patients who were treated by late career surgeons were very similar to those treated by midcareer surgeons (referent group; Table 1). The total number of cataract operations in Ontario over the study period before applying study exclusion criteria was 527,848 among the population 66 years and older. Among the excluded cases, 7387 (1.4%) were excluded because of concurrent ocular surgery. Across all study years, 34 surgeons performed fewer than 25 cases in a calendar year.

Association of Late Career Stage and Surgeon Age With Surgical Adverse Events

Adverse events occurred in 2832 cataract operations (0.6%). Specifically, dropped lens fragment occurred in 359 cases (0.1%), posterior capsule rupture in 2064 cases (0.4%), suspected endophthalmitis in 329 cases (0.1%), and retinal detachment in 80 cases (0.01%). The results of the random-effects logistic regression analysis for overall adverse events are presented in Table 2. This analysis estimates the association of career stage with the risk of cataract complications after controlling for calendar year as well as patient, surgeon, and...
institution covariates. Late career stage was not associated with an increased overall risk of surgical adverse events (odds ratio [OR] vs midcareer, 1.06; 95% CI, 0.85-1.32; Table 2). In the sensitivity analysis with surgeon volume removed from the model, late career stage remained nonpredictive of adverse surgical events (OR, 1.10; 95% CI, 0.88-1.38). Similarly, the secondary analysis did not find an association between surgeon age and the risk of adverse events (Table 3). Additionally, the sensitivity analysis in which patients with a recent history of noncataract ocular surgery were included showed results that were analogous with the primary analysis.

The random-effects logistic regression results for the individual adverse outcomes are presented in eTables 1 to 4 in the Supplement. Among the individual complications, late surgeon career stage was associated with an increased risk of dropped lens fragment (OR, 2.30; 95% CI, 1.50-3.54; eTable 2 in the Supplement) and suspected endophthalmitis (OR, 1.41; 95% CI, 1.01-1.98; eTable 4 in the Supplement). These corresponded to absolute risk differences and numbers needed to harm of 0.11% (95% CI, 0.09%-0.13%) and 947 (95% CI, 791-1178), respectively, for dropped lens fragment and 0.05% (95% CI, 0.03%-0.06%) and 2203 (95% CI, 1583-3622), respectively, for suspected endophthalmitis.

### Association of Cataract Surgical Outcomes With Late Surgeon Career Stages

Among the patient-level covariates, older age, male sex, more prescription medications used in the year preceding surgery, glaucoma medication use, and tamsulosin use were associated with higher overall risks of adverse events (Table 2). Lower surgeon procedure volume and academic center status were also associated with higher risks. In the analyses of the individual adverse events, a surgeon procedure volume association was observed for dropped lens fragment, posterior capsulorhexis, and suspected endophthalmitis (eTables 1, 2, and 4 in the Supplement). Additionally, older patient age, more prescription medications used in the year preceding surgery, and tamsulosin use were associated with dropped lens fragment and posterior capsulorhexis (eTables 1 and 2 in the Supplement). Finally, men were more likely to develop retinal detachment and suspected endophthalmitis (eTables 3 and 4 in the Supplement).

### Discussion

Surgical quality improvement initiatives have focused significant attention on surgeon-level factors that influence outcomes. Previous research has identified surgeon career stage as a possible risk factor for adverse outcomes in several areas of care. In this population-based study we found that overall cataract surgical adverse events were not more likely among surgeons at later career stages when compared with midcareer surgeons. This finding was consistent in a sensitivity analysis that removed surgeon volume, a potential mediator, from the model. While dropped lens fragment and suspected endophthalmitis were more likely in cases that were performed by late-career surgeons when compared with midcareer surgeons, the absolute risk differences for these 2 events were very small. Notably, late-career surgeons provided cataract surgery for almost a third of the total patient sample.

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**Table 1. Comparison of Baseline Characteristics of Patients Undergoing Cataract Surgery by Late-Career vs Midcareer Surgeons**

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (%)</th>
<th>Standardized Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Midcareer</td>
<td>Late Career</td>
</tr>
<tr>
<td></td>
<td>(n = 273 394)</td>
<td>(n = 143 108)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>112 265 (41.1)</td>
<td>59 567 (41.6)</td>
</tr>
<tr>
<td>Female</td>
<td>161 129 (58.9)</td>
<td>83 541 (58.4)</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66-70</td>
<td>59 523 (21.8)</td>
<td>30 906 (21.6)</td>
</tr>
<tr>
<td>71-75</td>
<td>73 481 (26.9)</td>
<td>38 049 (26.6)</td>
</tr>
<tr>
<td>76-80</td>
<td>59 763 (21.9)</td>
<td>31 046 (21.7)</td>
</tr>
<tr>
<td>≥81</td>
<td>80 627 (29.5)</td>
<td>43 107 (30.1)</td>
</tr>
<tr>
<td>Socioeconomic status quintile b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>49 063 (17.9)</td>
<td>28 935 (20.2)</td>
</tr>
<tr>
<td>2</td>
<td>55 911 (20.5)</td>
<td>30 115 (21.0)</td>
</tr>
<tr>
<td>3</td>
<td>54 696 (20.0)</td>
<td>27 782 (19.4)</td>
</tr>
<tr>
<td>4</td>
<td>56 324 (20.6)</td>
<td>27 643 (19.3)</td>
</tr>
<tr>
<td>5</td>
<td>56 455 (20.6)</td>
<td>28 151 (19.7)</td>
</tr>
<tr>
<td>Unknown</td>
<td>945 (0.3)</td>
<td>482 (0.3)</td>
</tr>
<tr>
<td>No. of unique medications used, median (IQR)c</td>
<td>9 (6-13)</td>
<td>9 (6-13)</td>
</tr>
<tr>
<td>Glaucoma medication use d</td>
<td>22 888 (8.4)</td>
<td>13 152 (9.2)</td>
</tr>
<tr>
<td>Oral antiviral medication use c</td>
<td>3059 (1.1)</td>
<td>1684 (1.2)</td>
</tr>
<tr>
<td>Tamsulosin use</td>
<td>13 473 (4.9)</td>
<td>7457 (5.2)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>84 604 (30.9)</td>
<td>46 282 (32.3)</td>
</tr>
</tbody>
</table>

Abbreviation: IQR, interquartile range.

*All data are presented as number of patients (percentage) unless otherwise indicated. The percentages correspond to the column percentage for each variable.

b Neighborhood income quintile (1 = lowest, 5 = highest).

c Within the year preceding surgery.

d Within the 90 days preceding surgery.
In other areas of surgical care, several studies have reported declining performance among late-career surgeons. In particular, later surgeon career stage was associated with a higher risk of mortality following coronary artery bypass surgery and carotid endarterectomy. However, such findings have not been universal, with other studies finding no association between late surgeon career stage and adverse outcomes.

The complexity of the procedures that were studied and the frequency at which surgeons perform the specific operations may be important interacting variables that underlie these varying results. Notably, studies that use postsurgical mortality as the primary outcome are difficult to interpret given that mortality is affected by numerous aspects of care beyond the technical quality of the operation itself, including multiple components of postoperative inpatient care.

Despite concerns about declining physician and surgeon performance with advancing career stage, our overall results do not suggest such an association among cataract surgeons. This finding likely reflects a maintenance of skills among those who continue to perform operations, as well as planned retirement from surgical practice at appropriate times before issues arise. Nevertheless, the association between the risk of dropped lens fragment and late surgeon career stage warrants further study.

In summary, we hypothesized that adverse outcomes in cataract surgery might be associated with late surgeon career stage. We found that late career status was not associated with increased risk of overall cataract surgery complications. Our findings also suggest that the overall cataract surgery complication risk was not associated with surgeon age. These findings may have important implications for the management of cataract surgery complications.

Strengths and Limitations

This study has important strengths, such as its population-based methods, large sample size, the evaluation of a series of significant adverse events, and the adjustment for relevant covariates. There are also limitations to the study. First, despite the large number of cataract operations that were evaluated in this study, the number of some of the individual complications was not large, so the results of the individual adverse event analyses should be interpreted cautiously. Second, misclassification may occur with the use of health care databases. However, the study used validated databases and the adverse events that were studied have been used in previous research reports, as well as the Ontario Ministry of Health and Long-Term Care cataract surgery quality assurance process.

Third, the inclusion of only the first adverse event for each patient likely led to an underestimation of the absolute risk of some complications, particularly those that may occur subsequent to an initial adverse event, such as retinal detachment and endophthalmitis. However, this would not be anticipated to influence the overall conclusions. Fourth, while many instances of suspected endophthalmitis would be diagnosed with infectious endophthalmitis, some would likely not have been culture proven as a bacterial infection. Nevertheless, severe complications.
postoperative inflammation that required the interventions that defined suspected endophthalmitis would be a serious adverse event regardless of culture results. Fifth, our findings may not be generalizable to health care systems in other countries and jurisdictions. However, cataract surgical training and practice are similar in Canada, the United States, and other developed nations, increasing the likelihood of similar issues existing across many countries.44-46

Conclusions

These findings suggest later-career surgeons are performing a substantial proportion of cataract operations with overall low surgical adverse event rates. Future studies might extend evaluations to the frequency of secondary surgical interventions as additional measures of surgical care quality.

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