Characterizing Canadian rural general surgeons: trends over time and 10-year replacement needs

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Background: Recruiting residents to practise rurally begins with an accurate characterization of rural surgeons. We sought to identify and analyze demographic trends among rural surgeons in Canada and to predict the rural workforce requirements for the next decade.

Methods: In this retrospective observational study, we assessed the demographic and practice characteristics of rural general surgeons in Canada, defined as surgeons working in cities with a population of 100,000 or less. Surgeons were identified using the websites of provincial colleges of physicians and surgeons. Demographic characteristics included year and country of medical degree achievement, fellowship status and primary practice location. We developed a model predicting future rural workforce requirements based on the following assumptions: that the current ratio of rural surgeons to rural patients is adequate, that the rural population will increase by 1.1% annually, that a rural surgeon’s career length is 36 years, and that 85 graduates will enter the workforce annually.

Results: Our study sample included 760 rural general surgeons. The majority graduated after 1989 (75%), were Canadian medical graduates (73%) and did not complete a fellowship (82%). There was a significant shift toward rural surgeons being trained in Canada, from 37% of surgeons graduating before 1969 to 91% of those graduating after 2009 ($p < 0.001$). Modelling predicts 282 rural general surgeons will retire by 2031, with 88 new surgeons needed to account for the population growth. Therefore, we predict a demand for 370 rural surgeons over the next decade, meaning 43% of general surgery graduates will need to enter rural practice.

Conclusion: Rural general surgeons in Canada vary widely in their background demographic characteristics. Future opportunities in rural general surgery are projected to increase. Recruitment and training of general surgery graduates to serve Canada’s rural communities remains essential.

Contexte : Le recrutement des résidents destinés à la pratique en milieu rural commence par une bonne caractérisation des chirurgiennes et chirurgiens en pratique rurale. Nous avons voulu identifier et analyser les tendances démographiques de la main-d’œuvre en milieu rural au Canada afin de pouvoir en prédire les besoins pour la prochaine décennie.

Méthodes : Dans cette étude observationnelle rétrospective, nous avons évalué les caractéristiques démographiques et relatives à la pratique de la chirurgie générale en milieu rural au Canada, ce milieu étant défini par la taille de 100,000 habitants ou moins. Les chirurgiennes et les chirurgiens ont été recensés à partir des sites Web des collèges provinciaux de médecins et chirurgiens. Les caractéristiques démographiques incluaient l’année et le pays d’obtention du diplôme de médecine, le statut au plan des spécialisations et le principal lieu de pratique. Nous avons créé un modèle de prédiction des besoins futurs en main-d’œuvre à partir des hypothèses suivantes : le rapport actuel chirurgiens/patients en milieu rural est adéquat, la population rurale est appelée à augmenter de 1,1 % par année, la durée d’une carrière en chirurgie en milieu rural est de 36 ans, et 85 diplômés en joindront les rangs annuellement.

Résultats : Notre échantillon comptait 760 praticiennes et praticiens en chirurgie générale. La majorité avait obtenu son diplôme après 1989 (75 %), était diplômée de facultés de médecine canadiennes (73 %) et n’avait complété aucune spécialisation (82 %). On a observé une transition significative vers la formation au Canada des chirurgiennes et chirurgiens en milieu rural, de 37 % des diplômés avant 1969, à 91 % après 2009 ($p < 0.001$). La modélisation prévoit que 282 praticiennes et praticiens en chirurgie générale en milieu rural prendront leur retraite d’ici 2031, et qu’il faudra 88 nouvelles candidatures pour répondre aux besoins de la population croissante.
Rural general surgeons in Canada offer an indispensable service. With more than 20% of the Canadian population living in communities with populations of 100,000 or less, rural general surgeons enable access to primary care, surgical consultation, emergency, and elective general surgery and trauma coverage among other services to a large proportion of people. Unfortunately, rural and remote communities are at a substantial disadvantage when it comes to accessing surgical care, often suffering a higher burden of preventable and treatable disease as a result. Despite their critical role in Canadian health care and unique practice patterns, the characteristics, training trends, and replacement needs for rural general surgeons in Canada have not been well described.

This knowledge gap exists despite ongoing challenges in recruiting, retaining, and preparing surgical graduates for rural practice. Although rural surgery emphasizes a broad scope and diverse skill set, general surgery training across Canada is becoming increasingly academic-focused and subspecialized, with most graduates choosing to pursue graduate degrees and fellowship training. There is also concern that general surgery residency training in Canada may not be adequately training graduates to serve the needs of rural communities. For example, only 3% of British Columbia's general surgeons believe that current graduates are “definitely prepared” to practise in rural communities. Characterizing training and trends for current rural general surgeons in Canada will inform future training, while predicting replacement needs will determine the number of trainees required to fulfill the demands of Canada’s rural population.

We aimed to analyze the current distribution of rural general surgeons in Canada, understand their training background characteristics including trends over time, and predict the future opportunities that will become available within rural general surgery.

**METHODS**

**Study design and data sources**

Our retrospective observational study characterized active general surgeons working in locations with a population of 100,000 or less. We analyzed data on training locations, fellowships, and characterized changes that occurred over time. In addition, we developed a model to predict the retirement of current rural general surgeons in Canada over the next 10 years and determined the proportion of trainees required to achieve replacement-level workforce supply. Our study was exempt from ethics review as all data were obtained from publicly available sources.

We generated a list of general surgeons practising in Canada using the websites of the provincial colleges of physicians and surgeons and the 2015 Canadian Association of General Surgeons (CAGS) hospital and surgeon database. For Quebec, we generated a list using all registered general surgeons in the Médecin Québec database and then cross-referenced the list with the Quebec provincial college website and the CAGS database. Surgeons with limited or restricted practice according to provincial college definitions, including restrictions owing to medico-legal sanctions, were excluded from this study. In addition to the above processes, 2 authors confirmed the surgeons’ information on the provincial college websites and verified the information using a systematic approach that included university or medical office directories, public announcements (including news articles and city repositories), publications, and social media websites including Twitter and LinkedIn. In other words, the list was verified using, at minimum, 2 sources and by 2 authors. If information was not available, surgeons’ offices were contacted directly to confirm demographic details. Surgeons with a medical degree conferred before 1970 were also contacted directly through office phone numbers to confirm their active status. All data collection was completed between September and November 2021 and confirmed as accurate for that time period. To complete the database, we manually reviewed the list of surgeons to eliminate duplicates and generate a final list.

Demographic information for each surgeon was collected, including name, primary practice location, primary hospital, year of medical degree achievement, country of medical degree achievement and fellowship status. For Quebec surgeons, the year of medical degree achievement was not readily available. Therefore, it was estimated by subtracting 5 years from the date of general surgery accreditation or by subtracting 7 years if they received fellowship accreditation in addition to general surgery accreditation. For Quebec surgeons who registered before 1985, their medical school graduation year was estimated by subtracting 1 year from the date of their registration, which reflects the start of their general
surgery residency after a single-year internship. Information on fellowship status and country of medical degree achievement was also not available for Quebec surgeons. For this study, surgeons were listed based on the city of their primary hospital site of work. City populations were characterized using the 2016 Canadian Census and surgeons working in locations with a population of 100,000 or less were included. This definition was used by Schroeder and colleagues where rural surgeons were characterized as those serving populations of 100,000 or less.

Study outcomes and analysis

The primary outcome of this study was the characterization of all general surgeons currently working in Canadian communities of less than 100,000 residents. Secondary outcomes were the change in these characteristics over time and the predicted demand for new rural general surgeons in the upcoming 10 years.

To develop our predictive model, we first estimated the number of surgeons expected to retire. The average age of medical school completion was determined using the Canadian Medical Education Statistics from 2015 to 2020.10 This was supplemented with data from the Association of American Medical Colleges.11 In both databases, the average age of medical school completion was 27 (median 26) years.10,11 This was further corroborated by Jeekel who identified an age of general surgery residency entry of 26.5 years. To provide a conservative estimate, we therefore predicted the age of medical school completion to be 27 years. We then predicted an age of retirement using a study by Jonasson and Kwakawa who, in 1995, reported an average retirement age of 63 years. This estimate falls within the range of 60–65 years described by Sheldon and colleagues who, in 1999, identified an age of general surgery residency entry of 26.5 years.12

To predict new demand based on population growth, we assumed that the current ratio of rural general surgeons to rural populations in Canada is adequate and that demand for general surgery procedures in rural centres will remain static. Rural population growth was estimated at 1.1% according to the 10-year average rate of growth for Canadian rural centres as per the 2016 Canadian Census.17

To predict supply, the number of general surgery residents entering the workforce annually was estimated at 85, calculated using the average number of training positions available in the Canadian Resident Matching Service from 2016 to 2021.18

Statistical analysis

All statistical analysis was completed using STATA software, version 17 (StataCorp). Categorical data were expressed as absolute values with percentages, while continuous data were expressed as a weighted mean ± standard deviation (SD). Between-group differences were evaluated using $\chi^2$ for categorical data and analysis of variance for continuous data. Trends in training were analyzed over time based on year of medical degree conferment, with differences between years evaluated for statistical significance.

Results

Demographics and trends over time

We identified a total of 760 rural general surgeons working in locations with a population of less than 100,000. The majority of rural surgeons were practising in Ontario and Quebec at the time of data collection ($n = 429, 56.4\%$). British Columbia had the next highest number of rural surgeons at 103 (13.6\%). Of the prairie provinces, Alberta had the most surgeons identified ($n = 45, 5.9\%$), followed by Manitoba and Saskatchewan with similar numbers ($n = 31, 4.0\%; n = 29, 3.8\%; respectively). In Atlantic Canada, Nova Scotia had the most practising rural surgeons ($n = 47, 6.2\%$) followed by Newfoundland and Labrador ($n = 36, 4.7\%$), New Brunswick ($n = 26, 3.4\%$), then Prince Edward Island ($n = 11, 1.4\%$). Yukon and the Northwest Territories had only 1 and 2 rural surgeons, respectively (<1% cumulatively). No general surgeons were identified as primarily practising in Nunavut.

Fellowship status

Regarding fellowship status, 18.0% of rural general surgeons in Canada had completed 1 or more fellowships (96 of 534). Quebec surgeons and those without clear fellowship information were excluded as fellowship information was not available. After rural surgeons were stratified by primary location of practice, we found that the proportion of rural general surgeons with fellowships in each province or territory was significantly different ($p < 0.001$) and varied from 0 to more than 30% across Canada (Table 1). British Columbia had the highest proportion of fellowship-trained rural general surgeons (31.4%, 32 of 102), followed by Nova Scotia and New Brunswick (29.8%, 14 of 47; 26.1%, 6 of 23; respectively). In contrast, 23 of
224 (10.3%) of rural general surgeons in Ontario were fellowship trained, a smaller proportion than Manitoba (13%, 3 of 23), Saskatchewan (13.8%, 4 of 29) and Alberta (22.2%, 10 of 45). Significantly fewer fellowship-trained surgeons were practising in Newfoundland and Labrador (6.7%) and none were primarily practising in Yukon (0%) or the Northwest Territories (0%).

The proportion of surgeons with fellowships did not change significantly over time, from 28.6% of surgeons who graduated before 1969 to 21.5% of surgeons who graduated after 2009 (p = 0.50, Table 2). However, there appeared to be more diversity in the types of fellowships completed over time, with only 4 different fellowship types among surgeons who graduated before 1978, compared with 12 different types of fellowships among all surgeons who graduated after 1999. When specific types of fellowships were considered, the number of surgeons who had fellowships in acute care surgery, critical care and minimally invasive surgery appeared to have the greatest increases over time (Table 3).

### Graduation year

The mean graduation year of this rural surgeon cohort was 1998 (751 ± SD 12.1). When stratified by province or territory, the average graduation year spans nearly a decade, ranging from 1994 in Alberta (45 ± SD 12.5) to 2002 in Manitoba (26 ± SD 12.7) (Table 1). After grouping surgeons according to the decade of medical school graduation, we found that only 11 had graduated before 1969 (1.5%), 53 (7.1%) graduated between 1969 and 1978, 125 (16.6%) between 1979 and 1988, 163 (21.7%) between 1989 and 1998, 233 (31.0%) between 1999 and 2008 and 166 (22.1%) between 2009 and 2018. Nine
surgeons were excluded from this analysis because their graduation year could not be confirmed.

Canadian medical graduate status

Overall, 73.4% of rural general surgeons graduated from Canadian medical schools (402 of 548). Information on country of medical school diploma was not available for Quebec and 9 other surgeons. Excluding the Northwest Territories, Saskatchewan had the smallest proportion of Canadian-trained rural general surgeons at 34.4% (10 of 29), followed by Newfoundland and Labrador, which had 55.6% (20 of 36). The rest of the provinces and territories ranged from 68% to 100% of their surgeons being Canadian-trained medical graduates (Table 1).

When stratified by graduation year, there was a significant increase in the proportion of rural general surgeons per cohort who were Canadian-trained medical graduates (Table 2). Of the surgeons in our study who graduated before 1969, 37.5% trained in Canada, compared with 91% of the surgeons who graduated after 2009 (p < 0.001).

Population served

The average population of primary practice communities varied significantly across provinces (Table 1, p = 0.01). Surgeons in Newfoundland and Labrador had the smallest average population served at 11 580, while those in British Columbia had the largest at 46 444. Primary practice populations among surgeons were similar when stratified by graduation year.

Ten-year rural general surgery workforce prediction model

Assuming a career length of 36 years, our model predicted that 283 rural general surgeons would retire by 2031 and that 88 new rural general surgeons would be needed to account for Canada’s population growth. This would predict that a total of 371 new rural general surgeons would be needed over a 10-year period to maintain the current workforce. When a shorter career length of 31 years was applied, the total demand for new rural general surgeons over the next 10 years increased to 466. In contrast, a longer career length of 41 years predicted a need for 286 new rural surgeons (Figure 1). Considering these estimates of workforce requirements, the average proportion of new general surgery graduates that would need to enter rural practice each year to meet the demand is 33% in the longest career-length model, 43% in the middle career-length model and 55% in the shortest career-length model (Figure 2).

Discussion

To our knowledge, this is the first study to date that has attempted to characterize Canada’s entire rural general surgery cohort and analyze the demographic trends that have arisen over time. Rural general surgeons in Canada have a diverse training background, which appears to be changing over time. The proportion of rural general surgeons who are Canadian-trained medical graduates is increasing dramatically. The proportion with fellowship training differs

Table 3. Trends in types of fellowships obtained by rural general surgeons in Canada over time

<table>
<thead>
<tr>
<th>Fellowship</th>
<th>Medical school graduation, yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute care surgery</td>
<td>0</td>
</tr>
<tr>
<td>Cardiovascular and thoracic surgery</td>
<td>0</td>
</tr>
<tr>
<td>Colorectal</td>
<td>0</td>
</tr>
<tr>
<td>Community medicine</td>
<td>0</td>
</tr>
<tr>
<td>Critical care</td>
<td>0</td>
</tr>
<tr>
<td>Endocrine surgery</td>
<td>0</td>
</tr>
<tr>
<td>Hepatopancreaticobiliary surgery</td>
<td>0</td>
</tr>
<tr>
<td>Hepatopancreaticobiliary transplant</td>
<td>0</td>
</tr>
<tr>
<td>Hand surgery</td>
<td>0</td>
</tr>
<tr>
<td>Head and neck surgery</td>
<td>0</td>
</tr>
<tr>
<td>Minimally invasive surgery</td>
<td>0</td>
</tr>
<tr>
<td>Minimally invasive surgery and bariatric surgery</td>
<td>0</td>
</tr>
<tr>
<td>Pediatric general surgery</td>
<td>0</td>
</tr>
<tr>
<td>Surgical oncology</td>
<td>0</td>
</tr>
<tr>
<td>Thoracic surgery</td>
<td>0</td>
</tr>
<tr>
<td>Transplant</td>
<td>0</td>
</tr>
<tr>
<td>Trauma</td>
<td>0</td>
</tr>
<tr>
<td>Urology</td>
<td>1</td>
</tr>
<tr>
<td>Vascular</td>
<td>1</td>
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widely across the country, as does the average population size that rural general surgeons serve. Furthermore, using this study sample, we suspect a large proportion of graduating general surgery residents in Canada will be required to maintain the current rural surgery workforce.

The most important finding is a dramatic trend toward Canadian-trained medical graduates filling rural general surgery positions. Previously, it was shown that rural communities were more likely than urban communities to be served by international medical graduates or surgeons older than 65 years. A suggested explanation for this phenomenon was a lack of interest in rural practice among Canadian-trained general surgery residents for reasons such as poverty of resources, lifestyle issues, unfamiliarity with subspecialty surgeries and lack of opportunity to practise specialized skills gained in fellowships. However, our study shows a paradoxical shift toward the employment of more Canadian-trained than international medical graduates in rural communities over time. The reason we see this trend could be because rural recruitment and retention strategies are becoming more effective or the overall job availability in general surgery is becoming increasingly competitive. New graduates may be struggling to find urban jobs, especially with the tendency toward increasing subspecialization. With the most recently graduated cohort of rural general surgeons trained in Canada (91%), the continuation of this trend may limit opportunities for international medical graduates in Canada and exacerbate job competition among Canadian-trained graduates. It also further emphasizes the need for Canadian residency programs to adequately train residents for broad-based rural practice. If rural positions become more competitive among Canadian-trained medical graduates, the need for rigorous rural recruitment incentives and strategies may decrease and more graduates may pursue specific fellowship training that would be relevant and desirable for rural practice.

Our study showed that the proportion of rural surgeons with fellowship training varied widely across the country but remained relatively unchanged over time. With the increasing number of general surgery graduates pursuing subspecialty training in Canada, the unchanged proportion of fellowships among rural surgeons over time was unexpected. However, our study showed that the diversity of fellowships pursued by rural general surgeons has broadened from 4 to 12 different types, with more surgeons pursuing fellowships in acute care surgery, critical care and minimally invasive surgery, which are more often tied to academic centres. One reason for this could be the increasing number of fellowships being formally recognized

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**Fig. 1.** Predicted number of new surgeons needed over a 10-year period (2022–2031).
by the Royal College of Physicians and Surgeons of Canada over time.22 Specifically, with regard to acute care surgery and critical care fellowships, a growing need for specialists capable of caring for these complex patients and acknowledgement of the unique skills required to do so has led to a substantial increase in training accessibility and interest;23 many of these skills are likely compatible with rural surgical care, which may explain the increase in these training pathways for rural general surgeons. Other reasons given by graduates for choosing fellowships include perceived increased employability, personal interest in the field and career goals of working in urban academic centres.21,24,25 Some graduates indicated that they pursued further training because they felt inadequately prepared for practice or needed to increase their confidence.21,26 Rural general surgeons in Canada may be pursuing more diverse fellowships for various reasons, including the desire to acquire specific skills tailored to serving the needs of a rural area or to increase overall confidence before independent practice. Adjunctly, the competitive urban job market may not have the demand to match the increasing supply of subspecialized surgeons, driving them to seek rural employment, where they may or may not be using their subspecialty skills. Fellowship training among rural general surgeons in Canada is an interesting area that warrants further study.

With our prediction model, we also see an increasing demand for rural general surgeons as Canada’s population grows and current practising surgeons move toward retirement. Whether career length was estimated conservatively (31 yr) or more aggressively (41 yr), the proportion of graduating general surgery residents that will be required to pursue rural general surgery to fill the demand was substantial (33%–55%). This need will be especially substantial if the trend toward employing Canadian-trained medical graduates reaches 100%. Notably, the 33%–55% of trainees required to fill rural surgical positions is greater proportionally than the 20% of Canadians living in rural regions. It should be recognized and highlighted that the relative

![Graph showing proportion of new graduates needed to enter rural general surgery annually to meet demand over a 10-year period (2022–2031).](image-url)
proportion of surgeons required to meet regional demands and serve remote communities may be greater than the number of patients in that region. For example, 1 surgeon serving a remote region may provide care for fewer patients but simultaneously may be critical to enable reasonable or adequate access to care for those patients. Our predictive model highlights that adequately preparing and recruiting residents to practise in rural communities will become increasingly important. General surgery training programs will need to incorporate more rural exposure, mentorship and experience into curricula as many as one-half of their graduates will be entering rural practice.9,27,28 If the demand for rural surgeons cannot be met with Canadian-trained graduates, consideration and implementation of internationally trained physicians may be needed to maintain current levels of care. On a larger scale, barriers to the recruitment and retention of rural physicians will remain important challenges to overcome.

Limitations

Our study had several limitations. Public data were unavailable for fellowship status and country of medical school graduation for Quebec surgeons. As a result, these surgeons were excluded from the analysis, limiting the accurate characterization of rural general surgeons as a national group. Furthermore, the year of medical school graduation for Quebec surgeons was calculated using estimated average residency and fellowship lengths but was unable to account for individual variability (i.e., time taken for research) and therefore may be less accurate. It is also possible that surgeons registered under different names or who changed practice locations may not have been adequately captured by our data set. Therefore, these data likely underestimate the current number of rural general surgeons in Canada.

Classifying an area as rural based on population size is a limitation as it does not capture other important aspects of rurality, such as distance from urban centre, feasibility of access to health care or geographic barriers. These factors may contribute to the discrepancies in health outcomes between rural and urban populations, and surgeons practising in rural areas may need different skill sets and training depending on the unique combination of factors affecting their particular area. Future studies better characterizing skills and training required for rural-remote communities compared with rural regions with easier access to care, would be highly beneficial.

The predictive model was based on several assumptions that are difficult to validate. Effort was made to base these assumptions on the most recently available data at the time of study design. For example, the Canadian rural population growth rate was estimated at a fixed 1.1% increase annually based on the most recent data; however, in actuality, the growth rate is variable from year to year. Similarly, the average length of career was assumed to be 36 years using data from previous studies. There are recent data showing that Canadian physicians practising in rural areas tended to retire earlier than the average and about 40% of physicians reduced their activity levels by at least 10% in the 3 years preceding their retirement.29 However, among other surgical subspecialties, there is a reported trend toward later retirement.30,31 Though this has not yet been shown within general surgery, an older average age of retirement could delay the steep rise in demand for new rural general surgeons.29 Our predictive model was limited in its ability to reflect the changing work habits of general surgeons, though the career span sensitivity analysis attempts to provide more accurate representation within the limitations of current data. In addition, our model cannot account for possible changes in disease and pathology over time, which can affect the overall demand for, and distribution of, general surgeons in Canada. Similarly, we assume that current surgeon supply is adequate to meet demands of the Canadian rural population, which is not well studied and remains unclear. Other factors that influence rural surgery, such as funding and resource allocation, virtual care models and the employment of general practitioners with enhanced surgical skills, were also not captured in this model. Lastly, the model was limited by its assumption that residency training positions will not increase or decrease over the next 10 years, even while Canada’s population and its needs change over time.

Overall, rural general surgeons play a crucial role in providing accessible care to Canada’s rural communities. Our study demonstrates that supporting the influx of new surgeons into rural practice at the institutional, provincial and national level will continue to be relevant, even more so than previous studies have suggested. The national Task Force on the Future of General Surgery has already identified decreasing interest in rural general surgery and difficulty of training surgeons for the broad skill set required as major barriers to sustainable rural surgical care.21 With increasing representation of Canadian-trained medical graduates among rural general surgeons and continued demand, it is of public health importance to develop strategies for training rural surgeons. One proposed solution is to increase exposure and mentorship opportunities in rural surgical practice for general surgery trainees. Having a general surgery mentor has been shown to substantially influence a graduate’s decision to choose general surgery practice over pursuing fellowship and subsequent subspecialty practice.24 Graduates who chose rural practice were more likely to have completed a rural clerkship during medical school.32 Therefore, providing trainees with positive rural experiences may encourage the pursuit of rural practice.33 In addition, the implementation of competency-based medical education in general surgery programs across Canada should ensure trainees are competent in skills applicable to rural practice.
CONCLUSION

To our knowledge, this study is the first to examine the demographics and background training of rural general surgeons in Canada. Overall, most surgeons were Canadian-trained medical graduates and had not pursued fellowships. There was a substantial increase in the proportion of Canadian-trained medical graduates entering rural practice over time. Future demand for new rural surgeons is projected to increase. Our results suggest that the recruitment and training of general surgery graduates to serve Canada’s rural communities is essential.

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Contributors: K. Purich designed the study. R. Dhaliwal, S.F. Skinner and K. Verhoeff acquired the data, which O. Ma, M. Strickland and K. Verhoeff analyzed. O. Ma wrote the article, which R. Dhaliwal, K. Purich, S.F. Skinner, M. Strickland and K. Verhoeff reviewed. All authors approved the final version to be published.

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