

A Pilot Study on Diagnostic Radiology Residency Case Volumes From a Canadian Perspective: A Marker of Resident Knowledge

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Abstract

Purpose: New guidelines from the Accreditation Council for Graduate Medical Education (ACGME) have proposed minimum case volumes to be obtained during residency. While radiology residency programs in Canada are accredited by the Royal College of Physicians and Surgeons of Canada, there are currently no minimum case volumes standards for radiology residency training in Canada. New changes in residency training throughout Canada are coming in the form of competency-based medical education. Using data from a pilot study, this article examines radiology resident case volumes among recently graduated cohorts of residents and determines whether there is a correlation between case volumes and measures of resident success. **Materials and Methods:** Resident case volumes for 3 cohorts of graduated residents (2016-2018) were extracted from the institutional database. Achievement of minimum case volumes based on the ACGME guidelines was performed for each resident. Pearson correlation analysis ($n = 9$) was performed to examine the relationships between resident case volumes and markers of resident success including residents' relative knowledge ranking and their American College of Radiology (ACR) in-training exam scores. **Results:** A statistically significant, positive correlation was observed between residents' case volume and their relative knowledge ranking ($r = 0.682$, $P < .05$). Residents' relative knowledge ranking was also statistically significant and positively correlated with their ACR in-training percentile score ($r = 0.715$, $P < .05$). **Conclusions:** This study suggests that residents who interpret more cases are more likely to demonstrate higher knowledge, thereby highlighting the utility of case volumes as a prognostic marker of resident success. As well, the results underscore the potential use of ACGME minimum case volumes as a prognostic marker. These findings can inform future curriculum planning and development in radiology residency training programs.

Résumé

Objectif : Les nouvelles directives établies par l'Accreditation Council for Graduate Medical Education (ACGME, comité d'accréditation en éducation médicale doctorale) ont proposé des volumes minimaux de cas à obtenir pendant la résidence. Les programmes de résidence en radiologie sont au Canada accrédités par le Collège royal des médecins et chirurgiens du Canada. Pourtant, aucune norme n'est actuellement établie dans ce pays concernant les volumes minimaux de cas pour ce programme. Partout au Canada, les nouveaux changements dans les programmes de résidence se présentent sous forme de formation médicale fondée sur les compétences. En exploitant les données d'une étude pilote, cet article vise à examiner les volumes de cas pris en charge par les résidents en radiologie, parmi les cohortes de résidents diplômés récemment, et à déterminer s'il existe une corrélation entre les volumes de cas et les mesures de la réussite des résidents. **Matériel et méthodes :** Les volumes de cas pris en charge par des résidents relevant de trois cohortes de résidents diplômés (2016-2018) ont été extraits de la base de données des établissements. L'obtention de volumes minimaux de cas basée sur les directives de l'ACGME a été évaluée pour chaque résident. Une analyse de corrélation de Pearson ($n = 9$) a été effectuée pour déterminer la relation entre les volumes de cas des résidents et les indicateurs de réussite de ces derniers, y compris le classement relatif aux connaissances et les notes aux examens intermédiaires de l'American College of Radiology (ACR). **Résultats :** Une corrélation positive statistiquement significative a été

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observée entre le volume de cas des résidents et leur classement basé sur leurs connaissances ($r = 0,682$; $P < 0,05$). Le classement relatif aux connaissances des résidents était également statistiquement significatif et corrélé positivement au rang-centile aux examens intermédiaires de l'ACR ($r = 0,715$; $P < 0,05$). **Conclusions :** Cette étude suggère que les résidents qui interprètent plus de cas sont davantage susceptibles de posséder un savoir supérieur, ce qui souligne l'utilité des volumes de cas en tant qu'indicateur pronostique de la réussite des résidents. De plus, ces résultats étayent l'utilisation possible des volumes minimaux de cas établis par l'ACGME en tant qu'indicateur pronostique. Ces résultats peuvent renseigner sur la planification des futurs programmes et l'élaboration des programmes d'éducation de résidence en radiologie.

Keywords

radiology, residency training, case volumes, resident knowledge

Introduction

Passing the respective radiology board examinations in the United States and Canada are a crude measure of success.¹ More subjective measures of success include evaluations such as the American College of Radiology (ACR) in-training exam scores and relative knowledge ranking. Radiology residency education is in the midst of change in the United States and Canada.^{2,3} Close and frequent tracking of resident performance will be required in the next Canadian radiology residency curriculum in the competency-based medical education (CBME) model.³ Having a set of prognostic markers which help predict resident success will be important in the new curriculum. Useful predictive markers of resident success during residency can be quite variable in performance but include ACR in-training exam scores and residency program director evaluations.⁴⁻⁹ New guidelines from the Accreditation Council for Graduate Medical Education (ACGME) have proposed minimum case volumes to be obtained during residency.^{10,11} A recent study has shown a correlation between total number of studies interpreted and clinical performance.¹² Canadian radiology residency programs are accredited by the Royal College of Physicians and Surgeons of Canada, which is separated from the ACGME. Currently, there are no minimum case volumes proposed for radiology residency training in Canada. However, new changes in residency training throughout Canada are coming in the form of CBME. At our university, we are the first Canadian program to transition to a CBME model, and with it, more quantitative measures of resident achievement are required.

We hypothesize that larger case volume will correlate positively with increased success as measured by these subjective assessments. This pilot study investigates radiology resident case volumes in the recent previously graduated cohorts and determines if there is a correlation between case volumes and measures of resident success.

Materials and Methods

Setting and Participants

Our radiology residency program is a relatively small Canadian program graduating on average 3 residents per year. It is located in an academic teaching tertiary center and began in

1992. Each resident is accepted for a 5-year diagnostic radiology residency which entails 1 year of off-service nonradiological clinical rotations and 4 years of on-service radiology rotations.

Data Collection

Research Ethics Board approval was obtained for this study. Total case volumes were obtained through the institutional database for the 3 graduating cohorts from 2016 to 2018 (one resident was excluded as they had an interruption in training; $n = 9$). Case volumes were further arranged into the subcategories proposed by the ACGME guidelines except for the positron emission tomography (PET; we have no institutional PET scanner) and computed tomography/magnetic resonance angiographic (CTA/MRA) studies (these scans are not specifically distinguished from cases which do not have an angiogram in the retrieved data). Magnetic resonance lower extremity volumes were presumed to be under the heading "MR Extremity"; however, these values may be slightly inflated due to mixing in of upper extremity MRIs (note, however, these values were well above the minimum). Attainment of the minimum ACGME requirements was determined for each resident and subcategory. A deficient ACGME category would be one where the resident did not meet the minimum volume suggested by the ACGME. A relative ranking of resident knowledge was performed for the graduating cohorts (rank 1-9, 1 being the most knowledgeable and 9 being the least knowledgeable) by the program director and undergraduate program director (a clinical teaching faculty member responsible for the medical school radiology curriculum). This ranking was determined based on the staff resident review group sessions (occurring every 6 months), resident performance evaluations, and their personal interactions/experiences with the residents. The program director and undergraduate program director was not changed during the residency of the studied cohorts. The most recent available ACR in-training exam score was also obtained for each resident (all except 1 score was obtained at the post-graduate year 4 level). Case volumes and number of deficient ACGME minimum categories were correlated with resident performance and ACR in-training exam scores using Pearson correlation.

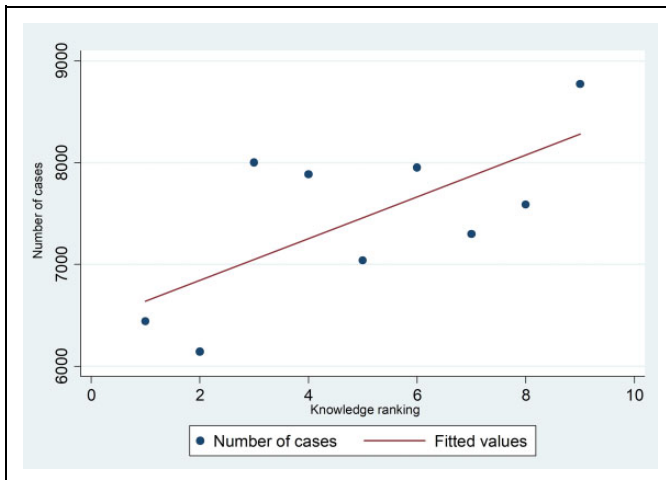


Figure 1. Plot of the total number of cases and the relative resident ranking of knowledge.

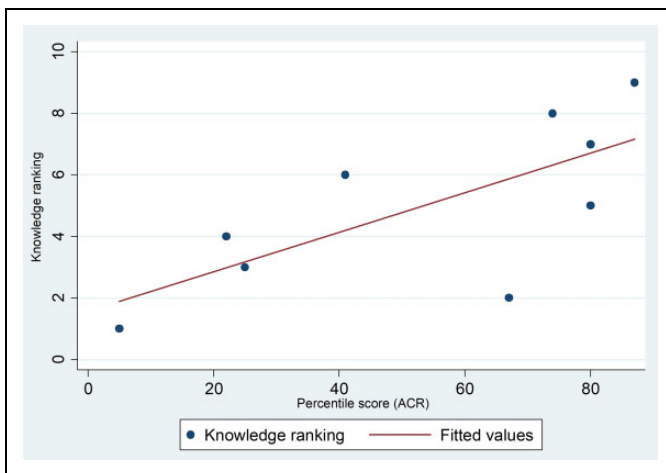


Figure 2. Plot of the relative resident knowledge ranking and the American College of Radiology in-training percentile.

Data Analysis

All variables of interest were measured at the interval–ratio level and descriptive statistics such as means and measures of dispersion including standard deviations and range were used to describe the data. Under specified and satisfied assumptions (ie, normality, interval–ratio level measurement of variables), we estimated pairwise Pearson correlations and examined the relationships between students’ case volume and their indicators of success (ie, relative knowledge ranking and their ACR in-training exam scores). Scatter plots were also used to graph observed and significant relationships (see Figures 1 and 2).

Results

Descriptive statistics presented in Table 1 show that the average number of cases performed by the residents was 7459 with a considerable amount of variability (standard deviation

Table 1. Descriptive Statistics of All Variables Used in the Analysis.

	Mean	SD	Minimum	Maximum
Number of cases	7459.33	824.22	6146.00	8774.00
Knowledge ranking	5.00	2.74	1.00	9.00
Percentile scores	53.44	30.50	5.00	87.00
Categories achieved per ACGME ^a	−2.78	1.39	−5.00	−1.00
N	9			

^aNegative values refer to the amount of deficient categories per Accreditation Council for Graduate Medical Education (ACGME) minimum standards.

Table 2. Pairwise Pearson Correlations Examining Relationships Among all Variables Used in the Analysis.

	Number of Cases	Knowledge Ranking	Percentile Scores	No. of Deficient Categories per ACGME
Number of cases	1.000	−	−	−
Knowledge ranking	0.682 ^a	1.000	−	−
Percentile scores	0.138	0.715 ^a	1.00	−
No. of deficient categories achieved per ACGM	0.536	0.622	0.315	1.000

Abbreviation: ACGME, Accreditation Council for Graduate Medical Education. ^aStatistical significance: $P < .05$.

[SD] = 824.2). The mean percentile score on the ACR in-training exam was 53.4 with an SD of 30.5.

Results from the correlational analysis shown in Table 2 reveal a strong positive and statistically significant correlation between the total number of cases performed by a resident and their relative knowledge ranking ($r = 0.682, P < .05$). As Figure 1 shows, the majority of the observations are clustered around the line of best fit, confirming the observed strong relationship. We also found a nonsignificant and weak positive correlation between the total number of cases performed by a resident and their ACR in-training percentile score ($r = 0.138, P > .05$). There was a strong and statistically significant positive correlation between the resident’s relative knowledge ranking and ACR in-training percentile score ($r = 0.715, P < .05$). This finding is clearly depicted and confirmed in Figure 2 where nearly all the observed values are closer to the line of best fit. Results from Table 2, however, suggests that decreasing the number of deficient categories achieved by residents per ACGME guidelines was not significantly correlated with any other variable of interest, despite its moderate to strong positive associations with residents’ knowledge ranking ($r = 0.536, P > 0.05$) and number of cases performed ($r = 0.622, P > 0.05$).

Discussion

There is an increasing interest in tracking resident case volumes in diagnostic radiology residency training.¹² This

article sought to analyze the correlation between case volumes and markers of resident success. We also determined that ACGME minimum case volumes demonstrate positive associations with markers of resident success.² The total number of cases performed by a resident and their relative knowledge ranking demonstrated a statistically significant positive correlation, confirming the anecdotal assertion that higher case volumes may result in higher resident knowledge. Additionally, a significant positive correlation between residents' relative knowledge ranking assessment and ACR in-training scores suggests the validity of the relative knowledge ranking assessment. However, a weak and statistically nonsignificant positive correlation was observed between case volume and ACR in-training scores, which may be due to the fact that the ACR in-training exam represents a single data point (a snapshot in time), whereas the relative knowledge ranking is based on a global assessment of the resident's performance through multiple interactions and feedback both directly and indirectly.

The finding that a decreased number of deficient categories as per ACGME minimum requirements is positively correlated with case volume suggests that the ACGME minimum requirements may be a potential prognostic marker.

However, similar results were obtained in the recent study of a residency program by Agarwal et al, despite the differences in study setting and purpose.¹² Agarwal and colleagues' research focused on an American program with 11 to 14 residents per year and would rank as one of the largest programs in Canada. Our institution is one of the smaller programs in the country and reflects the challenges faced by some of these similar sized programs in Canada. The objective of the Agarwal study was also to determine whether there is a maximum case volume which hinders resident performance; their results showed a nonlinear correlation between the total number of interpreted films and performance whereby clinical performance and the number of interpreted films increased to the mark of approximately 16 000, while volumes over 16 000 correlated with worse performance; this is inherently different from the goal of our study.¹² Another point to note is the difference in case volumes from our study and Agarwal et al which had higher case volumes, part of this may be explained by the fact that our resident's participate in a 3-month out-of-institution pediatrics block which is not included in the case volume totals as these data were not available. It would also be of interest for future work to determine the variability of resident case volumes between institutions.

Limitations

The limitations of the current study include the following. Firstly, CTA/MRA and PET categories were not accessible due to limitations of the database for CTA/MRA and no institutional access to a PET scanner. Secondly, case volumes are decreased as the mandatory 3-month pediatric block is performed at an outside institution where the data are unavailable. Thirdly, low sample size; however, statistically significant correlations were obtained citing the strong inherent correlation

between case volumes and relative ranking. Fourthly, there may be an inherent bias that residents who interpret more cases will demonstrate more favorable evaluations/ranking; however, it was shown that the relative ranking and ACR in-training exam are strongly correlated. Lastly, there is a limitation in the relative knowledge ranking performed by the program director and undergraduate program director, which was done at one point in time retrospectively, thus leading to a possible recall bias.

Conclusions

This article demonstrates that residents who interpret more cases are more likely to be more knowledgeable, confirming the possibility of using case volumes as a prognostic marker. Additionally, having decreased deficient minimum ACGME case volumes correlates positively with higher levels of knowledge ranking and ACR in-training score, which underscores the potential use of ACGME minimum case volumes as a prognostic marker. The current findings can inform future curriculum planning for radiology and make a case for the incorporation of case volume measurements within residency training programs. This information will play an important role in developing the new Canadian CBME curriculum in radiology.

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Declaration of Conflicting Interests

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