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CADTH: Canadian Medical Imaging Inventory Service Report

Average Volume of MRI Exams Conducted per Hour Across Canada



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Key Messages

- There is no known recent knowledge in Canada of the average volume of MRI exams performed per hour at the national level.
- Using data from the national Canadian Medical Imaging Inventory 2019 to 2020 survey, CADTH calculated an average of 1.80 MRI exams performed per hour across Canada.
- This average exam rate is adjustable by a wide variety of factors, including (but not limited to): the age of equipment, the number of MRI units on site, and the field strength of the MRI.
- An understanding of the average exam rate may help individual institutions to establish benchmarks that could help to signal potential operational bottlenecks and initiate strategies to improve workflow and, thereby, patient access to MRI.

Context

No recent national, publicly available knowledge of Canada's average hourly MRI exam volume exists. The most up-to-date published national average for MRI exam volume was 1.5 scans per hour, as reported from 2004 to 2005 data from the Canadian Institute for Health Information (CIHI). At that time, Canada had 176 MRI units,¹ compared to the 378 units reported during the 2019 to 2020 Canadian Medical Imaging Inventory (CMII) data collection cycle. The Canadian medical imaging landscape and the capabilities of modern MRI have changed during this period and understanding of the current average is warranted.¹⁻³

Decision-makers can use information on average MRI exams per hour to signal potential operational bottlenecks and initiate the identification of workflow efficiencies. This may enable higher numbers of patients to be examined and play a role in alleviating long wait times for medical imaging in Canada.⁴ However, an overall average does not consider all the factors that can influence exam volumes. The rate of exams varies site by site and may be affected by numerous confounding variables.^{3,5,6}

With the CMII survey data collection, CADTH is uniquely positioned to support the calculation and understanding of the average MRI exam volume per hour across Canada. Insights gained from this report may help decision-makers to measure performance, identify operational bottlenecks, and improve wait times.

Objective

This report summarizes information from the 2019 to 2020 [CMII](#) survey to calculate the average volume of MRI exams performed per hour at the national level. It also explores the impact of some factors that may influence that average, including:

- the age of the MRI units
- the number of MRI units per site

- MRI unit field strength
- whether MRI units are fixed or mobile.

Data for this report will be updated when CMII survey data from 2022 to 2023 has been analyzed.

About This Document

This document summarizes information gathered through the CMII survey collected by CADTH with each province and the Yukon Territory represented, denoted as jurisdictions moving forward. Sites reported the number of operational MRI units, their technical specifications, and year of equipment operation. Sites also reported the average annual MRI scans performed and the hours of operation.

An imaging exam is a single medical imaging session using an imaging modality to study 1 (or more than one) body structure, body system, or anatomic area that yields 1 or more views for diagnostic and/or therapeutic purposes.

The average hourly MRI exam throughput for a site was calculated by taking the reported average number of annual MRI exams, dividing by 52 weeks, and dividing by the reported average MRI operating hours per week. For the average hourly MRI exam throughput for an MRI unit type (i.e., unit age or field strength), the reported average number of annual MRI exams was divided by the number of MRI units at the site first and calculating the number of exams performed by applicable units. The resulting exams were then divided by 52 weeks and divided by the reported average MRI operating hours per week. If a site reported its average annual MRI exams but did not report its average MRI operation hours per week, hours were assumed to be the same as those of a hospital with comparable number of units, and similar average annual exams in the regional area.

Many confounding factors influence exam throughput. A small number are presented in this report, including the age of MRI units, number of MRI units per site, MRI unit field strength, and whether MRI units are fixed or mobile. The results are based on data collected through the CMII from 198 publicly funded sites that reported their average annual MRI exam volume in 2019 to 2020. In practice, at the site level, exam throughput is affected by a combination of factors, many of which this report does not address due to lack of data, including administrative and workflow processes, scheduling practices, availability of supportive tools and technologies, staff availability, staff experience, operating funds, population density, differences in health needs, and patient support.^{3,5,6}

Results

Site Average MRI Exams Per Hour

The national site average MRI hourly exam throughput for 2019 to 2020 is 1.80, ranging from 1.22 to 2.32 exams across provinces and territories with MRIs. Manitoba had the highest site average MRI hourly scan throughput at 2.32 exams per hour, followed by Ontario at 2.14. In some instances, results for a jurisdiction

may be lower than the national average, but some sites within a jurisdiction may have a higher than national site exam throughput.

Average MRI Exams per Hour by Age of Unit

The age of imaging equipment may have an impact on exam throughput. Older MRI machines may require more maintenance compared to newer equipment or may use outdated MRI sequences which can reduce MRI scan throughput.⁵⁻⁷ MRI units aged 15 years or older constitute the highest proportion of nationwide MRI machines at 33%, followed by units aged 10 to 14 years (31%), then units aged 5 to 9 years (28%), and ending with units aged 0 to 4 years (8%). At the national level, the age of MRI machine and average hourly exam throughput is reported as follows:

- MRI units aged 10 to 14 years had a throughput of 1.54 exams per hour
- MRI units aged 5 to 9 years had a throughput of 1.48 exams per hour
- MRI units aged 15 years or older had a throughput of 1.35 exams per hour
- MRI units aged 0 to 4 years had a throughput of 1.27 exams per hour.

At a jurisdictional level, 6 jurisdictions had the highest exam throughput from machines aged 5 to 9 years. However, machines aged 10 to 14 years had relatively close exam throughput in half of these jurisdictions.

When considering the performance of older equipment, some MRI units may be kept at a high level of maintenance and are used by well-trained staff. It is also possible that older machines handle less complicated scans, resulting in a higher throughput. Newer machines are often used for more complex cases, and therefore, may produce a lower exam throughput. Also, performance testing of newer machines, involving adjusting, calibrations, or modifications to ensure optimal performance and image quality, may take time away from patient exams.

Site Average MRI Exams per Hour by Number of MRI Units

Many sites with MRI operate more than one machine, which can impact exam throughput. Nationally, exam volumes per hour increased with the number of MRI units per site are reported as follows:

- sites with 1 MRI unit had an average MRI exam throughput of 1.44 exams
- sites with 2 MRI units had an average MRI exam throughput of 2.23 exams
- sites with 3 MRI units had an average MRI exam throughput of 3.11 exams
- sites with 4 or more MRI units had the highest site average MRI hourly exam throughput at 3.75 exams.

Most jurisdictions followed the trend of increasing site average MRI hourly exam throughput while increasing the number of MRI units. However, at some sites in 3 jurisdictions, the site average hourly exam volume decreased with a higher number of MRI units. These sites may undertake more complex cases that take longer to perform. For sites with 3 or more MRIs, some units may be used for exclusive research purposes rather than regular clinical use. These sites may also use their older units less intensively, reducing the site average hourly exam throughput. At a nationwide level, most sites only possess 1 MRI (67%), followed by

sites with 2 MRIs (24%). It should be noted that not all sites have the same hours of operation and this may influence overall hourly averages.

Average MRI Exam per Hour by Field Strength

Field strength, measured in Teslas (T), plays a role in MRI hourly exam throughput as higher field strength units can perform scans quicker and with higher resolution than MRI units with a lower field strength.^{8,9} Due to their ability to produce higher resolution, higher field strength MRI units are often used for more complex, time-intensive exams^{8,9} Nationally, exam volumes per hour did not increase with Tesla strength and are reported as follows:

- MRI with less than 1.5T had a throughput of 1.43 exams per hour
- MRI with 1.5T had a throughput of 1.59 exams per hour
- MRIs with 3.0T or greater had a throughput of 1.25 exams per hour.

The majority of MRI units in Canada have a field strength of 1.5T (80.9%), followed by units with a field strength of 3.0T or greater (18.2%), and lastly units with a field strength less than 1.5T (0.9%). At the jurisdiction level, 6 provinces saw a decrease in average hourly MRI scan throughput as field strength increased.

A potential explanation for this decrease in scan throughput at 3T field strengths may be linked to the assignment of more complex exam cases to these units. It is also likely that machines with a field strength greater than 3.0T are used for research and not typically used for clinical examinations.

Site Average MRI Exam per Hour by Mobile MRI Units

Mobile MRI provides a means of reducing disparities in the delivery of health care by expanding diagnostic imaging capacity to underserved locations such as rural and remote communities. Mobile MRI units require a lower field strength, which means exams can take longer to perform. Mobile MRI also requires increased downtime compared to fixed MRI units for maintenance purposes.¹⁰⁻¹²

At the national level, sites with fixed MRI units had a higher site average hourly MRI exam throughput of 1.88 (range: 1.28 to 2.32) compared to mobile MRIs at 1.05 exams per hour (range: 0.83 to 1.64).

Due to data aggregation, the data were not sufficiently granular to differentiate the average hourly MRI exam throughput for mobile and nonmobile MRIs at sites that possessed both. Most sites in Canada operate fixed MRIs only (90.9%) compared to sites with both (1.0%) or only mobile MRIs (8.1%).

Limitations

Given the aggregated nature of the data, it is not possible to ascertain whether specific MRI units were tasked with certain types of complex or time-intensive exams. Additionally, the average annual exams were equally split across all MRI units at a given site. This assumes each MRI unit takes an equal share of the exams, regardless of unit age or type, which may not reflect current practice.

This report is limited by the number of sites that reported the necessary information required for this analysis. Sometimes, the sample sizes may have been too small to provide a reliable result.

This analysis is also limited by what can be measured in the CMII survey as administrative practices like standardized protocols and robust scheduling methods were not investigated. Therefore, no data were available to examine the effects of these factors.

Implications for Decision-Making

A variety of factors influence exam throughput and are dependent on the unique circumstances of each facility. The use of standardized procedures and imaging protocols, advanced patient screening, appropriately staffed facilities, improved patient scheduling and ensuring punctuality of both patients and staff are strategies that may help improve exam throughput.^{8,13,14} The reduction of administrative bottlenecks has been shown in Ontario to boost throughput and allowed for improved scheduling of exams for higher efficiency, with some sites seeing a decrease of up to 89% in wait times.¹⁵

While increasing MRI exams throughput is a desirable goal, it is also important to focus on high-value exams to lessen the burden of increasing wait times. Patient screening may help to reduce some low-value exams and allow patients who urgently require medical imaging to be seen quickly.^{16,17}

Conclusion

An average hourly MRI exam throughput of 1.80 was calculated nationally for 2019 to 2020, representing a 20% increase from 2004 to 2005. Many confounding factors influence exam throughput, of which this report addressed a few.

When exam data were examined in combination with equipment age, the CMII data showed that machines in operation for 5 to 14 years had a higher average hourly MRI exam rate than MRI in other age categories, likely due to the complexity of scans and relatively young age of the units. Similarly, sites with more MRI units had a higher average hourly MRI exam throughput. The average hourly MRI scan rate was highest for MRI units with 1.5T field strength. While higher field strength machines can complete exams quicker and with better resolution, they are more likely to receive complex and time-intensive exams.

Fixed MRIs have a greater average hourly MRI exam throughput than mobile MRIs. However, exam throughput may run secondary to the purpose of mobile MRIs, which can be tasked to serve remote and rural areas that may not have easy access to advanced imaging equipment otherwise.

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