Kathleen Eddy, BSc, Alexander Ednie, BSc, Celeste Connell, Richard Eddy, MD, Kirk Eaton, John Mathieson, MD

Appropriate use of CT and MRI in British Columbia

Physicians in all regions of BC are requesting CT and MRI in compliance with established guidelines, according to a review of orders issued.

ABSTRACT:

***Background*: Between 2004 and 2007 the number of CT and MRI examinations per 1000 people in BC increased by approximately 50%, a finding that raised concerns about the appropriateness of the examinations. To address these concerns, the BC Ministry of Health commissioned a study of requests for CT and MRI in all health regions.**

***Methods:* An independent company considered expert in analyzing medical imaging data was contracted to assess 2000 randomly selected CT and MRI requisitions issued across BC between 2010 and 2011. The requisitions were analyzed using a five-point rating scale for appropriateness that was based on the Canadian Association of Radiologists guidelines and a meta-analysis of other guidelines. A computer program rated each requisition according to the appropriateness scale. Subsequently, a subset of the requisitions was reanalyzed by two independent reviewers.**

***Results*: In the computer analysis, 2% of the requisitions were rated "inappropriate," while 46% were rated "indeterminate" because the computer program was not able to interpret the written portion of a significant number of requisitions. However, the two independent reviewers encountered no difficulties in assessing the appropriateness of each requisition in the data subset and found that only a small number of examinations were "indeterminate" and none were "inappropriate."**

***Conclusions*: The results suggest that physicians in all regions of BC are requesting CT and MRI in compliance with established guidelines. In the computer analysis, CT and MRI orders rated "inappropriate" amounted to only 2% of all examinations, a figure considerably lower than an often quoted but poorly substantiated 30%. While the level of appropriateness found in BC orders for CT and MRI is acceptable, continued monitoring is needed and would be facilitated by the use of computerized physician order entry.**

Background

According to the Canadian Institute for Health Information (CIHI), between 2004 and 2007 the number of computed tomography (CT) and magnetic resonance imaging (MRI) examinations per 1000 people in British Columbia increased by approximately 50%.[1] While these numbers can only be truly understood in the context of utilization in other provinces and other developed countries, the increase raised concerns about the appropriateness of these examinations.

Objective data concerning the appropriateness of medical imaging tests have rarely been published. A widely quoted estimate that as many as 30% of imaging examinations are inappropriate is not supported by published data.[2-7] One Canadian prospec-

Ms Eddy and Mr Ednie are third-year medical students at the University of British Columbia, Trail Integrated Community Clerkship Program. Ms Connell is a student at Queen's University in Kingston, Ontario. Dr Eddy is a radiologist in the Vancouver Island Health Authority in Victoria. Mr Eaton is director of Diagnostic Imaging in the BC Ministry of Health. Dr Mathieson is medical director of Medical Imaging at Vancouver Island Health Authority.

tive study of ultrasound, CT, and MRI done by Butler and Stolberg found that only 2.5% were inappropriate.[8]

The purpose of this study was to accurately and objectively determine the appropriateness of CT and MRI examinations ordered in all health regions in BC.

Methods

The Ministry of Health in BC contracted with an independent company considered expert in analyzing medical imaging data to determine the appropriateness of CT and MRI examinations in BC. Appropriateness ratings were determined using both Canadian Association of Radiologists (CAR) guidelines and a meta-analysis of other available imaging guidelines. Thirty-seven hospitals representing all health authorities in BC were included in the study.

Requisitions for imaging were randomly selected to obtain a representative sample of approximately 1200 CT and 800 MRI exams completed between 2010 and 2011. The samples were drawn from the most commonly requested CT and MRI examinations, specifically those for the brain and lumbar spine. In addition, samples of requisitions for MRI examinations of the knee were also acquired.

Information from the paper requisitions was encoded to capture patient and physician data, geographical data, and clinical indications. Attempts were made to convert the free text (narrative portion of order) that characterized the clinical indications on the majority of forms by using a coding system to derive ratings of appropriateness. After unreadable or duplicate requisitions were discarded, 1927 valid requisitions remained from the original 2000. A further 26 were removed because they were not for the most commonly requested examinations being studied, leaving a sample of 1901 unique diagnostic orders.

The remaining 1901 documents were assessed using a computer program that categorized each requisition according to the five-point rating scale for appropriateness shown in **Table 1**.

A subset of 325 requisitions representing all cases from one health authority (17% of the total) was then reviewed by hand by two independent analysts. Rating was done using the appropriateness scale shown in **Table 1** as well as by a second scale derived from the Butler study.[8] The results of each reviewer's assessments were compared and any discrepancies discussed until agreement on a rating was reached.

Results

A review of detailed data on the hospital and health region as well as the patient age and gender for each requisition confirmed that a representative sample was obtained for analysis. The results of the computer analysis summarized in **Table 2** show that although only 2% of the imaging orders were deemed "inappropriate," a large number were "indeterminate" (46%) or "not validated" (25%).

The subset analysis performed by the two reviewers using the **Table 1** rating scale found that 5 of the 325 requisitions (1.5%) were "indeterminate," and none were "inappropriate." The results using the Butler scale[8] were similar.

Table 1. Rating scale for appropriateness of imaging examination.

Rating	Description	Interpretation
4	Appropriate	Based on available evidence, the procedure is considered useful or recommended for continued management of the patient given the described clinical condition.
3	Moderate	This procedure is considered reasonably useful in managing the patient for the described clinical condition, based on available evidence. This procedure would be reasonable if any other recommended procedures are unavailable or contraindicated.
2	Indeterminate	Due to lack of clinical data input, clinical reasonability of this procedure cannot be determined for the described clinical condition.
1	Inappropriate	Available evidence suggests that this procedure is considered unreasonable for the described clinical condition.
0	Not validated	The available (or enabled) clinical content does not cover the described clinical condition.

Table 2. Appropriateness of CT and MRI requisitions issued in BC 2010 to 2011, as determined by computer analysis.

Rating	Description	CT and MRI	CT	MRI
4	Appropriate	15%	13%	17%
3	Moderate	13%	20%	2%
2	Indeterminate	46%	41%	54%
1	Inappropriate	2%	2%	1%
0	Not validated	25%	24%	26%

Conclusions

The study results indicate that physicians in BC appear to be adhering to clinical guidelines when ordering CT and MRI examinations, with only 2% of orders being deemed "inappropriate." This finding is similar to the results of Butler's prospective study of ultrasound, CT, and MRI in Ontario hospitals. Using slightly different methodology, Butler found a very similar 2.5% of "inappropriate" imaging orders.

Data analysis challenge

One challenge when analyzing data gathered for the study was converting the free text from the requisition forms so that the clinical reasons for ordering a test could be assessed by computer. The very high number of "indeterminate" ratings found in the analysis was a result of this challenge, and motivated both a human review of data as well as a more detailed analysis of the computer program by the software vendor. This analysis revealed problems with limited software vocabulary. For example, 94% of knee MRI exams were called "indeterminate," even when a specific diagnosis such as "medial meniscal tear" was the provided indication. The "indeterminate" rating was thus frequently a reflection of the software's inadequate vocabulary and consequent failure to recognize valid clinical reasons for ordering a test. The "not validated" cases were the result of situations where the information on the requisitions did not match coding terminology.

Study limitation

One limitation of this study was the restricted number of body regions for imaging considered: CT of the brain and lumbar spine and MRI of those two regions plus the knee. These examinations were chosen because they are among the most common, making up at least 60% of CT and MRI studies on a typical day in BC. Furthermore, these regions were selected specifically with the expectation that they would involve more "inappropriate" orders when compared to orders for imaging other body regions, where much more specific questions are often asked. We would expect, therefore, that including imaging requisitions for other body regions would yield the same very low number of "inappropriate" orders.

Literature review

We could find no scientific support for the 30% "inappropriate" rate for CT and MRI quoted by some sources, and suspect that no evidence exists. However, given the discrepancy between this figure and the very low 2% "inappropriate" rate we obtained, we carried out a detailed literature search to determine the origin of this frequently quoted 30% figure.

The 2010 Health Council of Canada (HCC) publication mentions this high rate to encourage family physicians to be more selective when ordering diagnostic imaging.[2] The two sources that HCC cites for this assertion include a brochure,[3] which uses the 30% number but provides no references, and a report prepared for the government of Saskatchewan.[4] The report mentions the 30% number, for which the authors provide two references. The first is a Canadian study of the use of plain film in the 1990s for investigating cervical spine injury and not for CT or MRI. Nowhere in this study is mention made of a 30% inappropriate rate, or any inappropriate rate.[5] The second reference in the Saskatchewan report is an abstract from a Pennsylvania private insurance company that says they did a study but provides no details or references.[6]

The 30% inappropriate rate is also quoted by Picano in a 2004 *British Medical Journal* article focused on radiation exposure.[7] The references the Italian researcher uses are two articles published in *Pediatric Radiology* in 2002.[9,10] These articles both discuss radiation exposure in childhood and note that rates of CT scanning are high in the United States, but neither article discusses an appropriate or inappropriate rate of any sort, let alone mentions a specific number.[9,10] The often-quoted figure of 30% seems like the admonition to drink eight glasses of water a day; both ideas are accepted wisdom, but neither has any credible source and instead reflect mere repetition without scientific backing.[11]

Putting BC data in context

In BC the low number of "inappropriate" ratings for CT and MRI requisitions may reflect restricted access to these technologies. With respect to CT in BC, the Ministry of Health determines the number and distribution of scanners for the entire province. As far as MRI is concerned, the ministry provides fixed annual funding to control the number of examinations performed. According to CIHI data from 2008 to 2009,[12] the utilization of MRI in BC (26 per 1000 population), as shown in **Table 3**, is the third lowest of all 10 provinces, just ahead of Newfoundland and PEI. CT utilization in BC (106 per 1000 population) is closer to average, but is still less than the Canadian average (121 per 1000 population) and is the second lowest of all 10 provinces, just ahead of PEI. Considering Canada as a whole, our present use of CT and MRI per 1000 is approximately 50% of the US rate. On a more global scale, Canada's utilization rates for CT and MRI are below the OECD averages, and BC's use of MRI is 53% of the OECD average (49 per 1000 population).[12] The 2011 performance measure document for one of the principal regions of BC, the

Vancouver Island Health Authority, shows that only 30% of patients received routine MRI exams within the target time of 91 days,[13] and that some patients waited a full year for an MRI exam. Such delays can mean that inappropriate tests are ordered or a more invasive procedure is done. An example of the former is the examination of a young patient with inflammatory bowel disease using CT rather than MRI—the test of choice with its lack of ionizing radiation. An unfortunate example of the latter is the use of knee arthroscopy without an MRI examination first to determine the cause of the knee pain and establish the need for arthroscopy.

While the level of appropriate imaging found in BC is acceptable, continued monitoring is needed. This would be helped by further development of computerized physician order entry to improve access to clinical information and make data more readily available for computer analysis. Computerized physician order entry could also benefit communication between clinicians and radiologists and result in improved interpretations relevant to patient care.

Table 3. MRI and CT exams per 1000 population in various jurisdictions, 2008–2009.

Jurisdiction	MRI exams per 1000 population	CT exams per 1000 population
Alberta	54	124
New Brunswick	51	193
Ontario	48	111
Manitoba	41	136
Quebec	38	128
Nova Scotia	35	155
Saskatchewan	29	139
British Columbia	26	106
Newfoundland	24	144
Prince Edward Island	23	104
US	91	228
Belgium	54	183
OECD Average	49	139
Canada	41	121
Czech Republic	28	83
Slovak Republic	24	83

Competing interests

None declared.

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