Appropriateness of Spinal Imaging Use in Canada

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EXECUTIVE SUMMARY

Overview
Diagnostic imaging is an essential component of Canadian healthcare which contributes enormously to patient management. Common forms of imaging currently include magnetic resonance imaging (MRI), computed tomography (CT), and plain x-rays. Costs of diagnostic imaging in Canada have increased rapidly in the last 2 decades, and given fiscal pressures facing the Canadian government there is a pressing need to find efficiencies in the use of diagnostic imaging technology. It is estimated that 50–80% of the adult population will experience spine related complaints (e.g., low back pain) in their lifetime, and imaging of the lumbar spine accounts for approximately one-third of all MRI procedures in some Canadian provinces.

Key Findings

Systematic Review of the Literature
There are 22 studies that have explored appropriateness of spine-related imaging, and all have found some inappropriate use. The rate of inappropriate imaging varies considerably according to which criteria are used, and there appears to be little consensus on a common definition of appropriateness. 18 studies have explored interventions to improve appropriateness of spine-related imaging, and active decision aids appear more promising than passive dissemination of educational material. Patient-important outcomes are rarely considered in studies exploring appropriateness of imaging.

Survey of Canadian Spine Surgeons
Most Canadian spine surgeons (84%) require imaging studies to accompany all spine-related referrals. MRI is the most common form of imaging required, but there is tremendous variability in this area. Furthermore, even with imaging studies, 53% of surgeons refuse more than 20% of all referrals without a consultation, and less than 20% of patients who are assessed are surgical candidates. The current system of referring patients with spine-related complaints for surgical assessment in Canada appears to generate a substantial amount of unnecessary imaging.

Provincial Utilization Data
From 2001-2011, MRI spine utilization has increased markedly, but this has not reduced the use of spine x-ray or CT spine, and spine x-rays still currently account for nearly half (40%) of all spine imaging costs. Compared to Ontario, the increase in spine imaging expenditures in Manitoba has been disproportionate to the increase in the number of procedures performed because of increases in unit cost over the 10 year study period in Manitoba (i.e., fee schedule increases). Disparities in access to spinal imaging according to socioeconomic status were documented in both provinces. Improved health system coordination for patients with spinal complaints may help to improve efficiency of spine imaging use (e.g., diagnostic imaging pathways to reduce need for “lead up” testing with x-ray or CT spine before MRI; alternative and innovative models of care which provide standardized assessment of patients with low back pain could streamline referral of appropriate patients for advanced spine imaging and surgical consultation).
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Background
Diagnostic imaging is an essential component of Canadian healthcare which contributes enormously to patient management. Common forms of imaging currently include magnetic resonance imaging (MRI), computed tomography (CT), and plain x-rays. Advances in technology have allowed for earlier, less invasive and more accurate diagnosis of disease and have improved patient health outcomes in many cases. At the same time, the proliferation of advanced technology has led to substantial perceived need for these technologies, thereby increasing the utilization of imaging services. Increases in utilization of diagnostic imaging in Canada have far exceeded population growth; between 1993/1994 and 2003/2004 there was a 300% increase in the number of CT scans and a 600% increase in the number of MRI scans - more rapid growth than almost any other type of Canadian health service. Imaging of the lumbar spine accounts for approximately one-third of all MRI procedures in some provinces, such as Alberta where 25,000 lumbar spine MRIs were done in the fiscal year 2009/2010. It is not clear to what degree the increase in diagnostic imaging reflects optimal technology utilization. It is possible that financial interests, defensive medicine, or consumer demand may result in overutilization of imaging. A recent study led by one of us (YRR) studying Ontario patients with degenerative spine disease referred for surgical consultation found that 100% of CT scans and 60% of MRIs were unnecessary, resulting in an additional cost estimated at 24-million dollars/year. Another recent study by another applicant (TEF) found that over half of lumbar spine MRIs in Edmonton and Ottawa were either inappropriate or of uncertain value. International and intranational comparisons provide further evidence of possible overutilization. In 2004/05, Canada performed nearly four times the number of CT exams per capita and two times the number of MRI exams per capita than Sweden or the United Kingdom performed in 2002. Furthermore, there is considerable regional variation in the use of diagnostic imaging in Ontario.

Canada currently spends 10% of total outpatient expenditure on diagnostic imaging; the Ontario government’s spending on operating costs for diagnostic services represented approximately 5% of total operating costs of the Ministry of Health and Long-Term Care (MOHLTC) in 2003/04. The actual costs are higher if one also considers the capital costs of equipment and the costs of downstream tests and interventions due to imaging results.

To date, efforts to improve access to medical imaging have focused on increasing supply and the number of MRI scanners in Canada increased 14-fold from 19 in 1990 to 266 in 2009. Simply increasing the number of scanners in Ontario, without instituting methods to encourage the appropriate use of imaging technology, has not resulted in proportionate reduction in wait-times and may not be associated with improved health outcomes. Medicare enrollees in higher-spending regions in America receive more care than those in lower-spending regions, but do not have better health outcomes. A subsequent analysis focusing specifically on Medicare expenditures for diagnostic imaging, controlling for differences in patient characteristics, found that greater spending for diagnostic imaging was not associated with improved survival. Costs of diagnostic imaging in Canada have increased rapidly, and given fiscal pressures facing
the Canadian government there is a pressing need to find efficiencies in the use of diagnostic imaging technology.\textsuperscript{19}

\textbf{Limitations of Current Evidence}

Regulatory guidelines for medical device manufacturers focus on safety, rather than on clinical effectiveness. Decisions to fund or adopt imaging devices are made by those paying for the technologies. Health technology assessment (HTA) attempts to provide analyses of costs and benefits of technology;\textsuperscript{20} however, these assessments do not always follow an explicit, transparent or evidence-based process\textsuperscript{13}.

The Canadian Association of Radiologists (CAR) recently published its first edition of clinical practice guidelines for diagnostic imaging. This document stresses physician autonomy, stating that the guidelines are not intended as a means of restricting the physician’s role in the process of decision-making for imaging study requests.\textsuperscript{21} A 1-year pilot project was recently completed at the Children’s Hospital in Winnipeg which implemented an order entry tool based on the CAR Guidelines in an effort to reduce inappropriate ordering of diagnostic imaging. The investigators reported “minimal changes in order practices”. Specifically, only 2\% of 8700 orders for medical imaging followed decision support advice (i.e., ordering physicians chose to override and ignore the advice for 98\% of their imaging requests), and 11\% of all imaging orders were clearly inappropriate according to the CAR Guidelines (Dr. Markus Faulhaber, personal communication). Feedback from physicians indicated that the CAR Guidelines were largely based on expert opinion and were overly generic, and that recommendations should be based on the best available evidence.

\textbf{Filling the Knowledge Gap}

We propose to systematically review the research literature to inform the appropriateness of diagnostic imaging utilization, with a specific focus on spinal imaging. Our systematic review will also capture all studies that have explored the appropriateness of Canadian utilization of spine-related imaging. We will conduct a descriptive analysis of the utilization of spine-related diagnostic services in Canada (specifically in Ontario and Manitoba) in order to quantify current use, explore factors that may be associated with different rates of utilization, and estimate associated costs of inappropriate utilization. After the grant was awarded, and in consultation with Manitoba Health, we also decided to conduct surveys of Canadian spine surgeons to explore the current efficiency of surgical assessment of LBP patients and patterns of imaging use.
Objectives

This Knowledge Synthesis project, funded by the Canadian Institutes of Health Research (CIHR), addressed the following questions:

1. What research is available to identify rates of non appropriate imaging ordering and utilization in the area of spine-related complaints?

   Areas of interest include understanding the extent of imaging prior to, or as a condition to being seen by specialists versus ordering after examination to determine a diagnoses or to confirm/plan interventions such as surgery (i.e. pre-op care).

   Specific imaging to be investigated includes MRI, CT, and X-rays.

2. Are there effective interventions to decrease the rate of inappropriate spine-related imaging?

Of particular interest to Manitoba Health:

* Identification of breadth of inappropriate imaging (focused on CT, MRI and X-ray interventions)

* Cost and impact of the issue
1. Literature review on spine imaging appropriateness

We used a highly sensitive search strategy to identify all publications on the topic of appropriateness of spine-related imaging indexed on any of 6 electronic databases (MEDLINE, HealthStar, EMBASE, CINAHL, Index to Chiropractic Literature, and The International Guideline Library). We searched all databases from inception to May 29, 2012.

Eligible studies met any 1 of the following criteria: (1) reports data on the proportion of spine-related imaging that was inappropriate; or (2) tests a strategy to improve the appropriateness of spine-related imaging.

Of 12,636 unique citations, we reviewed 370 in full text and 39 provide eligible for our review. We located 1 unpublished study, resulting in 40 eligible studies for our systematic review (Figure 1).
Figure 1: Flow diagram of study selection

Literature Search Results (n=19,808)

- CINAHL: 1548
- EMBASE: 7119
- MEDLINE: 5783
- HealthSTAR: 4962
- Index to Chiropractic Literature: 72
- The International Guideline Library: 324

7,172 duplicate articles

12,636 abstracts screened

370 potentially relevant studies selected for review of full text

40 publications included in our systematic review

1 unpublished paper from a team member (TEF)
22 unique cohorts from 21 studies reported on the proportion of inappropriate spine-related imaging, involving populations from 7 different countries: 22-42

- USA - 12 studies
- Canada - 2 studies
- Norway - 2 studies
- Australia - 2 studies
- UK - 1 study
- France - 1 study
- Finland - 1 study (reporting 2 cohorts)

The literature on appropriateness of spine-related imaging is challenging due to the application of multiple standards. There were 22 different appropriateness criteria reported in 21 studies, only 4 of which were reported in more than 1 study (see Tables 1-3). All studies agree that inappropriate imaging occurs, but the size of the problem depends on the criteria applied. For example, the study by Ammendolia et al. applied 3 different criteria to their patient population and concluded that the rate of inappropriate imaging could be as low as 13% to as high as 47% depending on the criteria that was applied.42

There is little consensus on a comprehensive definition for appropriateness of spine-related imaging. Existing guidelines and decision rules are based on ensuring close to 100% sensitivity for all and any “clinically significant lesions”. This permits ‘rules’ with very low specificity. In most cases, the association with measures of direct patient-importance is unknown.

There does appear to be broad consensus that imaging is inappropriate for uncomplicated LBP, of any duration, and this may be an important target for reduction of inappropriate imaging.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country of Study</th>
<th>Population</th>
<th>Appropriateness criteria</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoffman et al., 2000 22</td>
<td>USA</td>
<td>X-rays for acute, blunt neck trauma (n=34,069)</td>
<td>The National Emergency X-Radiography Utilization Study (NEXUS) criteria</td>
<td>12.7% of X-rays were inappropriate</td>
</tr>
<tr>
<td>Oikarinen et al., 2009 23</td>
<td>Finland</td>
<td>CT scans of the neck (n=30)</td>
<td>Guidelines for imaging recommended by the European Commission</td>
<td>3% of CT scans were inappropriate</td>
</tr>
<tr>
<td>Moak et al., 2011 24</td>
<td>USA</td>
<td>Acute, blunt neck trauma patients (n=124)</td>
<td>NEXUS + dangerous mechanism of injury</td>
<td>7.4% of CT scans were inappropriate (9 of 122)</td>
</tr>
<tr>
<td>Griffith et al., 2011 25</td>
<td>USA</td>
<td>CT scans for acute, blunt neck trauma (n=1589)</td>
<td>The National Emergency X-Radiography Utilization Study (NEXUS) criteria</td>
<td>20% of CT scans were inappropriate</td>
</tr>
<tr>
<td>Kokabi et al., 2011 26</td>
<td>Australia</td>
<td>CT scans for acute, blunt neck trauma (n=106)</td>
<td>Goergen's criteria</td>
<td>53.8% of CT scans were inappropriate</td>
</tr>
<tr>
<td>Sheikh et al., 2012 27</td>
<td>USA</td>
<td>Acute, blunt neck trauma patients (n=1245)</td>
<td>American College of Radiology (ACR) Appropriateness criteria</td>
<td>100% of X-rays were inappropriate (433 of 433)</td>
</tr>
</tbody>
</table>
Table 2: Studies exploring the appropriateness of imaging for mixed axial complaints

<table>
<thead>
<tr>
<th>Study</th>
<th>Country of Study</th>
<th>Population</th>
<th>Appropriateness criteria</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vosburgh &amp; Kopta, 1994 28</td>
<td>USA</td>
<td>71 patients that underwent 90 MRI of the spine</td>
<td>Author-derived criteria</td>
<td>22% of MRIs were judged as inappropriate</td>
</tr>
<tr>
<td>Lehnert &amp; Bree, 2010 29</td>
<td>USA</td>
<td>72 outpatients referred for MRI or CT of the spine by their PCP</td>
<td>Proprietary evidence-based appropriateness criteria used by a national RBM program (HealthHelp, Inc, Houston, Texas)</td>
<td>53% (9 of 17) CT scans, and 35% (19 of 55) MRIs were judged as inappropriate</td>
</tr>
</tbody>
</table>

RBM program – Radiology benefits management program
Table 3: Studies exploring the appropriateness of imaging for low back complaints

<table>
<thead>
<tr>
<th>Study</th>
<th>Country of Study</th>
<th>Population</th>
<th>Appropriateness criteria</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tacci et al., 1999&lt;sup&gt;30&lt;/sup&gt;</td>
<td>USA</td>
<td>Workers with acute, uncomplicated LBP (n=98)</td>
<td>The AHCPR Guidelines, and the American College of Occupational and Environmental Medicine Guidelines</td>
<td>All imaging was inappropriate: 64 x-rays 22 MRIs</td>
</tr>
<tr>
<td>Hush, 2008&lt;sup&gt;31&lt;/sup&gt;</td>
<td>Australia</td>
<td>Workers with non-specific low back pain (LBP) (n=401)</td>
<td>“Numerous clinical guidelines for LBP state that X-rays and other diagnostic scans are not indicated for injured workers presenting with non-specific LBP.”</td>
<td>All imaging was inappropriate: 261 x-rays 285 CT scans 160 MRIs</td>
</tr>
<tr>
<td>Hourcade &amp; Treves, 2002&lt;sup&gt;32&lt;/sup&gt;</td>
<td>France</td>
<td>LBP patients who underwent a CT scan (red flags, n=5; non-specific acute/subacute, n=24; non-specific CLBP, n=23; sciatica, n=80)</td>
<td>The guidelines of the National Agency for Accreditation and Health Evaluation (ANAES) and the Consensus Conference on the use of medical imagery in low back pain and sciatica</td>
<td>Proportion inappropriate: Red flags – 0% Acute/Sub – 96% CLBP – 100% Sciatica – 65%</td>
</tr>
<tr>
<td>Weiner et al., 2006&lt;sup&gt;33&lt;/sup&gt;</td>
<td>USA</td>
<td>Chronic low back pain (LBP) (n=111; age≥65)</td>
<td>“Official guidelines that address when imaging studies should be ordered in patients with CLBP have not been established...Advanced imaging is typically not necessary”</td>
<td>61% of patients had undergone MRI, all of which were deemed inappropriate</td>
</tr>
</tbody>
</table>
Table 3 con't: Studies exploring the appropriateness of imaging for low back complaints

<table>
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<tbody>
<tr>
<td>Boden &amp; Swanson, 1998 34</td>
<td>USA</td>
<td>Low back pain (LBP) patients (n=110); 77 underwent a CT or MRI</td>
<td>Author-derived criteria (strict, moderate and lax)</td>
<td>Proportion inappropriate: Strict – 99% Moderate – 95% Lax – 73%</td>
</tr>
<tr>
<td>Schroth et al., 1992 35</td>
<td>USA</td>
<td>Acute LBP patients (n=183)</td>
<td>Informed by 2 prior publications</td>
<td>26% of plain films were inappropriate (10 of 38) 66% of CT and MRIs were inappropriate (12 of 18)</td>
</tr>
<tr>
<td>Rao et al., 2002 36</td>
<td>USA</td>
<td>LBP patients presenting to PCPs (n=279); 141 were referred for MRI</td>
<td>The U.S. Agency for Health Care Policy and Research (AHCPR) guidelines</td>
<td>28% of MRIs were inappropriate</td>
</tr>
<tr>
<td>Oikarinen et al., 2009 23</td>
<td>Finland</td>
<td>CT scans of the low back (n=30)</td>
<td>Guidelines for imaging recommended by the European Commission</td>
<td>77% of CT scans were inappropriate</td>
</tr>
<tr>
<td>Emery et al., 2013 37*</td>
<td>Canada</td>
<td>Patients referred for a low back MRI (n=500)</td>
<td>The RAND-UCLA appropriateness method, including a literature review, expert assessment and a chart review</td>
<td>56% of MRIs were inappropriate, and 29% were of uncertain value</td>
</tr>
</tbody>
</table>

* This study was unpublished at the time our search was conducted
Table 3 con't: Studies exploring the appropriateness of imaging for low back complaints

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Deyo &amp; Diehl, 1986³⁸</td>
<td>USA</td>
<td>621 walk-in patients with low back pain (LBP); 311 had an x-ray</td>
<td>“A list of 11 clinical findings and other indications, any one of which should prompt early radiography, was developed from criteria proposed by others”</td>
<td>27% of x-rays were inappropriate</td>
</tr>
<tr>
<td>Halpin et al., 1991³⁹</td>
<td>United Kingdom</td>
<td>100 patients attending for plain films of their low back</td>
<td>The guidelines of the Royal College of Radiologists</td>
<td>52% of x-rays were inappropriate</td>
</tr>
<tr>
<td>Espeland et al., 1999⁴⁰</td>
<td>Norway</td>
<td>Low back pain (LBP) patients referred for plain films (n=323)</td>
<td>Norwegian and British recommendations for the use of radiography</td>
<td>Proportion inappropriate: Norwegian – 34% (42% uncertain) British – 46% (18% uncertain)</td>
</tr>
<tr>
<td>Espeland et al., 2001⁴¹</td>
<td>Norway</td>
<td>LBP patients referred for plain films (n=99)</td>
<td>Norwegian and British recommendations for the use of radiography</td>
<td>Proportion inappropriate:* Norwegian – 71% British – 60%</td>
</tr>
<tr>
<td>Ammendolia et al., 2007⁴²</td>
<td>Canada</td>
<td>Acute LBP (n=1241); 481 were referred for x-ray</td>
<td>The U.S. Agency for Health Care Policy and Research (AHCPR) guidelines A modified version of the AHCPR guidelines The radiography guidelines by Simmons et al</td>
<td>Proportion of Inappropriate x-rays: 22% - AHCPR 47% - mAHCPR 13% - Simmons</td>
</tr>
</tbody>
</table>

* Patients who received inappropriate plain films rated imaging as more important than those who received appropriate imaging
We identified 18 studies that have explored interventions to improve the appropriateness of imaging for spine-related complaints, involving populations from 6 different countries.  

- USA - 8 studies
- UK - 6 studies
- Canadian - 1 study
- Australia - 1 study
- Ireland - 1 study
- Norway - 1 study

Passive interventions to modify imaging rates (distribution of educational materials, media campaigns), have shown inconsistent results. Interventions focussing on active decision aids appear more promising (see Table 4).

In general there is very little focus on patient-important outcomes, and as such the impact of reduced imaging on patients is uncertain. Both patient-factors (e.g. the desire for imaging) and clinician-factors (e.g. defensive medicine) may have to be considered to optimally reduce inappropriate spine-related imaging.
Table 4: Studies exploring interventions to improve the appropriateness of spine-related imaging

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Intervention</th>
<th>Control</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker, et al., 198743*</td>
<td>ED patients referred for lumbosacral x-ray (US)</td>
<td>Standardized referral form</td>
<td>General requisition form</td>
<td>47% reduction in number of lumbosacral x-rays performed</td>
</tr>
<tr>
<td>Deyo, et al., 198744</td>
<td>101 patients presenting to walk-in clinic with &quot;low risk&quot; low back pain (US)</td>
<td>Educational intervention + x-ray in 3 weeks if no improvement</td>
<td>Immediate x-ray</td>
<td>88% reduction in number of lumbosacral x-rays performed</td>
</tr>
<tr>
<td>Garala, et al., 1999</td>
<td>5 primary care practices (UK)</td>
<td>Primary care physician initiated quality improvement initiative + laminated guidelines sheet</td>
<td>Usual care</td>
<td>39% reduction in number of lumbosacral x-rays performed</td>
</tr>
<tr>
<td>Oakeshott, et al., 199446</td>
<td>62 primary care practices including 170 primary care physicians (UK)</td>
<td>Passive dissemination of guidelines (mail)</td>
<td>Usual care</td>
<td>31% reduction in number of spine imaging tests</td>
</tr>
<tr>
<td>Solberg, et al., 2010</td>
<td>MRI spine requests from primary care physicians within a 600 physician multi-specialty medical group (US)</td>
<td>Computerized order entry and decision support (based on American College of Radiology guidelines)</td>
<td>Usual care</td>
<td>20% reduction in spine MRI use</td>
</tr>
<tr>
<td>Stevenson &amp; Hay, 200448</td>
<td>Patients with acute low back pain seen in primary care (UK)</td>
<td>Integrated care pathway for patients with acute low back pain in primary care</td>
<td>Usual care</td>
<td>29% reduction in lumbosacral x-ray use; 67% reduction in wait times (36 to 12 weeks) for spinal specialist consultation</td>
</tr>
</tbody>
</table>

* Baker et al. introduced their standardized forms in 1982. A 10-year follow-up study found a 28% reduction in lumbosacral x-rays from 1982 to 1992 (Gallagher & Trotsky, 1998)
### Table 4 con't: Studies exploring interventions to improve the appropriateness of spine-related imaging

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<tbody>
<tr>
<td>Werner, et al., 2009[^49]</td>
<td>General public (2 intervention counties + 1 control county, Norway)</td>
<td>Media campaign</td>
<td>No media campaign</td>
<td>Inconclusive: major increase in MRI capacity in the control county during study period</td>
</tr>
<tr>
<td>Maurice, et al., 1996[^50]</td>
<td>Cervical spine x-ray referrals from ER (UK)</td>
<td>Introduction of guidelines</td>
<td>Usual care</td>
<td>47% reduction in number of cervical spine x-rays performed</td>
</tr>
<tr>
<td>Blackmore et al., 2011[^51]</td>
<td>An integrated, multidisciplinary healthcare network (US)</td>
<td>Mandatory series of questions at the point of care in the imaging order system. Failure to document compliance with approved indications would prevent the online order from being activated.</td>
<td>Usual care</td>
<td>33% decrease in the utilization rate of lumbar MRI for low back pain (risk ratio, 0.77; 95% confidence interval, 0.87-0.67)</td>
</tr>
<tr>
<td>Adams &amp; Adams, 2010[^52]</td>
<td>A University medical center (US)</td>
<td>Distribution of an algorithm for radiographic evaluation of post-CT cervical spines</td>
<td>Usual care</td>
<td>16% reduction in inappropriate plain films</td>
</tr>
<tr>
<td>Stiell et al., 2009[^53]</td>
<td>11 824 patients with blunt trauma to the head or neck at one of 12 hospitals (Canada)</td>
<td>Active strategies to implement the Canadian C-Spine Rule, including education, policy, and real time reminders on radiology requisitions</td>
<td>Usual care</td>
<td>25% reduction in cervical spine x-rays</td>
</tr>
<tr>
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</tr>
<tr>
<td>Goergen et al., 2006</td>
<td>Patients with blunt cervical trauma presenting to 1 hospital (Australia)</td>
<td>Guideline dissemination and implementation with decision-support software</td>
<td>Usual care</td>
<td>7% reduction in cervical CT &amp; x-rays; 4% increase in brain CT scans</td>
</tr>
<tr>
<td>Rao et al., 2002</td>
<td>Patients with LBP presenting to a university-affiliated Veterans Affairs medical center (US)</td>
<td>Dissemination of the 1994 Agency for Healthcare Policy and Research (AHCPR) LBP guidelines</td>
<td>Usual care prior to guideline release</td>
<td>No change in the proportion of patients who received an MRI</td>
</tr>
<tr>
<td>Klein et al., 2000</td>
<td>LBP patients attending a multispecialty group practice (US)</td>
<td>Dissemination and education regarding LBP guidelines, and access to a rheumatologist for questions</td>
<td>Usual care</td>
<td>81% reduction in low back CT scans, 28% reduction in low back MRIs</td>
</tr>
<tr>
<td>Kerry et al., 2000</td>
<td>69 primary care practices (UK)</td>
<td>Dissemination of the 1993 Royal College of Radiologists guidelines, and feedback on spine imaging referral rate</td>
<td>Usual care</td>
<td>20% reduction in requests for spinal examinations compared with control practices</td>
</tr>
<tr>
<td>Freeborn et al., 1997</td>
<td>67 general internal medicine physicians and 28 family practice physicians (US)</td>
<td>Dissemination of the 1994 AHCPR LBP guidelines, and feedback on referral practices for x-ray, CT scan and MRI of the lumbar spine</td>
<td>Usual care</td>
<td>No reduction in lumbar spine imaging referrals</td>
</tr>
</tbody>
</table>
Table 4 con't: Studies exploring interventions to improve the appropriateness of spine-related imaging

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<th>Intervention</th>
<th>Control</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>McNally et al., 1995&lt;sup&gt;58&lt;/sup&gt;</td>
<td>15 875 patients attending the accident department over two years (UK)</td>
<td>Use of posters to display guidelines encouraging the more effective use of radiology in patients with neck injuries</td>
<td>No posters</td>
<td>No change in cervical spine x-ray referrals</td>
</tr>
<tr>
<td>Tracey et al., 1994&lt;sup&gt;59&lt;/sup&gt;</td>
<td>322 patients with acute LBP presenting to a teaching hospital (Ireland)</td>
<td>Dissemination of guidelines, clinician education, and imaging referral forms that required endorsement that guideline criterion were met</td>
<td>Usual care</td>
<td>21% reduction in lumbar spine x-rays</td>
</tr>
</tbody>
</table>

CONCLUSIONS

All studies that have explored appropriateness of spine-related imaging have found some inappropriate use. The rate of inappropriate imaging varies considerably according to which criteria are used, and there appears to be little consensus on a common definition of appropriateness. Studies exploring interventions to improve appropriateness of spine-related imaging have generally shown a positive effect, but active decision aids appear more promising than passive dissemination of educational material. Patient-important outcomes are rarely considered in studies exploring appropriateness of imaging.
2. Surveys of Canadian Spine Surgeons

Survey 1
On January 6, 2012, we administered a 28-item survey to all 100 surgeon members of the Canadian Spine Society (CSS), with active surgical practices, to examine current practices for spine surgeons’ assessment and management of low back or low back-related leg pain patients, and their attitudes towards the involvement of LBP clinicians (chiropractors & physical therapists) to screen such patients referred for surgical assessment.

Eighty-five surgeons provided a completed survey for a response rate of 85% (85 of 100). Most respondents were male (97.6%) and approximately half (48.2%) had been in practice for more than 20 years. The majority of respondents (69.4%) dedicated over half their practice to elective spine surgery, and reports of inefficiency were common (Table 1). Approximately a third of spine surgeons turned away more than 20% of low back or low back-related leg pain patients that were referred to their practice, wait times for patients to be seen that were accepted typically exceeded 6 months, and 89.4% (76 of 85) acknowledged that their outpatient waiting time was not optimal. Only 29.5% of respondents (25 of 85) reported that their screening efficiency for low back or low back-related leg pain patients was optimal, with 41.6% screening more than 10 patients to identify a single surgical candidate. Once a patient’s complaint was identified as amenable to surgery, many respondents (43.5%) reported that patients waited >6 months for their procedure and only 16.5% of surgeons (14 of 85) characterized their surgical wait times as optimal.

Willingness to have LBP clinicians screen patients
Most spine surgeons (77.6%; 66 of 85) were either willing to work with LBP clinicians to screen their low back or low back-related leg pain patients (n=54) or were already doing so (n=12). Only 7 respondents (8.2%) were opposed to considering this arrangement, with 14.1% undecided.
Table 1: Practice characteristics (n=85)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of patients with a primary complaint of low back or low back-related leg pain, n (%)</td>
<td></td>
</tr>
<tr>
<td>&lt;20%</td>
<td>4 (4.7%)</td>
</tr>
<tr>
<td>21% to 40%</td>
<td>6 (7.1%)</td>
</tr>
<tr>
<td>41% to 60%</td>
<td>22 (25.9%)</td>
</tr>
<tr>
<td>61% to 80%</td>
<td>35 (41.2%)</td>
</tr>
<tr>
<td>&gt;80%</td>
<td>18 (21.2%)</td>
</tr>
<tr>
<td>Proportion of practice spent on elective spine surgery</td>
<td></td>
</tr>
<tr>
<td>&lt;25%</td>
<td>6 (7.1%)</td>
</tr>
<tr>
<td>25% to 50%</td>
<td>20 (23.5%)</td>
</tr>
<tr>
<td>51% to 75%</td>
<td>29 (34.1%)</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>30 (35.3%)</td>
</tr>
<tr>
<td>Proportion of LBP patients referred to your practice, but not accepted</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>20 (23.5%)</td>
</tr>
<tr>
<td>1% to 5%</td>
<td>12 (14.1%)</td>
</tr>
<tr>
<td>6% to 10%</td>
<td>7 (8.2%)</td>
</tr>
<tr>
<td>11% to 15%</td>
<td>10 (11.8%)</td>
</tr>
<tr>
<td>16% to 20%</td>
<td>10 (11.8%)</td>
</tr>
<tr>
<td>&gt;20%</td>
<td>26 (30.6%)</td>
</tr>
<tr>
<td>Outpatient wait time</td>
<td></td>
</tr>
<tr>
<td>1 week to 1 month</td>
<td>2 (2.4%)</td>
</tr>
<tr>
<td>1 to 3 months</td>
<td>5 (5.9%)</td>
</tr>
<tr>
<td>3 to 6 months</td>
<td>31 (36.5%)</td>
</tr>
<tr>
<td>&gt;6 months</td>
<td>47 (55.3%)</td>
</tr>
<tr>
<td>Number of LBP or low back-related leg pain patients screened to identify a surgical candidate †</td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>15 (17.9%)</td>
</tr>
<tr>
<td>5 to 10</td>
<td>34 (40.5%)</td>
</tr>
<tr>
<td>11 to 20</td>
<td>27 (32.1%)</td>
</tr>
<tr>
<td>&gt;20</td>
<td>8 (9.5%)</td>
</tr>
<tr>
<td>Surgical wait time</td>
<td></td>
</tr>
<tr>
<td>1 week to 1 month</td>
<td>2 (2.4%)</td>
</tr>
<tr>
<td>1 to 3 months</td>
<td>21 (24.7%)</td>
</tr>
<tr>
<td>3 to 6 months</td>
<td>25 (29.4%)</td>
</tr>
<tr>
<td>&gt;6 months</td>
<td>37 (43.5%)</td>
</tr>
</tbody>
</table>

† = one respondent did not provide an answer for this question
History and exam findings requiring surgical assessment

Our respondents largely endorsed four findings that would necessitate surgical assessment: signs or symptoms associated with a ‘red flag’ condition, leg dominant pain, and low back or low back-related leg pain that was consistent with either neurological findings or imaging results (Table 2). Each of these items were endorsed by greater than 85% of surgeons, and only 5 respondents suggested criteria other than what we provided for consideration.

A clear majority of surgeons advised they would want to confirm an indication for surgery themselves, whether the indication was clearly identified or suspected by a LBP clinician (88.2% and 89.4% respectively). However, a majority of respondents (75.3%, 64 of 85) also agreed they would be comfortable not assessing a low back or low back-related leg pain patient referred to their practice if clear indications for surgery were ruled out by a LBP clinician; 17.6% were unsure and 7.1% would still want to assess the patient themselves. Spine surgeons were divided as to whether their patients would expect to be seen by them after an assessment by a LBP clinician, with 40.0% (30 of 85) endorsing they would, 25.9% being undecided, and 34.1% disagreeing.

Table 2: History and exam findings requiring surgical assessment (n=85)

<table>
<thead>
<tr>
<th>History or Exam Finding</th>
<th>Level of Endorsement, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs or symptoms associated with a ‘red flag’ condition †</td>
<td>80 (95.2%)</td>
</tr>
<tr>
<td>Leg dominant pain</td>
<td>77 (91.7%)</td>
</tr>
<tr>
<td>Low back or low back-related leg pain with correlating neurological findings</td>
<td>74 (88.1%)</td>
</tr>
<tr>
<td>Low back or low back-related leg pain with correlating findings on imaging</td>
<td>73 (86.9%)</td>
</tr>
<tr>
<td>The absence of ‘yellow flags’ ‡</td>
<td>31 (36.9%)</td>
</tr>
<tr>
<td>Severe low back pain that is unresponsive to conservative care</td>
<td>26 (30.1%)</td>
</tr>
</tbody>
</table>

† Red flag conditions were defined as cauda equina syndrome, fracture, infection, or cancer

‡ Yellow flags were defined as receipt of disability benefits, ongoing litigation, current smoker, or high emotional stress
**Survey 2**
On August 27, 2012, we administered an 8-item survey to all 100 surgeon members of the Canadian Spine Society (CSS), with active surgical practices, that inquired about demographic variables and imaging practices related to patients referred for spine-related complaints.

Fifty-five spine surgeons completed our survey, for a response rate of 55%. Most respondents were male (98.2%) and approximately half (45.5%) had been in practice for more than 20 years. Most respondents (65.4%) dedicated over half their practice to elective spine surgery. The majority of respondents (78.2%; 43 of 55) required imaging studies to accompany all spine-related referrals; the types of imaging studies required were highly variable, with respondents endorsing 7 different types of imaging or imaging combinations (Figure 1). Of the 11 surgeons that did not require imaging to accompany spine-related referrals, 4 indicated a preference for MRIs with referrals.

**Figure 1: Combinations of imaging required for accepting a spine-related referral among respondents who indicated that they require imaging to accompany a new referral (n=43)**

![Pie chart showing combinations of imaging required](image-url)
Written comments were provided by 23 respondents and the most common themes were contradictory: (1) imaging is an essential part of spine-related referrals, (2) better triaging of referrals can reduce unnecessary imaging, and (3) most spine-related referrals do not require imaging. For example:

“MRI is the gold-standard for imaging of the spine. We went through this same debate for CT scans about 15 years ago. It is useless to resist. Patients want them. Referring physicians want them. Spine surgeons want them. It is only a matter of time before MRI will become the key to spine referrals anywhere it already hasn’t. Regulating or restricting it only makes the system less efficient”

“We have a triage clinic now which doesn't require an MRI. Patients get a phone call from a spine nurse, and if potentially surgical, get an MRI… We phoned about 700 patients last year, and less than 10% were surgical”

“The vast majority of investigations are not indicated, or if indicated do not change management, resulting in inordinately long waiting times to obtain scan in those where they are indicated for management”

CONCLUSIONS

Most Canadian spine surgeons (84%) require imaging studies to accompany all spine-related referrals. MRI is the most common form of imaging required, but there is tremendous variability in this area. Furthermore, even with imaging studies, 53% of surgeons refuse more than 20% of all referrals without a consultation, and less than 20% of patients who are assessed are surgical candidates. The current system of referring patients with spine-related complaints for surgical assessment in Canada appears to generate a substantial amount of unnecessary imaging. There may be an opportunity to engage LBP clinicians to provide standardized screening and triaging of LBP patients referred for surgical assessment to improve efficiency and reduce use of advanced imaging.
3. Provincial Spine Imaging Utilization Data

We conducted a retrospective study using health administrative databases to examine patterns of spinal imaging utilization in 2 Canadian provinces (Manitoba and Ontario) between April 1, 2001 to March 31, 2011.

The analyses were of 2 types: (i) population-based analyses of all claims for spinal imaging procedures of interest amongst adults (age 18 years or older) residing in these 2 provinces; and (ii) cohort-based analyses focused on patterns of health services use amongst specific subpopulations of individuals, e.g., examination of health services use amongst patients who receive an MRI spine procedure in a given fiscal year.

In Manitoba, we used physician claims data available through Manitoba Health to identify spinal imaging procedures, the fees paid for these procedures, and other related health services (e.g., spine surgery or spine surgery consultation). We used national census data to obtain data regarding patients’ place of residence (e.g., urban vs rural) at the time a given spinal imaging procedure was performed and their neighbourhood income quintile.

In Ontario, we used health administrative database holdings at the Institute for Clinical Evaluative Sciences. Specifically, we used the Ontario Health Insurance Plan (OHIP) database to identify spinal imaging procedures, the fees paid for these procedures, and other related health services (e.g., spine surgery, spine surgery consultation). We used the Registered Persons Database (RPDB) and Statistics Canada census data to obtain data regarding patients’ place of residence at the time a given spinal imaging procedure was performed and their neighbourhood income quintile.

Using the above data sources, we conducted the following population-based analyses in each province (Manitoba and Ontario) from fiscal years 2001/02 to 2010/11:

1. Annual number of spine imaging procedures (spine x-ray, CT spine, MRI spine)
2. Annual rates of spine imaging utilization per 100,000 individuals
3. Annual costs (fees paid) of spine imaging procedures
4. Regional variation in population rates of spine imaging procedures
5. Variation in population rates of spine imaging procedures by socioeconomic status (neighbourhood income quintile)
6. Annual rates of repeated testing (using 7 day, 30 day, 6 month, and 1 year observation periods)

Using the above data sources, we conducted the following cohort-based analyses:

1. Patterns of lead up testing prior to MRI spine
2. Patterns of lead up testing prior to CT spine
3. Patterns of lead up testing prior to spine surgery consultation
4. Frequency of spine surgery after advanced spinal imaging (CT or MRI)
5. Frequency of spinal imaging after spine surgery
Key Findings

- Rates of MRI spine use increased markedly from 2001 to 2011

In Manitoba, population rates (age- and sex-adjusted) of MRI spine scanning increased by 350% from 2001 to 2011 (233 vs. 1,040 MRI spine scans per 100,000 individuals in 2001 vs 2011). Changes in population rates of spine x-ray (3.0% increase) and CT spine (30% increase) were much less dramatic over the same 10 year study period (Figure 1).

![Figure 1. Spine Imaging Rates (age-, sex-adjusted), Manitoba, 2001-2011.](image)

In Ontario, time trends were very similar, although in Ontario x-ray and CT rates saw a small decrease, rather than the small increase seen in Manitoba (Figure 2). Overall population rates of MRI spine use were similar in both provinces in 2010/2011 (approximately 1,000 per 100,000 individuals), but population rates of CT scanning were 61% higher in Manitoba compared to Ontario.

It is not possible to determine the appropriateness of testing at the individual patient level because physician claims data used for these analyses do not contain the clinical reason for the imaging request.
Spine x-ray accounts for approximately half of spine-related imaging costs

In Manitoba, the total cost of spinal imaging (x-ray, CT, MRI) was $2.2 million in 2001/2002. This increased to $5.0 million in 2010/2011, an increase of 127% over 10 years. Although spending increases were greatest for MRI spine over the 10 year study period, costs of spine x-ray were $2 million in 2010/2011, which still accounts for 40% of total spine imaging costs in Manitoba and is equal to the expenditures on MRI spine.

In Ontario, the total cost of spinal imaging (x-ray, CT, MRI) was $40.4 million in 2001/2002. This increased to $62.6 million in 2010/2011, an increase of 55% over 10 years. The costs of spine x-ray were $32.9 million in 2010/2011, accounting for 53% of total spine imaging costs in Ontario.

Compared to Ontario, the increase in spine imaging expenditures in Manitoba has been disproportionate to the increase in the number of procedures performed because of increases in unit cost over the 10 year study period in that province (i.e., fee schedule increases).
Differences in access to spinal imaging procedures according to socioeconomic status

We observed differences in population rates of spinal imaging procedures according to socioeconomic status, both in Manitoba and Ontario.

In Manitoba, the effect of socioeconomic status on spinal imaging utilization was different in urban compared to rural areas. In urban areas, higher neighbourhood income was associated with higher rates of MRI utilization, but lower rates of x-ray or CT spine utilization. In rural areas, utilization of spinal imaging was greater (regardless of imaging modality) amongst individuals with higher socioeconomic status (Figures 3, 4, 5).

Figure 3. Spine x-ray use, by neighbourhood income, Manitoba (2010/11)
Figure 4. CT spine use by neighbourhood income, Manitoba (2010/11)

Figure 5. MRI spine use by neighbourhood income, Manitoba (2010/11)
In Ontario, there was somewhat greater use of MRI spine for individuals living in higher income neighbourhoods, whereas rates of spine x-ray and CT spine utilization were lower. Rates of CT spine utilization were appreciably higher for individuals living in rural versus urban areas across all neighbourhood income quintiles (Figures 6, 7, 8).

Figure 6. Spine x-ray use by neighbourhood income, Ontario (2010/11)

Figure 7. CT spine use by neighbourhood income, Ontario (2010/11)
“Lead up” testing accounts for an important fraction of spine imaging

In Manitoba, approximately half (45.7%) of all patients who received an MRI spine scan in 2009/2010 had received another type of spine imaging procedure (spine x-ray or CT spine) in the 1 year before their MRI scan. Similarly, approximately half (42.4%) of all patients who received a CT spine scan in 2009/2010 had received a spine x-ray in the 1 year before their CT scan. These “lead up” tests account for 14% of all CT spine procedures, and for as much as 16% of all spine x-rays performed in Manitoba in 2009/2010. The same patterns were observed in Ontario.

Most patients received advanced imaging (CT or MRI spine) before a spine surgery consult, but few patients receiving advanced imaging ultimately receive surgery

In Manitoba, the majority (69%) of patients who saw a spine surgeon for a new consultation in 2009/2010 had received advanced imaging (CT or MRI spine) in the 2 years before the consultation. In contrast, for all patients receiving advanced imaging (CT or MRI spine) in 2005/2006, only 6.6% had undergone spine surgery by 2 years after the index imaging test (approximately 1 in every 15 patients scanned). The same patterns were observed in Ontario.
CONCLUSIONS

From 2001-2011, MRI spine utilization has increased markedly, but this has not reduced the use of spine x-ray or CT spine, and spine x-rays still currently account for nearly half (40%) of all spine imaging costs. “Lead up” testing prior to advanced spine imaging (CT or MRI), requirements for advanced imaging before surgical consultation, and low frequency of spine surgery after advanced imaging, are symptoms of fragmented care delivery for patients with spine-related complaints. Improved health system coordination for patients with spinal complaints may help to improve efficiency of spine imaging use. For example, diagnostic imaging pathways to reduce need for “lead up” testing with x-ray or CT spine before MRI, and alternative and innovative models of care which provide standardized assessment of patients with low back pain could streamline referral of appropriate patients for advanced spine imaging and surgical consultation.
References

2. Chies M. Alberta Health Services, annual diagnostic imaging statistical data. 2011; personal communication.
10. Emery, D, Forster, A, Shojania, K, Feasby, TE. The appropriateness of magnetic resonance imaging. Submitted for publication.


