

Imaging studies in patients with spinal pain

Practice audit evaluation of Choosing Wisely Canada recommendations

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Abstract

Objective To evaluate an a priori threshold for advanced imaging in patients with spinal pain.

Design Patients with spinal pain in any region for 6 to 52 weeks were assessed to determine if radiologic studies beyond x-ray scans were indicated, including magnetic resonance imaging (MRI), computed tomography (CT), and radionuclide bone scans. An a priori threshold was set before MRI, CT, or bone scans would be considered. Those who did not have MRI, CT, or bone scans ordered were followed for at least 1 year to determine if any of them went on to be diagnosed with a more serious spinal disorder (eg, infection, fracture, spondylitis, tumour, neurologic compression).

Setting Four large primary care clinics in Edmonton, Alta.

Participants A total of 1003 consecutively presenting patients with symptoms suspected to be related to the spine (for a duration of generally 6 to 52 weeks) who had not already undergone advanced imaging and did not have a diagnosis of nonbenign back pain.

Main outcome measures Number of cases of nonbenign spinal disorder in participants who underwent advanced imaging and participants who did not undergo advanced imaging (ie, did not have any red flags).

Results There were 399 women (39.8%) and 604 men (60.2%). The mean (SD) age of the group was 47.2 (14.6) years. The mean (SD) duration of symptoms was 15.1 (8.6) weeks. Of the 1003 participants, 110 met an a priori threshold for undergoing at least 1 of MRI, CT, or bone scan. In these 110 participants, there were newly diagnosed cases of radiculopathy (n = 12), including a case of cauda equina syndrome; spondyloarthropathy (n = 6); occult fracture (n = 2); solitary metastasis (n = 1); epidural lipomatosis (n = 1); osteomyelitis (n = 1), and retroperitoneal hematoma (n = 1), each of which was considered likely to be the cause of the patient's spinal symptoms. The remaining 893 participants were followed for at least 1 year and none showed evidence of a nonbenign cause of his or her spinal pain.

EDITOR'S KEY POINTS

- The Choosing Wisely Canada (CWC) recommendations indicate that imaging for lower back pain should be done only if red flags are present. This study aimed to determine the outcomes of patients with spinal pain who did not undergo advanced imaging unless they met an a priori threshold for testing in keeping with the spirit of the CWC recommendations.
- Of the 893 participants who did not have advanced imaging done and were followed for approximately 1 year, none had a nonbenign spinal disorder.
- Using red flags as the threshold for ordering advanced imaging yields a very low risk of missing any serious cases of spinal pain. The CWC recommendations regarding radiology testing in spinal pain are generally supported by this study; however, further study on red flags is needed to guide the use of advanced imaging in the most cost-effective manner.

Conclusion In the evaluation of nonspecific spinal pain and symptoms, setting and following an a priori threshold for ordering MRI, CT, or bone scans in the spirit of the current Choosing Wisely Canada recommendations has a very low risk of missing a case of a serious cause of back pain.

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Les examens d'imagerie pour les douleurs dorsales

Applique-t-on les recommandations de « Choisir avec soin Canada »?

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Résumé

Objectif Évaluer certaines conditions requises pour demander une imagerie spécialisée pour des patients souffrant de douleur dorsale.

Type d'étude Des patients présentant depuis 6 à 52 semaines des douleurs à un niveau quelconque de la colonne ont été évalués pour déterminer si des études radiologiques plus spécialisées qu'une simple radiographie étaient indiquées, ce qui inclut une imagerie par résonance magnétique (IRM), une tomodensitométrie (TDM) et une scintigraphie osseuse. Certaines conditions avaient été établies pour qu'on envisage de recourir à une IRM, à une TDM ou à une scintigraphie osseuse. Les patients qui n'ont eu aucun de ces derniers examens ont été suivis pendant au moins un an pour déterminer si certains ont développé un problème vertébral plus sévère (p. ex. infection, fracture, spondylite, tumeur, compression neurologique).

Contexte Quatre grandes cliniques de soins primaires à Edmonton, Alberta.

Participants Un total de 1003 patients consécutifs se plaignant de symptômes d'une durée de 6 à 52 semaines susceptibles d'être reliés à la colonne qui n'avaient pas déjà eu d'examen d'imagerie spécialisée et qui n'avaient pas reçu de diagnostic de douleur dorsale non bénigne.

Principaux paramètres à l'étude Nombre de cas de problèmes vertébraux non bénins chez les participants qui ont eu un examen d'imagerie spécialisée et chez ceux qui n'ont pas eu ce type d'examen (p. ex. ceux qui n'avaient pas de signaux d'alarme).

Résultats Le groupe comprenait 399 femmes (39,8%) et 604 hommes (60,2%). L'âge moyen (DS) était de 47,2 ans (14,6). La durée moyenne des symptômes était de 15,1 semaines (8,6). Sur les 1003 participants, 110 ont présenté des conditions suffisantes pour avoir au moins une IRM, une TDM ou une scintigraphie osseuse. Chez ces derniers, il y a eu 12 nouveaux diagnostics de radiculopathie, incluant un cas de syndrome de la queue de cheval; 6 cas de spondylarthropathie; 2 cas de fracture occulte; un cas de métastase solitaire; un cas de lipomatose épидurale; un cas d'ostéomyélite; et un cas d'hématome rétropéritonéal, chacune de ces pathologies était considérée susceptible d'avoir causé les maux de dos accusés par le patient. Les 893 participants qui restent ont été suivis pendant au moins un an; aucun n'a montré des signes qu'une cause non bénigne était responsable de ses douleurs vertébrales.

Conclusion En présence de douleurs et de symptômes dorsaux non spécifiques, le fait d'appliquer les recommandations de Choisir avec soin Canada concernant les conditions nécessaires pour demander une IRM, une TDM ou une scintigraphie osseuse présente très peu de risque de manquer un problème vertébral sérieux.

POINTS DE REPÈRE DU RÉDACTEUR

- Les recommandations de Choisir avec soin Canada (CSC) stipulent qu'une imagerie pour une douleur lombaire devrait être demandée seulement s'il y a des signaux d'alarme. Cette étude voulait vérifier les issues de patients souffrant de douleurs dorsales qui n'avaient pas eu d'imagerie spécialisée parce que, suivant les recommandations de CSC, il n'y avait pas de raison de le faire.

- Après un suivi d'environ un an, aucun des 893 participants qui n'avaient pas eu d'imagerie spécialisée n'avait un problème sérieux.

- Le fait d'utiliser la présence de signaux d'alarme comme condition pour demander une imagerie spécialisée entraîne très peu de risque de manquer un problème grave de douleur dorsale. Cette étude supporte les recommandations de CSC en ce qui concerne les examens radiologiques pour les douleurs dorsales. Il faudra toutefois plus d'études sur les signaux d'alarme si on veut utiliser les examens d'imagerie spécialisée de la façon la plus efficace financièrement.

Cet article a fait l'objet d'une révision par des pairs.
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Choosing Wisely Canada (CWC) is a project concerned with optimizing value in medical care, given that health care costs are increasing and that there is evidence of waste and harm associated with overuse of investigations.¹⁻³ The College of Family Physicians of Canada,⁴ the Canadian Association of Radiologists,⁵ and the Canadian Rheumatology Association⁶ have each contributed imaging recommendations for the CWC campaign. With regard to imaging for acute low back pain, the College of Family Physicians of Canada and the Canadian Association of Radiologists recommend that one should not “do imaging for lower-back pain unless red flags are present.”^{4,5} With regard to radionuclide scans for spinal and limb pain, the Canadian Rheumatology Association states the following: “Do not perform whole body bone scans (e.g., scintigraphy) for diagnostic screening for peripheral and axial arthritis in the adult population.”⁶ Indeed, it has been shown that bone scans have little or no clinical usefulness in this setting.⁷

Advanced imaging (here defined as magnetic resonance imaging [MRI], computed tomography [CT], or bone scans) is often viewed as having little clinical usefulness in the evaluation of spinal pain without specific clinical features to indicate a nonbenign cause. Here, *nonbenign* refers to spinal disorders with objective lesions beyond age-related changes; many of these disorders require specific interventions. Examples of these nonbenign disorders include malignancy, fracture, nerve root compression, spinal stenosis, and infection. Most spinal pain is not accompanied by objective pathology and is often labeled as mechanical pain, “muscular” pain, myofascial pain, neuropathic pain, etc. However, advanced imaging is often ordered for these patients for fear of missing a serious disorder. Researchers have compared the cost-effectiveness of MRI with a conventional cancer-screening program using history, physical examination, erythrocyte sedimentation rate, and radiography for detecting spine malignancies among patients seen in primary care clinics. They found that MRI cost 10 times as much as the conventional strategy and the cost of finding each extra patient with a spine malignancy in the MRI group exceeded \$625 000 (US).⁸ Further, there is the well-recognized (at least in the literature) problem that MRI, CT, and bone scans are all associated with a high prevalence of nonspecific findings among asymptomatic individuals.⁹⁻²⁴ It is normal for healthy individuals, beginning in the third decade of life, to have an increasing prevalence of degenerative changes in all parts of the spine, with spondylosis, minor degrees of vertebral slippage, and foraminal stenosis present in asymptomatic participants.²⁴ Thus, these findings do not improve the diagnostic process. In the absence of clinically correlated neurologic findings, the radiologic

findings are not associated with the presence of spinal pain.²⁴ However, this knowledge has not prevented patients with nonspecific spinal pain and normal changes seen on MRI from having spinal surgery. For example, it has been shown that a higher rate of spinal surgeries for low back pain occurs where there is a greater use of advanced imaging technology; however, the outcomes for patients with more advanced imaging do not improve.²⁵ Indeed, randomized clinical trials have shown that among patients without red flags (ie, clinical signs and symptoms indicating serious underlying conditions), early imaging does not improve patient outcomes compared with conservative treatment without imaging.²⁶⁻²⁸

However, there have been no studies to determine what would occur if the recommendation not to order MRI, CT, or bone scans in the absence of red flags were put into practice. What would be the outcome for patients who present with, for example, spinal pain with or without other nonspecific symptoms but are not investigated with any of these scans? How many cases of serious spinal disorders would be missed? The goal of this study was to determine the outcomes of patients with subacute and chronic spinal pain, or with other clinical concerns about the possibility of a spinal disorder, but who did not undergo advanced imaging (MRI, CT, or bone scans) unless they met an a priori threshold for testing in keeping with the spirit of the CWC recommendations. This approach has been shown to be useful in avoiding wasteful serologic testing in patients with chronic limb pain.²⁹

METHODS

Participants and setting

During a period of 30 months in 2012 to 2014, patients from 4 large primary care clinics in Edmonton, Alta, were referred to the author for assessment of spinal pain with or without limb pain, stiffness, or other concerns (eg, limb numbness or weakness) suggesting the possibility of a spinal disorder. These clinics serve a catchment area of 1.5 million persons, with a large and varied clinical spectrum of patients. Patients were referred to the author, who acted as a consultant for the assessment of musculoskeletal and rheumatic diseases. In addition, the setting of the study was such that primary care physicians routinely referred patients with musculoskeletal symptoms that persisted beyond 6 weeks, and for which no inciting and obvious cause was evident (ie, nontraumatic symptoms). Thus, they referred consecutively presenting patients with symptoms (for a duration of generally 6 to 52 weeks) suspected to be related to the spine in a dedicated fashion (ie, to reduce referral bias, minimal selection criteria were applied by the referring physicians, and they ordered no advanced

radiology). The period of 6 to 52 weeks was chosen because this duration increases the likelihood of a non-benign source of spinal pain, and advanced imaging is more likely to be considered for persistent spinal pain if initial treatment efforts were not effective.

Procedure

Evaluation. Each referred patient provided a history and underwent a physical examination, as well as additional imaging and investigations as deemed appropriate by the author. The author was provided with additional history and had access (through electronic medical records) to all of the primary care physician charts and investigations to date. The author made a preliminary diagnosis, usually on the first assessment. During the initial evaluation the author determined if red flags were present and if advanced imaging was warranted. If the patient's status changed while he or she was being treated, on subsequent visits the author again determined if the patient met the a priori threshold for advanced imaging. Patients were permitted to undergo x-ray scans or other imaging studies, such as ultrasound of the abdomen or pelvis, in cases in which gastrointestinal, aortic, or pelvic disorders were suspected. In many cases, this occurred before referral to the author.

A priori threshold for advanced imaging. To determine an a priori threshold, one considers the literature describing traditional red flags; however, reviews indicate that many of these red flags are not clearly associated with nonbenign causes of low back pain, and it is not always clear whether the duration of spinal pain requires a different set of red flags for consideration.^{30,31} It was nevertheless deemed appropriate to include a traditional and fairly extensive list of red flags, as this creates a lower threshold that is unlikely to miss cases of nonbenign spinal disorders (ie, creates high sensitivity). If this lower threshold still led to a low rate of advanced imaging, it would thus prove to be cost effective (ie, it would limit testing but not miss serious spinal disorders). Participants who had at least 1 of the red flags in **Box 1** thus underwent 1 or more advanced imaging studies. The remaining participants had no advanced imaging unless they reported having developed 1 of the red flags at a subsequent visit with the author or the referring physician.

Outcome measure

The outcome of interest was the number of cases of nonbenign spinal disorders in participants who had advanced imaging and those who did not have advanced imaging (ie, did not have any red flags). Again, in this study, *nonbenign spinal disorder* is spinal pain not associated with nerve root or spinal cord compression (which

might or might not require surgery), infection, fracture, malignancy, or spondylitis (eg, ankylosing spondylitis). To determine the outcome of interest, each participant was given a provisional diagnosis, with treatment and follow-up as needed, and was also reviewed at approximately 1 year. The author aimed to follow up with participants at repeat visits for their spinal pain or for other conditions (ie, their spinal pain had resolved but they were referred with other musculoskeletal disorders for which the author was the only consultant used by the clinics involved in this study), but he also had access to each patient's electronic medical record, containing all medication lists, investigations, and often consultant

Box 1. The a priori criteria for ordering bone scan, MRI, or CT in a patient presenting with spinal pain of nontraumatic origin: Any 1 of these red flags prompted 1 or more advanced imaging techniques in 110 patients.

Relevant history

- Cancer
- Recent infection or risk of tuberculosis
- Intravenous drug abuse
- HIV infection or immunosuppressed state
- Diabetes mellitus
- Age >65 y
- Previous spinal surgery
- Surgical intervention or procedure near the spinal region of interest

Relevant symptoms

- Unexplained weight loss
- Anorexia
- Bowel or bladder incontinence
- Symptoms of neurogenic claudication
- Fever or chills

Relevant physical examination findings

- Objective muscle weakness or wasting
- Absent reflexes or hyperreflexia
- Dermatomal sensory loss
- Sensation is lost below a specific spinal level
- Pyramidal tract signs

Suspected spondylitis (inflammatory back pain)

- Back or buttock pain with at least 1 of the following:
 - morning stiffness lasting longer than 1 h;
 - enthesitis;
 - uveitis;
 - dactylitis;
 - psoriasis;
 - Crohn disease or ulcerative colitis;
 - excellent response to nonsteroidal anti-inflammatory drugs;
 - family history of spondyloarthritis;
 - positive test results for human leukocyte antigen B27; or
 - elevated erythrocyte sedimentation rate or C-reactive protein level

CT—computed tomography, MRI—magnetic resonance imaging.

reports regardless of where the patient had ongoing care. For those participants who could not be followed clinically, the author was able to discern if there were other interventions (eg, surgery, antibiotics, radiation, chemotherapy) or consultant reports consistent with a diagnosis of nonbenign spinal disorder. Where no such evidence existed, the participant was deemed to have a benign spinal disorder. For participants lost to follow-up, referring physicians were also able to confirm whether the participants had ongoing symptoms and to describe their current treatment. If the participants did not have ongoing symptoms, and if current treatment or interventions did not indicate any of the above nonbenign spinal disorders, they were deemed likely to have a benign source of spinal pain. In some cases, longer periods of follow-up were needed (eg, some patients who were initially lost to follow-up had left the geographic region but returned the following year).

Imaging

Advanced imaging included radionuclide (technetium 99) scans and CT, with or without contrast. Numerous radiologic sites with different imaging protocols were used, but the protocols for bone scans were nearly identical at each site. For patients suspected to have spondyloarthropathy, the MRI protocols included short τ inversion recovery and T1-weighted imaging.

Exclusion criteria

Participants were excluded if they were younger than 18 years of age, or if they had a known nonbenign spinal disorder. They were also excluded if they had already undergone advanced imaging for their current spinal pain. Patients who had previous spinal surgery were not excluded, as they were at risk of recurrence.

Data collection and analysis

Data were gathered on age, sex, and duration of symptoms for which the referral was made, the number of participants who met the a priori threshold for advanced imaging, and the number of participants in each group (those who had had advanced imaging and those who had not) who had a confirmed or probable case of nonbenign spinal disorder.

Descriptive statistics were calculated for age, sex, and duration of symptoms for which the referral was made. The proportion of participants in each group with nonbenign spinal pain was calculated.

Sample size calculation

There are no previous studies of this type for comparison. However, the author considered it important to ascertain if the proportion of participants with a missed diagnosis using this approach was less than 2 in 1000, a relatively low (albeit arbitrarily set) risk of missing a

case of nonbenign spinal disorder on first assessment. The author aimed for a sample size such that the upper limit of the estimate of the CI for the proportion of those having a diagnosis of nonbenign spinal disorder on follow-up (but who were initially missed owing to lack of advanced imaging) would be approximately 2% with 95% confidence. The sample size was calculated for a 95% CI about a proportion where one assumed that the upper limit of the CI in a binomial distribution would be approximately 2%. A sample of 1000 participants was required to achieve these values. A convenience sample of more than 2 years of referrals was used to ensure at least this number of participants.

Ethics

Ethics approval for this study as a practice audit was obtained from the Health Research Ethics Board of Alberta.

RESULTS

Recruitment

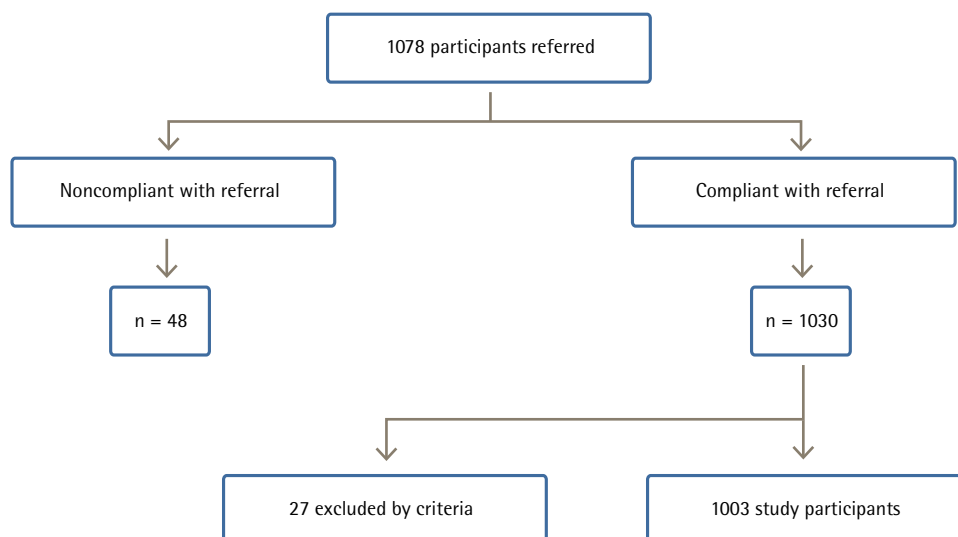
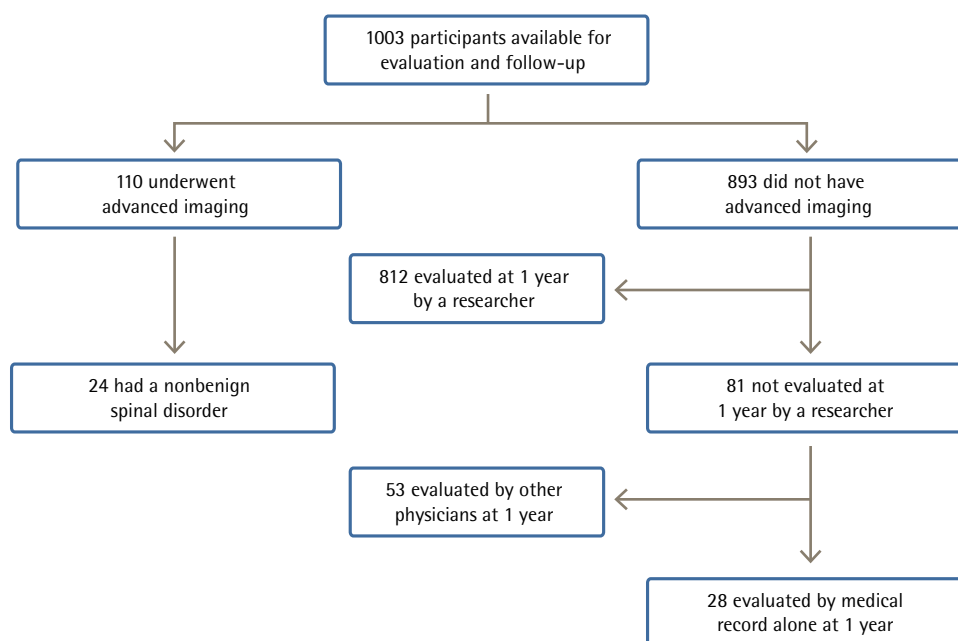
A total of 1078 participants were initially referred, but 66 patients declined the referral and thus were not immediately evaluated (**Figure 1**). However, 18 of these 66 patients were seen in the subsequent weeks or months, leaving 48 participants who declined referral and were not evaluated. An additional 27 participants were excluded: 16 because they had already undergone advanced imaging, without a diagnosis of nonbenign back pain; 5 because of recent traumatic or osteoporotic fractures documented on x-ray scan; 3 had known spondyloarthropathy; 1 had a known metastatic malignancy; 1 had known osteomyelitis under treatment; and 1 had a known aortic aneurysm and was awaiting surgery. Thus, the sample population was the 1003 remaining participants referred to and evaluated by the author.

Participant demographic characteristics

Among the 1003 participants that were evaluated and considered using the a priori threshold for ordering advanced imaging, there were 399 women (39.8%) and 604 men (60.2%). The mean (SD) age of the group was 47.2 (14.6) years (range 18 to 92 years). The mean (SD) duration of symptoms was 15.1 (8.6) weeks (range 6 to 54 weeks).

Advanced imaging and follow-up

In the sample of 1003 participants, 657 had undergone x-ray imaging; 509 of these had done so before consultation with the author. Of the 1003 participants, 102 initially met the a priori threshold for ordering advanced imaging, and an additional 8 participants met the a priori threshold for ordering advanced imaging on follow-up

Figure 1. Recruitment of participants**Figure 2. Participant follow-up**

(ie, they developed other symptoms that met the criteria for red flags on follow-up). This led to a total of 110 participants who had advanced imaging (**Figure 2**). Among these 110 participants, there were 24 newly diagnosed cases of nonbenign back pain following assessment and advanced imaging results. These included 12 cases of radiculopathy (including case of 1 cauda equina

syndrome) owing to nerve root or spinal cord compression (correlating with clinical neurologic findings), 6 cases of spondyloarthropathy, 2 cases of occult fracture (not seen on x-ray imaging), 1 case of solitary metastasis, 1 case of osteomyelitis, 1 case of retroperitoneal hematoma, and 1 case of epidural lipomatosis. Of the 1003 participants evaluated, 842 had a diagnosis made

on the first visit, 90 required 2 visits, and 71 required more than 2 visits (range 3 to 5).

Of the 893 participants who did not have advanced imaging done and were followed for approximately 1 year (range 11 to 20 months), none showed evidence of a nonbenign spinal disorder. The follow-up consisted of 812 of 893 participants being evaluated by the author, with 81 participants being lost to clinical follow-up with the author. However, follow-up via family physicians confirmed that 53 of the 81 participants had symptoms that resolved in less than 1 year. There were 7 patients completely lost to follow-up, but clinical chart review at 3 to 6 months revealed resolution of symptoms of spinal pain; the electronic medical records of these patients, as well those of the remaining 21 participants, did not report any diagnosis or intervention for nonbenign spinal pain. In total, on follow-up with the author or the referring physicians, 421 of 893 participants had symptom resolution, while the remainder had recurrent or chronic symptoms.

The diagnoses in the 893 participants who were not initially evaluated by advanced imaging included mechanical spinal pain and fibromyalgia. There were no differences in mean age, sex distribution, or mean symptom duration between those who met the a priori advanced imaging criteria and those who did not.

The number of red flags among the 110 participants who underwent advanced imaging are shown in **Figure 3**. The range of red flags was from 1 to 6.

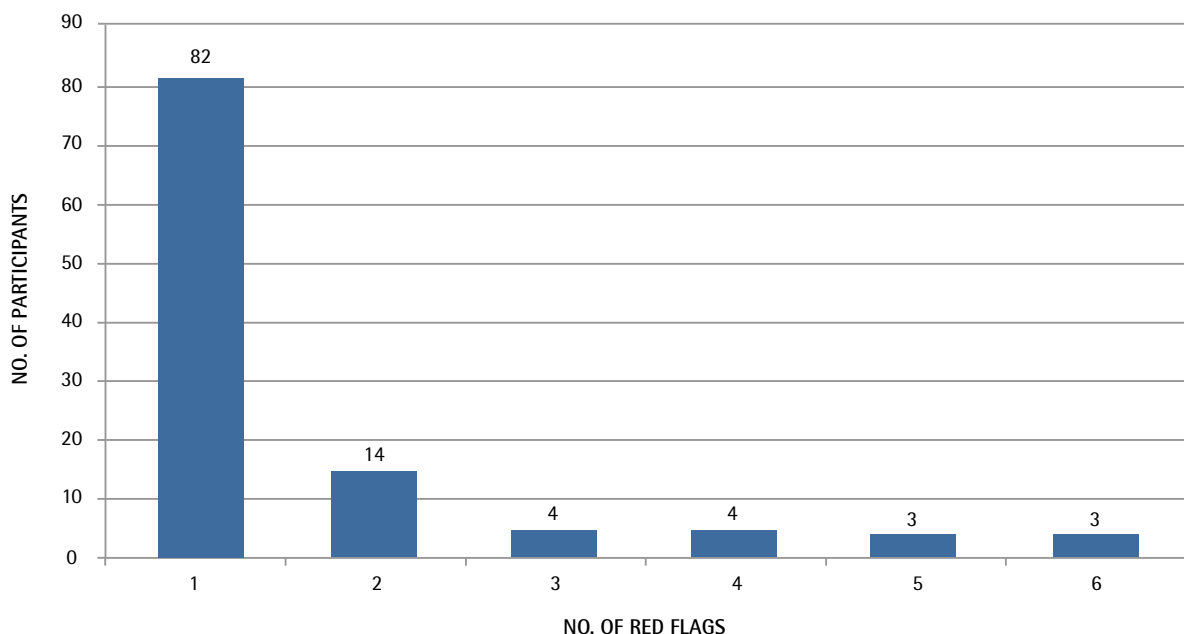
The binomial, 1-tailed 95% CI about the proportion of 0 cases of nonbenign spinal disorder missed out of 1003

participants using the a priori threshold for advanced imaging was 0.002, or 2 per 1000.

Advanced imaging outside the study protocol

It should be noted that 337 patients who did not initially undergo advanced imaging went on to have MRI (in most cases), CT, or bone scans despite being advised that they did not need them. They saw other physicians or persisted in having these scans with their family physicians and some ordered and paid for the scans through a private system. At least 77 patients paid for them privately. Others had to wait an average of 11 months for their scans, as they were not deemed urgent. A total of 44 patients had MRI scans, 108 had CT scans, and 116 had bone scans. There were 44 patients who had both CT scans and MRI. There were 25 patients who had all 3 types of scans. The author was able to obtain the scan reports, the consultants' reports on the scans, and patients' self-reports of the scans (in some cases private MRI scans were not available on the provincial electronic system). None of the reports indicated a diagnosis of nonbenign spinal disorder. Instead, patients were told or believed they had "arthritis of the spine," "squashed disks," "degenerating spines," and "bone-on-bone disease wear and tear." In other words, the scan findings were those of degenerative changes. The scan findings did not alter management in any cases and patients were prescribed analgesics. None had surgery. Many patients (at least 36) were referred to orthopedic surgeons,

Figure 3. Distribution of red flags among participants who underwent advanced imaging: $N = 110$.



neurosurgeons, and neurology specialists, and were advised not to have surgery.

DISCUSSION

This practice audit shows that the risk of missing a diagnosis of nonbenign spinal disorder is very low when one follows the CWC recommendations that indicate not to order advanced imaging unless there are red flags present. In this study, the author chose a relatively low threshold for ordering advanced imaging given the lack of good data concerning how well traditionally held red flags predict a nonbenign source of spinal pain. This nevertheless allowed for an a priori threshold for ordering advanced imaging such that only 11% of participants with persistent spinal pain required imaging. Despite the fact that this approach did not miss any cases of nonbenign spinal disorder, 337 of 893 patients who were initially told they did not need advanced imaging went on to have it anyway. The costs of these unnecessary (in terms of diagnostic usefulness) scans is about \$400 000, which includes the cost of additional physician visits associated with this testing. Dividing this figure among 893 participants as the group at risk of unnecessary testing (because they have no red flags) results in a cost of nearly \$450 per person.


Although this study was not designed to determine the sensitivity and specificity of individual red flags or combinations of red flags, it is noteworthy that some traditionally held red flags were not particularly helpful. For example, 47 participants had “age older than 65 years” as their only red flag. None of these participants had an eventual diagnosis of nonbenign spinal disorder. In that sense, additional studies are much needed to determine the optimal set of red flags for various clinical settings. However, the approach described in this study was both liberal and effective (ie, it was a low enough threshold to not miss serious spinal disorders, but it was high enough that wasteful testing was avoided).

Limitations

First, it is possible that, at the outset, the referring primary care physicians excluded some patients with advanced imaging who would not have met red flag criteria and yet had a nonbenign spinal disorder. This seems unlikely given that there was a concerted effort to make consecutive referrals before imaging, and certainly does not change that fact that the author was able to apply the a priori threshold without missing any cases of nonbenign spinal pain. Another limitation is that there might have been some cases of very mild spondyloarthropathy that the author missed. None of the patients in the “nonimaging” group received known drug therapies for spondyloarthropathy other than

nonsteroidal anti-inflammatory drugs; was labeled as having spondyloarthropathy by other physicians; or had symptoms that worsened over time. Still, it is possible that this study missed patients with mild cases of spondyloarthropathy who responded very well to nonsteroidal anti-inflammatory drugs, exercised, and had few or no symptoms. In addition, some cases had to be reviewed through the electronic medical record alone. Care that took place out of the province is not reflected in the results. Finally, it could be that the author is more skilled than primary care physicians are in determining whether a patient has red flags; however, when one examines the list in **Box 1**, it can be readily determined whether red flags are present, as most of them are based on history and symptoms, and thus a special skill set is not required.

Conclusion

This practice audit shows that the current practice of using advanced imaging in spinal pain without the presence of red flags is wasteful and can be improved. While one could argue that the negative predictive value of a normal MRI, for example, increases the confidence of the practitioner that the patient does not have a serious spinal disorder, at a cost of \$1000 or more, ordering this many MRI scans in 893 participants to achieve the goal of not having missed a single case is not the most reasonable approach. As a screening tool, advanced imaging is too expensive. Thus, the CWC recommendations concerning radiology testing in spinal pain are generally supported, but more discussion and further study on red flags are needed to guide the use of advanced imaging in the most cost-effective manner. 

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Competing interests

None declared

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