Impact of delisting diagnostic imaging studies for uncomplicated back pain in Ontario

Benjamin Fine[1,3], Susan E. Schultz[2], Lawrence M. White[1,3], David Henry[2,4]

[1] Department of Medical Imaging, University of Toronto

[2] Institute for Clinical Evaluative Sciences, Toronto

[3] Joint Department of Medical Imaging, University Health Network / Mount Sinai Hospital / Women's College Hospital, Toronto

[4] Dalla Lana School of Public Health and Institute of Health Policy Management and Evaluation, University of Toronto, Toronto

ABSTRACT

Background

Uncomplicated low back pain is common. Imaging tests rarely identify a treatable cause and lead to unnecessary healthcare costs, radiation exposure and possible over-diagnosis. In 2012 the Ontario government announced withdrawal of insurance coverage for imaging tests for uncomplicated low back pain in Ontario.

Objectives

To measure the impact of the coverage restriction on the ordering of lumbar spine imaging tests in Ontario by family practitioners and specialists

Methods

We compared the numbers of imaging tests ordered by family practitioners and specialists in the 3 years before and after the policy change in April 2012, linking all claims for lumbar spine X-rays, single segment MRI of the spine and CT of the lumbar spine in the Ontario Health Insurance Program (OHIP) with a physician data-base at the Institute for Clinical Evaluative Sciences. Descriptive statistics were used to summarise triennial and annual numbers of the three imaging tests and rates of ordering per physician. We used segmented regression analysis of interrupted time series data to assess and compare changes in rates of monthly test ordering by specialists and family physicians before and after the policy change.

Results

The annual numbers of lumbar X-ray exams fell from 405200 in the 3 years prior to the policy change to 318129 in the 3 years after it. Lumbar CT examinations fell from 81285 to 64907/year, while single segment MRIs rose slightly from 157801 to 165070/year. In the case of family practitioners (FP), ordering of lumbar spine X-rays dropped by 0.81 tests/month/FP (P<.0.0001) after the restriction, from an already declining baseline. Thereafter, ordering remained stable at 1.5 to 2.0 tests/month/FP below baseline. Ordering of lumbar spine X-rays by specialists (SP) was lower (1.0/month/SP) and unaffected by the restriction. Ordering of lumbar spine CT by FP fell prior to the restriction, from 0.75 to 0.6 tests/month/FP. The intervention resulted in a further fall of 0.1 test/month/FP (P<0.0001), followed by a stable ordering rate of 0.5 to 0.6/month/FP. The

restriction had little impact on ordering of spine CT examinations by SP. Ordering of limited spine MRI by FP rose from around 0.7 to 1.0 tests/month/FP in the 3 years prior to the restriction, fell by 0.18/month/FP (P<0.0001) shortly after the restriction and started to rise again at a lower rate than previously. Ordering of limited spine MRI by SP, which had been stable at around 1/month/SP, fell by 0.1/month/SP (P=0.0009) shortly after the restriction and then climbed back to the pre-intervention levels.

Conclusions

Overall, the restriction in coverage caused a larger decrease in the ordering practices of family practitioners than specialists and a larger and more sustained reduction in the use of more widely accessible imaging tests (lumbar spine X-rays and spine CT) than MRI.

Introduction

Doctors frequently order imaging tests for patients with uncomplicated back pain, despite evidence that imaging does not improve the quality or outcomes of care in many settings (1, 2). Over-use of imaging tests adds to health care costs and may expose patients to ionising radiation with little prospect of benefit and occasional harm (3, 4). Clinical guidelines (5-8), including 'Choosing Wisely' campaigns in Canada, and around the world, have identified imaging for uncomplicated low back pain, where no clinical 'red flags' are present (trauma, infection, radiculopathy, malignancy), as a low value intervention that should not be performed (9-11). Despite this, conventional radiographs (X-rays), magnetic resonance imaging and computed tomography of the spine continue to be performed in large numbers (3, 12-14).

Changing health professional practice is not simple. There are a wide range of possible interventions and systematic reviews have documented variable results (15). Some interventions, such as clinical decision support systems, preauthorization and targeted reminders have shown short term success in reducing low back pain imaging utilization, while others such as guideline dissemination have not (15-17).

One option available to payers, regulating access to imaging tests through changes in reimbursement (17, 18), has not been systematically evaluated at a population level. In May 2012, the Government of Ontario removed reimbursement payment coverage for diagnostic imaging for uncomplicated back pain (19). This study was designed to evaluate the impact of this intervention on the ordering of imaging tests for low back pain in Ontario.

Methods

In April 2012 the Government of Ontario announced a modification to the Schedule of Benefits for Physician Services under the Health Insurance Act (Box 1)(19, 20).

Box 1

Computed Tomography (CT) and/or Magnetic Resonance Imaging (MRI) for Chronic Low Back Pain:

X-ray, CT or MRI studies of the lumbar spine are only eligible for payment when rendered for low back pain with suspected or known pathology.
Examples include, but are not limited to: infection, tumour, osteoporosis, ankylosing spondylitis, fracture, inflammatory process, radicular syndrome, and cauda equine syndrome.

We assessed the impact of the policy change by comparing the numbers of imaging tests ordered for uncomplicated low back pain (LBP) before and after the restriction. We used the number of imaging tests ordered for other (non-LBP) indications as a control.

All medically-necessary procedures (including imaging studies) in Ontario are funded by the Ontario Health Insurance Plan (OHIP). We examined the OHIP schedule of physician benefits to identify billing codes most likely to be ordered by clinicians for the investigation of LBP. Based on the available billing codes, we selected lumbar spine radiography, lumbar spine CT and single segment spine MRI as the most relevant investigations. We retrieved data on the numbers of these tests that were reimbursed between January 1, 2009 and March 31, 2015 by OHIP. We used the billing data held at the Institute for Clinical Evaluative Sciences (ICES), which were linked to information on the ordering physician, including specialty. We included all physicians in our analyses, divided into two groups: family physicians (FPs) and specialists (SP). To create a control series of imaging tests that should not have been affected by the policy change, we retrieved data on several non LBP-related imaging studies: brain CT, brain MRI and whole spine MRI. We decided to relate the number of imaging tests to the number of physicians, rather than the population covered, as the intervention being assessed was designed to change physician practice. By calculating tests ordered on a per-physician basis we were able to compare the intervention's impact on the two physician groups.

Overall test ordering was analysed for the three imaging modalities during the three years before and after the policy change (April 2012). We compared ordering by the different physician groups

on an annual basis before and after the policy change. We used segmented regression analysis of interrupted time series data to assess changes in monthly test ordering separately by specialists and family physicians over 72 consecutive months. We calculated monthly ordering rates for specialists and FPs by dividing the total number of tests ordered per month by each group by the total number of physicians who ordered the test at least once during that calendar year. This method takes into account months where a physician ordered no tests of a given type. We used the SAS Autoreg procedure to test for autocorrelation via the Durbin-Watson (D-W) statistic. Correction for autocorrelation was performed where the D-W statistic was significant. The outputs of the analyses were: secular trends, autocorrelation, the pre-post change in ordering rates and the pre and post regressions slopes.

RESULTS

Triennial numbers of imaging tests ordered by all physicians

The average annual numbers of tests ordered by all physicians in the three years before and after the policy change are presented in Figure 1. Following the restriction there were declines in the numbers of lumbar spine X-rays and CT examinations, but not single segment MRIs, where numbers rose slightly. In comparison, annual numbers of head CT examinations fell marginally, while head MRI examinations and whole spine MRI testing rose.

Annual numbers of imaging tests by physician groups: Lumbar X-rays

Family Physicians (FP)

In the first year after the policy change, there was a reduction of 28.7% in the number of lumbar X-rays ordered, compared to the average ordered annually during the baseline period (2009/10 to 2011/12) (Table 1). The total numbers of X-rays ordered in each year increased by 11.1% in 2013/14 and a further 1.3% in 2014/15, but remained below the baseline rates. When compared to the baseline period, the average numbers of lumbar X-rays ordered annually by each FP fell by a proportionally greater amount (-31.9%) in 2012/13, and increased less in subsequent years than the total number of tests ordered annually. The differences between the changes in overall test ordering rates and the per physician ordering rates were due to an increase in the number of FPs ordering lumbar x-rays in 2012/13 and 2013/14, compared to the baseline period.

Specialists (SP)

Specialists ordered fewer lumbar spine X-rays than FPs, both before and after the policy change, in part due to the smaller number of specialists ordering tests and also reflective of lower per-physician ordering rates of SPs compared to FPs (Table 1). The fall in test ordering in the first year after the policy change was small (6% fall in total X-rays ordered annually and 3.9% fall in tests ordered per SP), with a small rebound, which essentially took the number of tests back to their pre-intervention levels (-0.3% difference) at 3 years after policy change.

Annual numbers of imaging tests: Single segment spine MRI

Family Physicians

In the year following the policy change (2012/13), there was a small proportional fall (5.7%) in the per-FP ordering rate for spine MRIs (9.9 pre v 9.4 post [tests/physician/month]), compared with the baseline period (2009/10 to 2011/12) (Table 1). However, the total number of single segment spine MRIs ordered by FPs rose by 0.8%, the result of a 7.2% rise in the number of FPs ordering this investigation. In 2013/14, and to a lesser extent in 2014/15, there were increases in both the number of FPs ordering spine MRI and the rate of ordering per FP, resulting in annual numbers of tests ordered 3 years after the policy change of 15.7% above baseline.

Specialists

At baseline, the (average annual) number of single segment MRIs ordered by SPs was approximately half the number ordered by FPs (Table 1). However, the ordering rate per physician group was approximately 10-20% higher among SP compared with FPs. The apparent impact of the policy change was similar to what was seen with FPs: a transient small decline in the ordering rate per SP in 2012/13 (-8.0%) against a background of increasing numbers of SPs ordering tests resulting in an increase in the total annual numbers of tests ordered 2012/13 through 2014/15 (10.3% above baseline).

Annual numbers of imaging tests: Spine CT

Family physicians

Spine CT use declined rapidly in the year after the restriction. In 2012/13 the number of FPs ordering the test and the number of tests ordered per FP dropped by 7.5% and 22.9% respectively, resulting in an overall decrease in the number of spine CTs of 28.7% compared with baseline (Table 1). Although there was a small rebound increase in number of CTs ordered by FPs in 2013/14 (8.1%), this was not sustained in 2014/15 (-4.1%) and rates remained below the pre-intervention level (-26%).

Specialists

Both before and after the policy change, SPs as a group ordered about one third of the annual average number of spine CTs compared with FPs. The baseline test ordering rate per SP was slightly lower than that of FPs (Table 1). The apparent impact of the policy change was substantially less than seen in FPs in 2012/13: a 9.1% fall in annual CTs ordered, a 7.7% fall in CTs ordered per SP and a 1.5% fall in the number of SP ordering the test. These numbers all increased in 2013/14 although this trend was not sustained in 2014/15 (Table 1). In contrast to FP use, after three years, annual average spine CT ordered by SPs was slightly (2.7%) higher than baseline average.

Time series analyses: monthly ordering data

The monthly ordering data on a per physician basis for the three imaging modalities, over 72 consecutive months, are presented in Figures 2 to 4 and the outputs from the interrupted time series (ITS) analyses are presented in Table 2. The vertical lines in the figures denote the start of the period of the policy change. The data for the first 2 months after this date have been omitted from the analyses to improve the stability of the estimates of the slopes before and after implementation.

Lumbar spine X-rays

Visual inspection of the curves suggests a fairly stable level of ordering of lumbar spine X-rays by SPs, with no discernable effect of the policy change (Fig 2). This is reflected in the interrupted time series analyses (ITS), which show no significant slope either before or after the intervention, and no evidence of a significant fall in ordering as a result of the intervention (Table 2). In contrast, there was a small (-0.006 tests/physician/month), borderline significant (P=0.047) negative slope

in test ordering by FPs prior to the policy change, a step decline of around 0.8 test/physician/month (P <0.0001) immediately after the intervention, followed by a small but statistically significant rebound increase in test ordering (0.010 tests/physician/month, p=.0032),. Visually, this appears to be levelling off by the end of the follow-up period (Fig 2). As can be seen from Fig 2, the test ordering rates by FPs 3 years following policy change remained approximately 0.5 tests/month/FP below baseline levels.

Single segment spine MRI

The ITS analyses showed a stable baseline ordering rate by SPs and a small (0.007 tests / physician / month) but statistically significant (P<0.0001) upward trend amongst FPs prior to the policy change (Fig 3 and Table 2). A steep decrease in test ordering was seen at the time of the policy change for FPs (-0.17/physician/month) and for SPs (-0.10 tests/physician/month) (both were statistically significant, P < 0.0001 and p = 0.0009, respectively)). After the intervention, the MRI utilization rate by FPs increased, but at a lower rate than prior to the intervention (0.003 tests/physician/month, p=0.0002); meanwhile, specialist ordering rate was higher than baseline post intervention (0.002 tests/physician/month, p=0.023).

Spine CT

The ITS analysis revealed small but statistically significant negative slopes in the rates of test ordering by both SPs (-0.0012 tests/physician/month, p = 0.0007) and FPs (-0.0028 tests/physician/month, p<0.0001) before the policy change. Family physicians had higher ordering rates than SPs and a downward slope that was approximately double that seen in specialists, leading to convergence in the rates prior to the policy change (Table 2 and Fig 4). The policy change resulted in a step change in test ordering by FPs of 0.10 test/physician/month (p<0.0001), but no significant fall among SPs . Post intervention ordering rates by both SPs and FPs in the 2 years thereafter were stable, small and similar (Table 2).

DISCUSSION

There is general agreement that imaging for uncomplicated low back pain (without clinical indicators of trauma, infection, malignancy or neurological complications) is unlikely to reveal a

treatable cause, likely won't alter patient management and may reveal incidental findings (in the case of MRI and CT) that can lead to further unnecessary and possibly invasive tests (3, 5).

The Ontario government's intervention in 2012 had a number of observed effects. These varied by physician specialty and the individual imaging test. The most marked and most sustained change was the reduction in ordering of lumbar spine X-rays by family physicians. The policy change had no measurable effect on ordering of X-rays by SPs, whose pre-intervention ordering rates were less than half those of FPs. The reduction in ordering of X-rays by FPs is not trivial. Radiography represents over half of Ontario's spine imaging costs (21). So, the reduction we documented here represents a notable cost decrease. Radiography is also a source of ionizing radiation; Ontarians cumulatively avoided the equivalent of a single person's natural radiation exposure over 40,000 years.

The decrease in ordering of lumbar spine X-rays may also reflect a decline in 'lead up' imaging prior to MRI. A recent report found that approximately half of patients undergoing MRI had undergone x-ray or CT before the procedure (21). After the intervention, the decrease in x-ray utilization without a drop in MRI use may reflect a practice change reducing "lead up" imaging– a possible positive result from an imaging appropriateness perspective.

Importantly, the data we present here show no evidence of large scale switching from ordering lumbar spine X-rays to newer, more expensive imaging tests (CT and MRI); there was an overall reduction in total imaging tests of around 100,000/year after the policy change.

In the case of single segment MRI examination of the spine, the policy change was associated with a short-lived reduction in ordering volumes by both SPs and FPs. But they differed in one important respect. Specialists had a stable and constant level of test ordering prior to the intervention with a shallow 'recovery' afterwards. In contrast, FPs had a rising trend in ordering of spine MRI prior to the policy change, which fell to a greater extent than did the SP's rate and then rose again at about half the pre-intervention rate. This suggests that FP imaging ordering patterns are potentially more responsive to insurance reimbursement policy changes such as that evaluated in our study, than those of SPs.

In the case of spine CT, the policy change appeared to have a smaller impact in ordering, on a background of decreasing use. CT ordering rates fell prior to the intervention, likely reflecting substitution by MRI: an increasingly accessible and, in many circumstances, more appropriate test. The policy change resulted in modest further reductions in ordering followed by small rebounds; however we suspect that these small rebound increases in CT ordering will not be sustained and that ordering rates may resume their previous decline.

The overall effects of restricting insurance reimbursement coverage for imaging of uncomplicated lumbar spine pain were fairly complex. After the policy change, FPs demonstrated a larger alteration in test ordering practices than did SPs. However, there was evidence in both of these physician groups of a general movement away from X-rays and CTs and toward single segment MRI examinations, which has greater sensitivity for a number of treatable pathologies (3). The greatest difference between the two physician groups was seen with lumbar spine X-rays where FPs had a substantially higher ordering rate, but had a greater response to the new coverage policy implementation. This pattern of greater overuse amongst non-specialist practitioners has been reported previously (12). Specialists may be more familiar with practice guidelines in spine imaging, more adherent to those guidelines and therefore less likely to show changes in ordering practice after the policy initiative. However, it is also known that FPs order studies for non-clinical reasons, including patient demand and fear of litigation (22, 23). It is possible that FPs were aware of the limited value of lumbar spine imaging in the management of uncomplicated low back pain, and the removal of insurance coverage helped them reinforce this in discussions with patients. Finally, in interpreting these data, it is important to note that in many cases spine surgeons require spine imaging before accepting a patient referral from an FP (84% in one Canadian study (21)). This emphasizes the importance of FP ordering practices on overall imaging utilization, but also highlights the difficulty FPs may have imaging “appropriately” when they plan to refer their patients with low back pain to a specialist in Ontario.

Strengths of the study

The study covered all lumbar spine imaging tests for the entire population of Ontario (over 13 million) for 6 years. The full population coverage means that the results are representative and

the sample size was large enough, and the duration of follow up long enough, to quantify quite small changes. Linkage of data to physician characteristics enabled separate study of family physicians and specialists. We had access to 72 months of data, which provided a stable data-set for interrupted time series analysis. The latter provided adjustment for underlying trends and provides good evidence of causality. In other words, we have confidence that the observed changes were due to the policy intervention.

Limitations of the study

There are two major limitations to acknowledge in our study. Firstly, we cannot be certain that patients referred for L-spine imaging were being evaluated for symptoms of uncomplicated low back pain and we cannot identify patients who had 'red flags'. This limitation is the result of the fact that clinical indications for imaging referral are not recorded in OHIP billing data and we did not have access to the details of patient clinical information needed to make a judgment about "appropriateness" of imaging. Undoubtedly, some imaging studies were done for reasons other than low back pain. In one prior study performed in Ontario, only 22% of all outpatient spine MRI requisitions provided "back pain" as the indication for imaging referral (24). This does not invalidate the results of this study but rather makes it likely that we under-estimated the true impact of the policy on test ordering in the target patient population.

Undoubtedly, many of the tests ordered during the period of the study were necessary. Unfortunately, an assessment regarding "appropriateness" of referrals over the course of the baseline or post policy change periods could not be made on the basis of reimbursement data, which did not include clinical referral information details. Previous studies, including one in Ontario, which reviewed the clinical history provided on requests for imaging studies, concluded that between 28 and 50% of outpatient lumber spine MRIs lack appropriate clinical indications (12, 13, 18).

In conclusion, these data support the proposition that payer clinical policy restrictions can help modify physician ordering patterns for low back pain imaging. The 2012 Ontario intervention resulted in a significant decrease in the numbers of imaging tests of the spine performed over three years in Ontario. This likely represents a trend toward more appropriate imaging, less

radiation exposure for the population and a cost saving for the payer. While physicians may continue to order imaging for uncomplicated low back pain to avoid “missing” diagnoses or due to patient demands, this study demonstrates that policy interventions – even without enforcement or penalties – may help physicians practice “choose wisely” when it comes to imaging for low back pain.

Table 1. Annual utilization by test and grouped specialty

Type of Imaging Test	Specialty	Measure	Baseline average (2009/10 - 2011/12)	2012/13	% change from baseline	2013/14	% change from prev yr	2014/15	% change from prev yr	% change from baseline
Lumbar x-ray	FPs	Total tests per year	342,949	244,352	-28.7	271,439	11.1	275,082	1.3	-19.8
		Tests ordered per phys	31.4	21.4	-31.9	23.1	8.0	23.7	2.5	-24.7
		Phys ordering test	10,924	11,426	4.6	11,755	2.9	11,626	-1.1	6.4
	Specialists	Total tests per year	62,251	58,540	-6.0	61,927	5.8	62,049	0.2	-0.3
		Tests ordered per phys	12.6	12.1	-3.9	12.4	3.1	12.5	0.8	-0.2
		Phys ordering test	4,956	4,850	-2.1	4,977	2.6	4,949	-0.6	-0.1
Single segment spine MRI	FPs	Total tests per year	90,890	91,640	0.8	103,369	12.8	105,155	1.7	15.7
		Tests ordered per phys	9.9	9.4	-5.7	10.2	8.3	10.3	1.0	3.2
		Phys ordering test	9,116	9,774	7.2	10,181	4.2	10,250	0.7	12.4
	Specialists	Total tests per year	43,574	43,738	0.4	47,225	8.0	48,072	1.8	10.3
		Tests ordered per phys	11.8	10.8	-8.0	11.2	3.8	11.4	1.3	-3.3
		Phys ordering test	3,702	4,040	9.1	4,204	4.1	4,223	0.5	14.1
Spine CT	FPs	Total tests per year	60,966	43,467	-28.7	46,975	8.1	45,047	-4.1	-26.1
		Tests ordered per phys	7.9	6.1	-22.9	6.4	4.8	6.3	-1.1	-20.1
		Phys ordering test	7,728	7,147	-7.5	7,370	3.1	7,147	-3.0	-7.5
	Specialists	Total tests per year	20,319	18,472	-9.1	20,900	13.1	20,866	-0.2	2.7
		Tests ordered per phys	6.3	5.8	-7.7	6.3	9.3	6.5	2.3	3.2
		Phys ordering test	3,229	3,179	-1.5	3,292	3.6	3,212	-2.4	-0.5

Table 2. Durbin-Watson statistic and regression parameter estimates after correcting for autoregression where appropriate

Type of test	Physician specialty	DW statistic	Time (overall secular trend)		Effect of intervention		Post-intervention slope	
			estimate	p-value	estimate	p-value	estimate	p-value
Lumbar and lumbosacral x-ray	FP	2.2041	-0.006	0.0467	-0.813	<.0001	0.00964	0.0032
	Specialist	2.522	-0.0019	0.1158	-0.003	0.9423	0.00105	0.4644
Limited spine MRI	FP	2.231	0.0067	<.0001	-0.175	<.0001	0.00343	0.0002
	Specialist	2.2941	0.0009	0.3588	-0.102	0.0009	0.00224	0.0233
Spine CT	FP	1.584	-0.0028	<.0001	-0.099	<.0001	0.0001	0.9053
	Specialist	2.091	-0.0012	0.0007	-0.01	0.3775	0.0014	0.0452

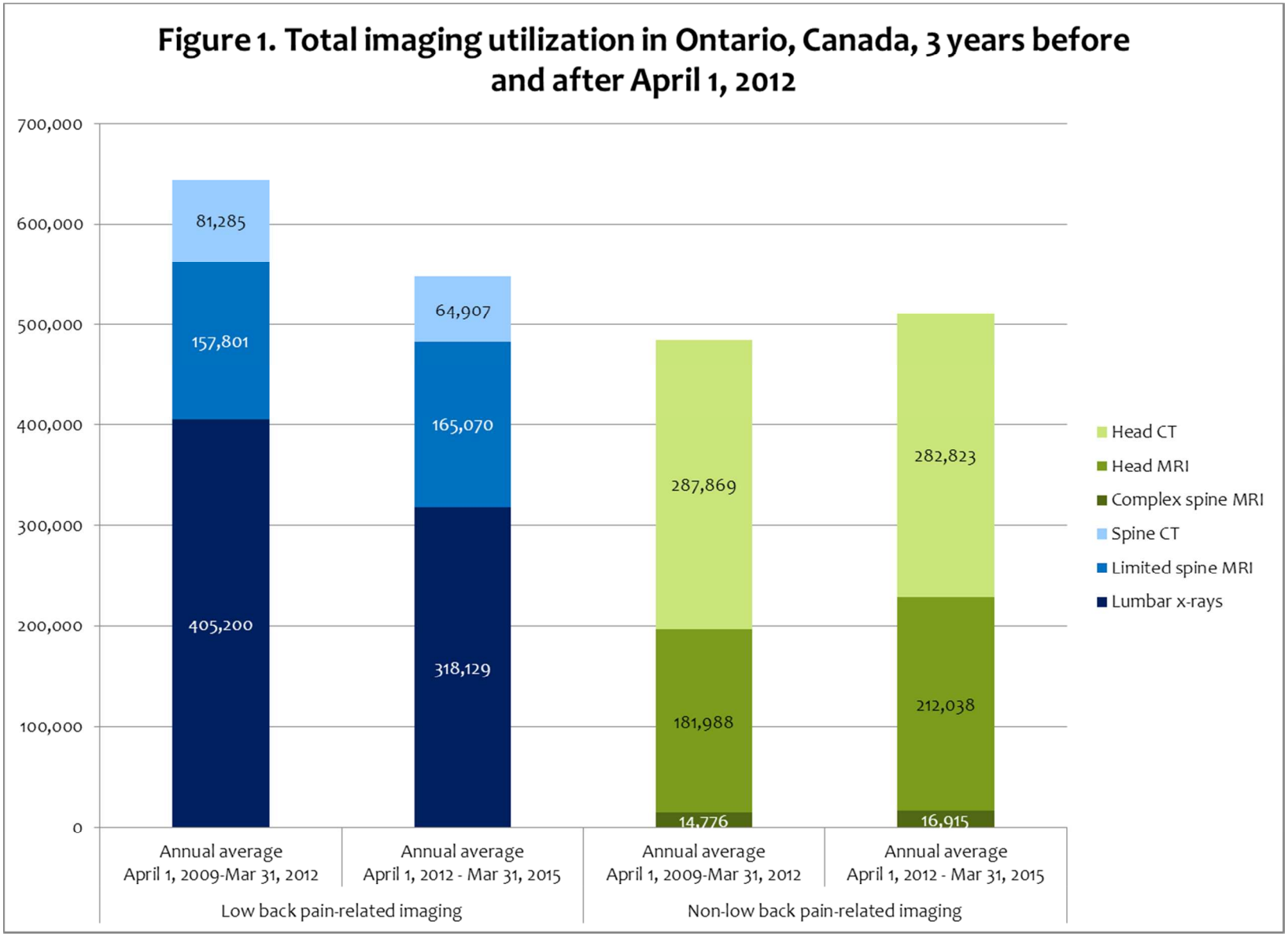

Fig 2

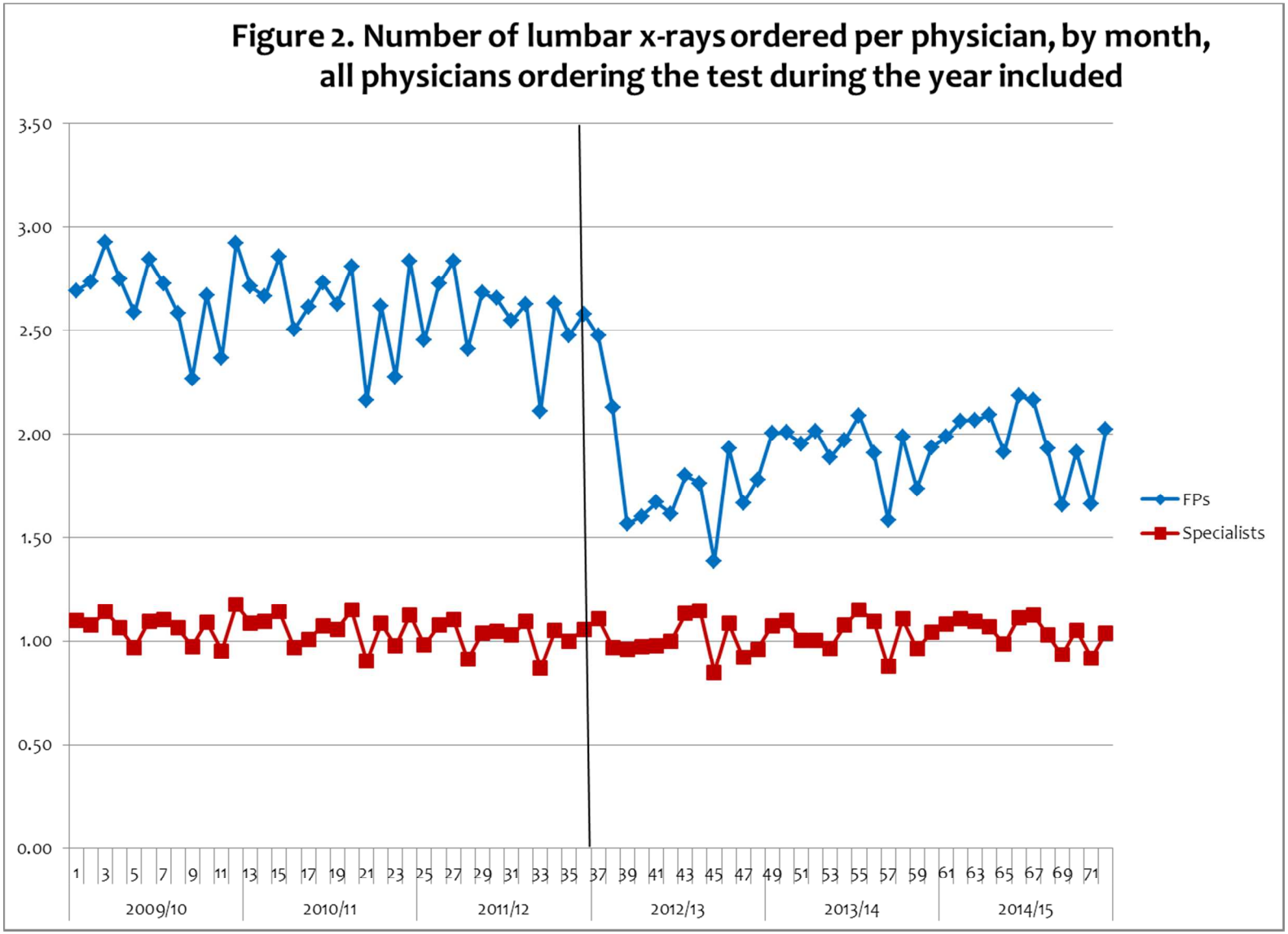

Fig. 3

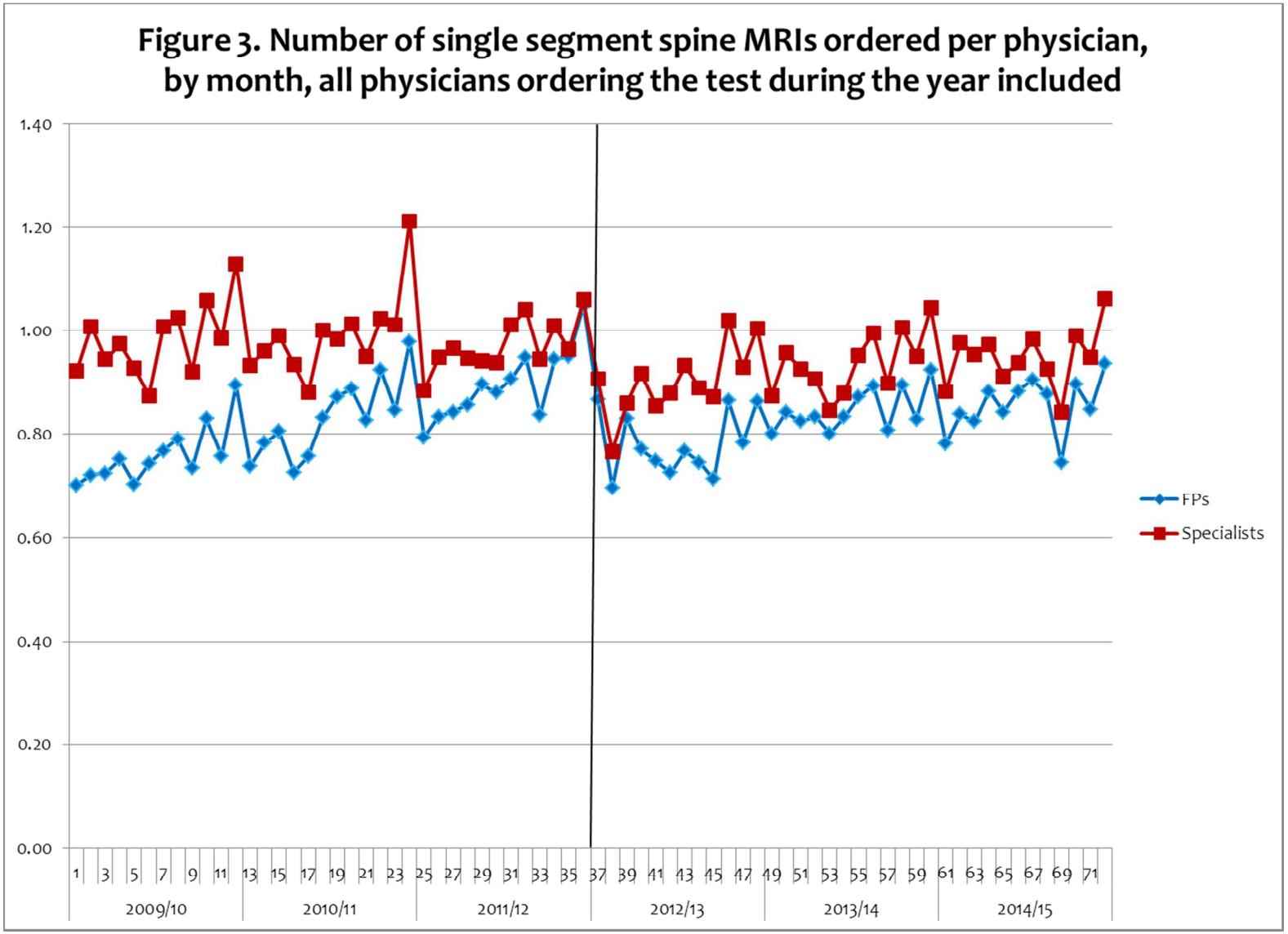
Figure 3. Number of single segment spine MRIs ordered per physician, by month, all physicians ordering the test during the year included
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
FPs
Specialists

Fig 4

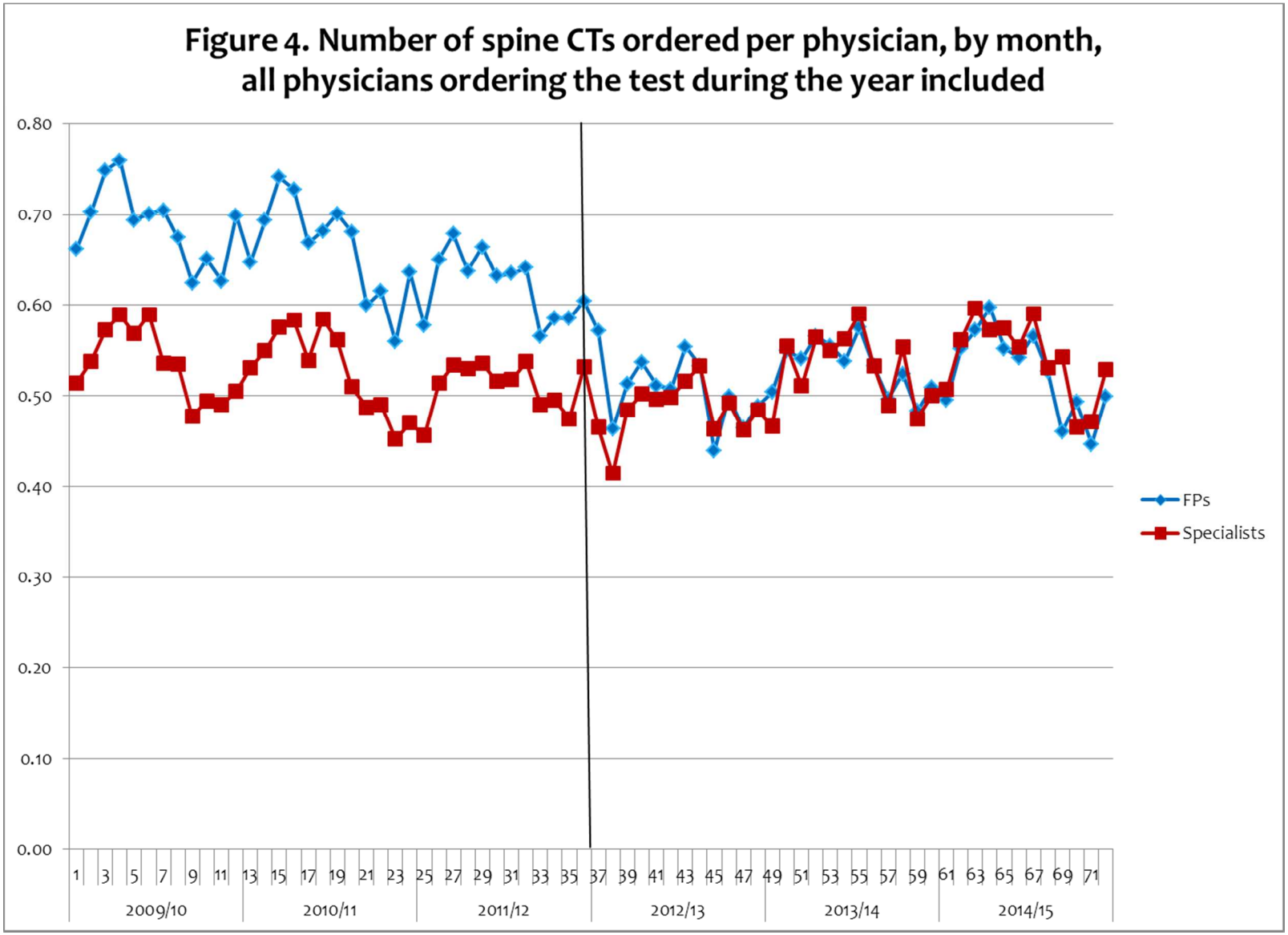
Figure 4. Number of spine CTs ordered per physician, by month, all physicians ordering the test during the year included
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
FPs
Specialists

References

1. Chou R, Fu R, Carrino JA, Deyo RA. Imaging strategies for low-back pain: systematic review and meta-analysis. Lancet. 2009;373(9662):463-72.

2. Chou D, Samartzis D, Bellabarba C, Patel A, Luk KD, Kisser JM, et al. Degenerative magnetic resonance imaging changes in patients with chronic low back pain: a systematic review. Spine (Phila Pa 1976). 2011;36(21 Suppl):S43-53.

3. Chou R, Deyo RA, Jarvik JG. Appropriate use of lumbar imaging for evaluation of low back pain. Radiol Clin North Am. 2012;50(4):569-85.

4. Flynn TW, Smith B, Chou R. Appropriate use of diagnostic imaging in low back pain: a reminder that unnecessary imaging may do as much harm as good. J Orthop Sports Phys Ther. 2011;41(11):838-46.

5. Dagenais S, Tricco AC, Haldeman S. Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. Spine J. 2010;10(6):514-29.

6. National Collaborating Centre for Primary C. National Institute for Health and Clinical Excellence: Guidance. Low Back Pain: Early Management of Persistent Non-specific Low Back Pain. London: Royal College of General Practitioners (UK)

Royal College of General Practitioners; 2009.

7. Diagnostic imaging referral guidelines. Saint-Laurent, Quebec: Canadian Association of Radiologists; 2012.

8. Chou R, Qaseem A, Snow V, Casey D, Cross JT, Shekelle P, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. Ann Intern Med. 2007;147(7):478-91.

9. Imaging Tests for Back Pain Philadelphia, PA: ABIM Foundation; 2012 [Available from: http://www.choosingwisely.org/patient-resources/imaging-tests-for-back-pain/.

10. Imaging tests for lower back pain: When you need them—and when you don't Toronto, ON: Choosing Wisely Canada; 2014 [Available from: http://www.choosingwiselycanada.org/materials/imaging-tests-for-lower-back-pain-when-you-need-them-and-when-you-dont/.

11. Wolfson D, Santa J, Slass L. Engaging physicians and consumers in conversations about treatment overuse and waste: a short history of the choosing wisely campaign. Acad Med. 2014;89(7):990-5.

12. Emery DJ, Shojania KG, Forster AJ, Mojaverian N, Feasby TE. Overuse of magnetic resonance imaging. JAMA Intern Med. 2013;173(9):823-5.

13. Rosenkrantz AB, Doshi A. Characterizing the Performance of the Nation's Hospitals in the Hospital Outpatient Quality Reporting Program's Imaging Efficiency Measures. J Am Coll Radiol. 2014.

14. Chou R, Qaseem A, Owens DK, Shekelle P, Physicians CGCotACo. Diagnostic imaging for low back pain: advice for high-value health care from the American College of Physicians. Ann Intern Med. 2011;154(3):181-9.

15. Jenkins HJ, Hancock MJ, French SD, Maher CG, Engel RM, Magnussen JS. Effectiveness of interventions designed to reduce the use of imaging for low-back pain: a systematic review. CMAJ. 2015;187(6):401-8.

16. Blackmore CC, Mecklenburg RS, Kaplan GS. Effectiveness of clinical decision support in controlling inappropriate imaging. J Am Coll Radiol. 2011;8(1):19-25.

17. Blachar A, Tal S, Mandel A, Novikov I, Polliack G, Sosna J, et al. Preauthorization of CT and MRI examinations: assessment of a managed care preauthorization program based on the ACR Appropriateness Criteria and the Royal College of Radiology guidelines. J Am Coll Radiol. 2006;3(11):851-9.

18. Kennedy SA, Fung W, Malik A, Farrokhyar F, Midia M. Effect of governmental intervention on appropriateness of lumbar MRI referrals: a Canadian experience. J Am Coll Radiol. 2014;11(8):802-7.

19. Care OMoHaL-t. Amendments to the Schedule of Benefits to reflect evidence-informed care 2014 [Available from: http://www.health.gov.on.ca/en/pro/programs/ecfa/action/primary/lb_sob.aspx.

20. Schedule of Benefits for Physician Services under the Health Insurance Act. In: Care MoHaL-T, editor. 2012.

21. Busse J. Appropriateness of Spinal Imaging Use in Canada. In: Alexander PE, editor.: Canadian Institute of Health Research; 2013. p. 36.

22. You JJ. ICES report: Appropriateness: the next frontier in the quest for better access to CT and MRI. Healthc Q. 2009;12(4):25-7.

23. Allan GM, Spooner GR, Ivers N. X-ray scans for nonspecific low back pain: a nonspecific pain? Can Fam Physician. 2012;58(3):275.

24. You JJ, Purdy I, Rothwell DM, Przybysz R, Fang J, Laupacis A. Indications for and results of outpatient computed tomography and magnetic resonance imaging in Ontario. Can Assoc Radiol J. 2008;59(3):135-43.