Imaging for low back pain
Systematic review and
meta-analysis

Presented by
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Acknowledgements

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Background

LBP major contributor to disease burden

Often no patho-anatomical cause

Serious pathology:
  1% in primary care (Henschke, 2009)
  (higher in emergency)

Diagnostic imaging guidelines:

Image only for risk of serious pathology (Chou, 2011)
Image when likely to change management (NICE, 2017)

“Radiological imaging for acute non-specific LBP is not appropriate”
(ACI Model of Care MSK Network, 2016)
Background

Imaging for LBP is overused in primary care

- Australia 25% (Williams, 2010)
- USA 25% (Tan, 2016)
- UK 20% (Dey, 2004)

Estimates inconsistent (e.g. MRI in primary care)

- Australia 5% (Britt, 2014)
- 80% (Carey, 2015)

Trend over time inconsistent

- ↑307% MRI over 12 years (Deyo, 2009)
- ↑30% early MRI in elderly over 5 years (Pham, 2009)
- ↓4% imaging after Choosing Wisely (Hong, 2017)
Risk:
Researchers / policy makers may use a non-systematic approach when selecting estimates

No systematic review of studies has evaluated frequency of imaging in patients presenting with LBP
AIMS

i. Estimate the current proportion of patients seeking care for LBP who are imaged

ii. Explore trends in frequency of diagnostic imaging since the introduction of clinical imaging guidelines in 1994, and examine the effect of study-level factors on estimates of imaging frequency
Methods
Data sources
Medline, EMBASE, CINAHL
1995 - 2017 in any language

Search terms
Relating to:
• Primary or emergency care (include: allied health)
• Imaging type
• LBP

Eligibility
Imaging ordered or performed
First contact care for that episode
>75% sampling frame from 1995 onwards
Data extraction

Study design, patient demographic and clinical data

- Observational design = entire study sample
- RCT = control arm

Risk of bias tool

- Hoy, 2012
  - 10 items (High/Low) + summary item (High/Moderate/Low)

Quality of the pooled estimates

- GRADE for observational studies (Guyatt, 2008; Iorio, 2015)
  - **Downgrade:**
    - Observational < 50%
    - Summary ROB “Moderate” or “High” > 50%
    - Point estimate range > 25%
    - Pooled CI > 10% either side pooled estimate
Synthesis

Simple imaging: X-Ray, U/S
Complex imaging: CT, MRI, Bone scan
Current imaging: Studies with >75% sampling frame after 2010

(i) Current imaging
Pooled proportions
   Random effects meta-analysis
   Extreme outliers: identified visually

(ii) Trends in frequency over time
Explored trends from 1995-2015
   Pre-specified study-level factors
   Mixed effects meta-regression
   Final model selection: clinical rationale (not data driven)
   Outliers: plot of standardized shrunken residuals after regression
PRELIMINARY results
PRISMA flow

Total identified
\[ N = 7,339 \]

Full-text assessed
\[ N = 191 \]

Included in analysis
\[ N = 45 (41) \]
Characteristics of included studies

45 studies
～18,690,000 consultations to primary or emergency care
～4,234,000 imaging referral/events
21 year period (September 1994 – July 2015)

Study sample ranged 55 to >10M

Majority were: Government supported
North American populations
Adult sample (2 elderly)
Predominately X-Ray, CT and MRI
Current imaging proportion in Primary care (2010+)

Statistical heterogeneity was influenced by large study sample-size (Higgins, 2008)
### Current imaging proportion in Emergency care (2010+)

<table>
<thead>
<tr>
<th>Setting</th>
<th>Author, year</th>
<th>Study population</th>
<th>Imaging proportion % (95% CI)</th>
<th>Weight %</th>
<th>ROB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMERGENCY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple imaging</td>
<td>Rizzardo, 2016 n=1289</td>
<td></td>
<td>41.0 (38.3, 43.7)</td>
<td>25.61</td>
<td>mod</td>
</tr>
<tr>
<td></td>
<td>Nunn, 2017 n=325</td>
<td></td>
<td>27.4 (22.6, 32.6)</td>
<td>24.49</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>Rao, 2015 n=100</td>
<td></td>
<td>10.0 (4.9, 17.6)</td>
<td>23.79</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>Schlemmer, 2015 n=14838</td>
<td></td>
<td>26.3 (25.6, 27.1)</td>
<td>26.10</td>
<td>low</td>
</tr>
<tr>
<td><strong>Pooled</strong></td>
<td></td>
<td></td>
<td>26.5 (16.9, 36.0)</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>Complex imaging</td>
<td>Rizzardo, 2016 n=1289</td>
<td></td>
<td>4.0 (3.0, 5.2)</td>
<td>28.65</td>
<td>mod</td>
</tr>
<tr>
<td></td>
<td>Nunn, 2017 n=325</td>
<td></td>
<td>5.2 (3.1, 8.2)</td>
<td>26.86</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>Rao, 2015 n=100</td>
<td></td>
<td>20.0 (12.7, 29.2)</td>
<td>15.47</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>Schlemmer, 2015 n=14838</td>
<td></td>
<td>10.2 (9.7, 10.7)</td>
<td>29.02</td>
<td>low</td>
</tr>
<tr>
<td><strong>Pooled</strong></td>
<td></td>
<td></td>
<td>8.6 (4.1, 13.1)</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Image proportion (%)

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The University of Sydney
Simple imaging trend over time
(n = 36)

Simple imaging frequency has not reduced over 20 years

Adjusted model:
Setting
primary care
emergency care

Observation window
referred within 4w
referred over study period

Bubble: Study imaging proportion (study sample size)
Fitted line: Adjusted model - mixed effects meta-regression

21.2% (16.2-27.2)  
P = 0.985
21.3% (16.4-27.2)
Complex imaging trend over time
(n = 27)

54% increase in complex imaging frequency over 20 years

Adjusted model:
Setting
primary care
emergency care

Observation window
referred within 4w
referred over study period

Bubble: Study imaging proportion (study sample size)
Fitted line: Adjusted model - mixed effects meta-regression

7.4% (5.7–9.6)  p = 0.030  11.4% (9.6–13.5)
Key messages

Currently:

ONE QUARTER patients in primary care are referred for imaging
(n = 10, moderate quality evidence)

ONE THIRD patients in emergency care are imaged
(n = 5, high quality evidence)

No evidence for decrease in imaging over time

Evidence for increase in MRI over 20 years (1995-2015)

Geographic influence (not shown)

Simple imaging: ↓Oceania (ref. Nth America)
Complex imaging: ↓Oceania ↓Europe (ref. Nth America)
**Strengths/limitations**

✓ pre-specified protocol
✓ All languages
✓ ROB / Quality assessment of pooled estimates
✓ 41 studies pooled
✓ Adjusted model based on clinical rationale

✗ ↑ between study variance
  ✓ grouped by setting, image type, random-effects MA
  ✓ mixed effects MR to further explain variance
  ✓ constrained #factors to maintain power

✗ Data quality/extraction issues
  - Some pre-specified variables unable to collect
  - Potentially long period between consultation and imaging
Research and policy implications

Despite 25 years Guideline-based advice, Choosing Wisely: Imaging for LBP has not reduced

This is an international problem: We need resources and attention

Time for new approach?

Policy
Guidelines

Recent efforts

ACI model of care
↓use red flags in guidelines (Chou, 2011; NICE, 2017)
Shared decision making (Jenkins, 2016)
Clinical decision support tools
Thankyou

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References


Risk of Bias

1. Target population
2. Representative sampling frame
3. Random selection
4. Minimal non-response bias
5. Appropriate mode of data collection
6. Acceptable case definition
7. Appropriate study instrument
8. Same mode of data collection
9. Imaging observation window <4w
10. Appropriate count statistic

Low risk of bias (+)  High risk of bias (-)
### Pre-specified study-level factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variable type</th>
<th>Categories</th>
<th>Data (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>continuous</td>
<td>(median date of study sample frame)</td>
<td>100</td>
</tr>
<tr>
<td>Clinical setting</td>
<td>categorical</td>
<td>primary care; emergency care</td>
<td>100</td>
</tr>
<tr>
<td>Study design</td>
<td>categorical</td>
<td>prospective; retrospective</td>
<td>100</td>
</tr>
<tr>
<td>Data source</td>
<td>categorical</td>
<td>clinical encounter; insurer data; patient survey</td>
<td>100</td>
</tr>
<tr>
<td>Imaging count method</td>
<td>categorical</td>
<td>imaging performed; imaging ordered</td>
<td>100</td>
</tr>
<tr>
<td>Geographic region</td>
<td>categorical</td>
<td>North America; Europe; Oceania; UK</td>
<td>100</td>
</tr>
<tr>
<td>Imaging observation window</td>
<td>categorical</td>
<td>Imaging with 4w; imaging within study period</td>
<td>100</td>
</tr>
<tr>
<td>First consultation</td>
<td>categorical</td>
<td>first; subsequent; any consultation</td>
<td>96</td>
</tr>
<tr>
<td>Workers’ compensation†</td>
<td>categorical</td>
<td>yes; no</td>
<td>64</td>
</tr>
<tr>
<td>Duration of episode†</td>
<td>categorical</td>
<td>&lt;3 months; ≥3 months</td>
<td>40</td>
</tr>
<tr>
<td>Older age (&gt;64y)†</td>
<td>categorical</td>
<td>yes; no</td>
<td>38</td>
</tr>
<tr>
<td>Radicular syndrome†</td>
<td>categorical</td>
<td>yes; no</td>
<td>36</td>
</tr>
</tbody>
</table>
Simple imaging trend over time
(n = 36, adjusted for setting & observation window)

Not reducing...simple imaging frequency over 20 years

The model did not improve when adjusted for:

- **Setting** (primary vs. emergency care)
  \( p = 0.196 \)
- **Imaging observation window**
  (referred within 4w vs. over study)
  \( p = 0.228 \)

**Circles**: imaging proportion for each study
(size = inverse of the within-study variance)

**Fitted line**: Adjusted model mixed effects meta-regression
Complex imaging trend over time
(n = 27, adjusted for setting & observation window)

54% increase in complex imaging frequency over 20 years

Adjusted model reduced variance by 75% (adj. $R^2$)

Adjusted mean proportions:
- Setting ($p=0.001$)
  - 18% primary care
  - 11% emergency care
- Observation window ($p=0.001$)
  - 7% referred within 4w
  - 11% referred over study period

Circles: imaging proportion for each study
(size = inverse of the within-study variance)
Fitted line: Adjusted model mixed effects meta-regression