**Supplemental material**

**Appendix 1.** MEDLINE search string

**Appendix 2.** Imaging proportion for all studies grouped by care setting and image type listed by descending date order of mid-point in data collection

**Appendix 3**. Sensitivity analyses for pooled imaging proportions based on summary risk of bias

\*No study scored high for summary risk of bias in the Emergency care setting †Total between group difference (mixed effects analysis)

**Appendix 4.** Association of study-level factors on imaging proportion (univariate analysis)

\*Extreme outlier studies were excluded from each regression analysis based on a plot of standardised shrunken residuals **†**Proportion of imaging for each factor in the univariate model).

**Appendix 1.** MEDLINE search string

|  |  |
| --- | --- |
| 1 | exp General Practitioners/cl, sn, sd, td, ut [Classification, Statistics & Numerical Data, Supply & Distribution, Trends, Utilization] |
| 2 | General pract\*.mp. |
| 3 | exp General Practice/cl, sn, td [Classification, Statistics & Numerical Data, Trends] |
| 4 | exp Primary Health Care/cl, sn, sd, td, ut [Classification, Statistics & Numerical Data, Supply & Distribution, Trends, Utilization] |
| 5 | primary care.mp. |
| 6 | PCP\*.mp. |
| 7 | exp Family Practice/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 8 | family pract\*.mp. |
| 9 | \*practice patterns, Physicians'/ |
| 10 | Physiotherap\*.mp. |
| 11 | Chiropract\*.mp. |
| 12 | Osteopath\*.mp. |
| 13 | exp Ambulatory Care/st, sn, td, ut [Standards, Statistics & Numerical Data, Trends, Utilization] |
| 14 | ambulatory medical care.mp. |
| 15 | exp "Delivery of Health Care"/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 16 | exp Emergency Service, Hospital/st, sn, td, ut [Standards, Statistics & Numerical Data, Trends, Utilization] |
| 17 | exp Emergency Medical Services /st, sn, td, ut [Standards, Statistics & Numerical Data, Trends, Utilization] |
| 18 | emergency department/ |
| 19 | emergency department.mp. |
| 20 | \*Insurance claim reporting/ |
| 21 | exp Workers' Compensation/og, st, sn, td, ut [Organization & Administration, Standards, Statistics & Numerical Data, Trends, Utilization] |
| 22 | exp "Insurance Claim Review"/ec, sn, td, ut [Economics, Statistics & Numerical Data, Trends, Utilization] |
| 23 | exp Fee-for-Service Plans/st, sn, td, ut [Standards, Statistics & Numerical Data, Trends, Utilization] |
| 24 | exp Health Maintenance Organizations/st, sn, td, ut [Standards, Statistics & Numerical Data, Trends, Utilization] |
| 25 | exp Health Care Surveys/mt, sn, td, ut [Methods, Statistics & Numerical Data, Trends, Utilization] |
| 26 | health services utilization.mp. |
| 27 | practice variation.mp. |
| 28 | exp Fees, Medical/st, sn, td [Standards, Statistics & Numerical Data, Trends] |
| 29 | exp Insurance, Health/sn, sd, td, ut [Statistics & Numerical Data, Supply & Distribution, Trends, Utilization] |
| 30 | exp Health Benefit Plans, Employee/sn, sd, td, ut [Statistics & Numerical Data, Supply & Distribution, Trends, Utilization] |
| 31 | 1 or 2 or 3 or 4 or 5 or 6 or 8 or 9 or 10 or 11 or 12 or 13 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 28 or 29 or 30 |
| 32 | medical management.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] |
| 33 | exp Lumbar Vertebrae/ra, us [Radiography, Ultrasonography] |
| 34 | exp Magnetic Resonance Imaging/sn, sd, td, ut [Statistics & Numerical Data, Supply & Distribution, Trends, Utilization] |
| 35 | magnetic resonance imaging.mp. |
| 36 | MRI.mp. |
| 37 | exp Tomography/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 38 | exp Tomography, X-Ray/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 39 | exp Tomography, X-Ray Computed/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 40 | CT.mp. |
| 41 | exp Diagnostic Imaging/sn, td, ut [Statistics & Numerical Data, Trends, Utilization] |
| 42 | imaging.mp. |
| 43 | exp Radiography/di, sn, td, ut [Diagnosis, Statistics & Numerical Data, Trends, Utilization] |
| 44 | exp Radiology/di, sn, td, ut [Diagnosis, Statistics & Numerical Data, Trends, Utilization] |
| 45 | exp X-Rays/ |
| 46 | X-ray\*.mp. |
| 47 | Ultrasound.mp. |
| 48 | 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 45 or 46 or 47 |
| 49 | exp Back Pain/cn, di, in, pa, ra, sn, us [Congenital, Diagnosis, Injuries, Pathology, Radiography, Statistics & Numerical Data, Ultrasonography] |
| 50 | (back adj3 pain).mp. |
| 51 | (lumbar adj3 pain).mp. |
| 52 | exp Low Back Pain/cl, cn, di, ep, eh, et, pa, ra, us [Classification, Congenital, Diagnosis, Epidemiology, Ethnology, Etiology, Pathology, Radiography, Ultrasonography] |
| 53 | exp Back Injuries/di, ep, eh, et, ra, us [Diagnosis, Epidemiology, Ethnology, Etiology, Radiography, Ultrasonography] |
| 54 | exp Sciatica/cn, di, ep, eh, et, pa, ra, sn, us [Congenital, Diagnosis, Epidemiology, Ethnology, Etiology, Pathology, Radiography, Statistics & Numerical Data, Ultrasonography] |
| 55 | Sciatica.mp. |
| 56 | radicular syndrome.mp. |
| 57 | exp Radiculopathy/di, ep, et, pa, ra, us [Diagnosis, Epidemiology, Etiology, Pathology, Radiography, Ultrasonography] |
| 58 | Radiculopathy.mp. |
| 59 | backache.mp. |
| 60 | nerve compression syndrome/ |
| 61 | piriformis muscle syndrome/ |
| 62 | exp Spondylosis/di, ep, eh, et, pa, ra, us [Diagnosis, Epidemiology, Ethnology, Etiology, Pathology, Radiography, Ultrasonography] |
| 63 | spondylosis.mp. |
| 64 | exp Spondylolisthesis/di, ep, eh, et, ra, sn, us [Diagnosis, Epidemiology, Ethnology, Etiology, Radiography, Statistics & Numerical Data, Ultrasonography] |
| 65 | 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 |
| 66 | 31 and 48 and 65 |
| 67 |  limit 66 to ed=19950101-20171210 |
| 68 | limit 67 to (clinical study or clinical trial, all or comparative study or controlled clinical trial or dataset or duplicate publication or evaluation studies or government publications or journal article or multicenter study or observational study or pragmatic clinical trial or published erratum or randomized controlled trial or technical report) |

**Appendix 2.** Imaging proportion for all studies grouped by care setting and image type listed by descending date order of mid-point in data collection

**Appendix 3**. Sensitivity analyses for current imaging proportions based on summary risk of bias

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Care setting\* | Imaging type | Summary ROB score | Number of studies | Imaging proportion% (95% CI) | Total between (Q-value) | Total between (P-value)**†** |
| Primary care | Simple imaging | high risk | 1 | 17.8 (17.2-18.4) |  |  |
|  |  | low or moderate risk | 6 | 15.8 (10.1-23.9) | 1.6 | 0.21 |
|  | Complex imaging | high risk | 2 | 6.7 (1.3-28.3) |  |  |
|  |  | low or moderate risk | 6 | 9.3 (7.7-11.3) | 0.3 | 0.59 |
|  |  |  |  |  |  |  |

\*No study scored high for summary risk of bias in the Emergency care setting †Total between group difference (mixed effects analysis).

**Appendix 4.** Association of study-level factors on imaging proportion for all studies (univariate analysis)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Imaging type** | Study factor (study-N)\* | Category | P-value | Unadjusted proportion† (%) |
|  |   |   |   | Estimate (95%CI) |
| **Simple imaging**  | Year (N=35) | 2015 | 0.835 | 21.2 (17.2-25.8) |
|  |   | 1995 (reference) |   | 20.4 (16.5-25.0) |
|  | Clinical setting (N=35) | Emergency care | 0.117 | 20.0 (17.8-22.4) |
|   |   | Primary care (*reference*) | 16.1 (11.3-22.5) |
|   | Study design (N=33) | Retrospective | 0.098 | 21.8 (19.6-24.2) |
|   |   | Prospective *(reference)* | 18.2 (14.9-21.9) |
|   | Data source (N=29) | Insurer data | <0.001 | 26.7 (24.4-29.8) |
|   |   | Patient survey | 0.240 | 22.4 (15.3-31.4) |
|   |   | Clinical encounter *(reference)* | 19.0 (17.2-20.9) |
|   | Image count method (N=38) | Performed | <0.001 | 14.9 (12.2-18.2) |
|   |   | Requested *(reference)* |   | 23.0 (20.7-25.4) |
|   | Geographic region (N=34) | Europe | 0.178 | 26.5 (18.8-35.9) |
|   |   | Oceania | <0.001 | 12.8 (09.7-16.8) |
|   |   | United Kingdom | 0.188 | 17.5 (10.2-28.3) |
|   |   | North America *(reference)* | 22.6 (20.2-25.2) |
|   | Imaging observation window (N=38) | Imaging within study period | 0.708 | 21.2 (18.0-24.9) |
|   |   | Imaging within 4w (*reference*) | 20.4 (17.5-23.5) |
|   | Imaging at first consultation (N=35) | Subsequent consultation | <0.001 | 9.7 (07.1-13.2) |
|   |   | Any consultation | 0.001 | 25.2 (24.0-27.4) |
|   |   | First consultation (*reference*) | 22.5 (21.4-23.5) |
|  |   |   |   |   |
| **Complex imaging**  | Year (N=28) | 2015 | 0.813 | 10.2 (07.6-13.6) |
|   |   | 1995 (*reference*) |   | 9.5 (06.4-14.0) |
|   | Clinical setting (N=27) | Emergency care | 0.003 | 11.4 (09.8-12.0) |
|   |   | Primary care (*reference*) | 18.0 (12.3-25.6) |
|   | Study design (N=28) | Retrospective | 0.011 | 8.7 (07.2-10.2) |
|   |   | Prospective *(reference)* | 14.7 (10.3-20.4) |
|   | Data source (N=25) | Insurer data | <0.001 | 12.4 (10.4-14.7) |
|   |   | Patient survey | 0.003 | 23.7 (12.8-39.7) |
|   |   | Clinical encounter *(reference)* | 6.7 (05.5-08.2) |
|   | Image count method (N=29) | Performed | 0.712 | 9.7 (08.0-11.6) |
|   |   | Requested *(reference)* |   | 9.0 (06.2-12.9) |
|   | Geographic region (N=28) | Europe | 0.001 | 3.2 (01.6-06.1) |
|   |   | Oceania | 0.045 | 5.7 (03.3-08.5) |
|   |   | North America *(reference)* | 10.1 (08.5-12.0) |
|   | Imaging observation window (N=26) | Imaging within study period | 0.002 | 12.1 (10.2-14.2) |
|   |   | Imaging within 4w (*reference*) | 8.5 (07.3-09.8) |
|   | Imaging at first consultation (N=28) | Subsequent consultation | 0.126 | 16.2 (07.8-30.6) |
|   |   | Any consultation | 0.922 | 9.5 (06.8-13.2) |
|   |   | First consultation (*reference*) | 9.0 (07.3-10.9) |
|  |   |   |   |   |

\*Extreme outlier studies were excluded from each regression analysis based on a plot of standardised shrunken residuals. **†**Proportion of imaging for each factor in the univariate model