NSS Information and Intelligence

NHS National Services Scotland

# Scottish Arthroplasty Project.

## Annual Report 2017.

**ISD Scotland Publications**
Information Services Division
NHS National Services Scotland
Gyle Square
1 South Gyle Crescent
Edinburgh EH12 9EB

phone: +44 (0)131 275 6233
email: NSS.PHIgraphics@nhs.net

Designed and typeset by
ISD Scotland Publications

Translation Service
If you would like this leaflet in a different language, large print or Braille (English only), or would like information on how it can be translated into your community language, please phone 0845 310 9900 quoting reference 287407.

# Table of Contents

# Foreword

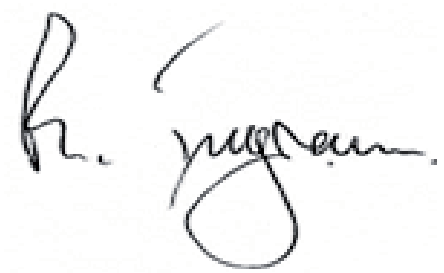
This has been a busy year for the Scottish Arthroplasty Project (SAP) and in this 2017 report we present some of the recent data on joint replacement surgery involving not just hip and knee replacement but shoulder, elbow and ankle joints also. These “other” joints represent a large volume of the workload within Scottish hospitals and it seems only right that they come under scrutiny and are part of our ongoing audit.

We remain indebted to the Orthopaedic community as a whole who clearly take great interest in the Scottish Arthroplasty Project and without their collective input we would achieve much less. I am glad to report that some of the longer-term initiatives have now come to fruition. We believe that individual consultant access to their own data online is a “game changer”. Consultants can currently access their primary and revision hip and knee replacement data, including patient lists and complications presented on CUSUM graphs (see appendix) for infection, dislocation, venous thromboembolism and early revision. The data will be near real time and should make it very simple for individuals to correct any errors (eg. cases attributed to the wrong consultant) and to see where they are in relationship to the threshold, above which they would be recognised as an “outlier”. Since adopting CUSUM methodology the number of outliers has dropped steadily over the last 5-6 years, and may in itself be an indication of better outcomes for Scottish arthroplasty patients. It is our hope that we will be able to give surgeons performing shoulder, elbow and ankle arthroplasty similar access in the near future.

The focus on low volume surgery has stimulated much interest and discussion, with a clear requirement for up to date and accurate data. There is a need for ongoing debate to explore the potential for “Realistic Medicine” in this context, as per the Chief Medical Officer’s recent directive.

A proof of concept study undertaken in 2016/17 to link implant data to the patient by scanning Unique Device Identifier bar codes in the operating theatre was a success. This project is being rolled out to a number of pilot sites with government backing. We hope that it will become “national” before long and give the SAP the power to link all the data we currently present to accurate implant data.

Scotland is now an associate member of the International Society of Arthroplasty Registers, with the chairman and a principal analyst attending this year’s annual conference and afforded the opportunity to present some of our work and explain how we do things in Scotland. We were warmly received and made many friends in the international community which we hope will stand us in good stead as we move forward and further develop the Scottish Arthroplasty Register.



Mr R Ingram
Chair, Scottish Arthroplasty Project Steering Committee

# Introduction

The Scottish Arthroplasty Project remains one of the oldest Arthroplasty registry organisations in the world. We are now members of the International Society of Arthroplasty Registries and in comparison to many other countries are able to produce good quality data for a very modest outlay with the principal aim of providing quality assurance and adverse outcome monitoring of major joint replacement surgery in Scotland. The mechanism by which this is achieved has been outlined in several previous reports.

The 2017 report demonstrates continued high volumes of joint replacement work nationally with generally very low complication rates. One notable exception is the rising rate of renal complication in recent years, though we still cannot be certain if this is real or perceived. Further work locally in centres noted to be “outliers” is to be encouraged in an effort to shed light on this area.

Low volume surgery is addressed again but a clear and accurate picture remains difficult when numbers are small and the perennial problems with coding and data validity remain. Improving individual surgeon access to online data should help both of these issues and this remains one of our imperatives.

As ever we would like to thank all Orthopaedic Surgeons in Scotland for their contribution to the Scottish Arthroplasty Project for without them it would not work.

## Scottish Arthroplasty Steering Committee 2016 – 2017

| Clinical | Non-Clinical |
|---|---|
| Mr Roland Ingram (Chairman) | Mr Sandy Shirra (Lay member) |
| Mr James Bidwell | Mr Robert Frame (Lay member) |
| Mr Ben Clift | Mr Thomas Ferguson (Lay member) |
| Dr Karen Cranfield | Mrs Jacqueline Campbell (Senior Info. Analyst) |
| Mr William MacLeod | Mr Martin O’Neill (Principal Info. Analyst) |
| Mr Matthew Moran | Mrs Kate James |
| Mr Martin Sarungi | |

The committee would like to acknowledge and thank the assistance and valuable input from recent committee members: Mr Brian Singer and Derek Murphy.

# Key points

Number of arthroplasty operations performed in 2016

hip - 7783

knee - 7525

Average age of patients undergoing an NHS Scotland arthroplasty operation

hip - 71 yrs

knee - 68 yrs

Incidence of death within 90 days following a hip or knee arthroplasty

hip - 0.19 %

knee - 0.27 %

Average length of stay when undergoing a hip or knee arthroplasty

2001 - 10 days

2016 - 5 days

Revision rate within 5 years of arthroplasty operation

Hip - 2.4 %

Knee - 2.6 %

# 1. Number of Arthroplasties

## 1.1 National rates

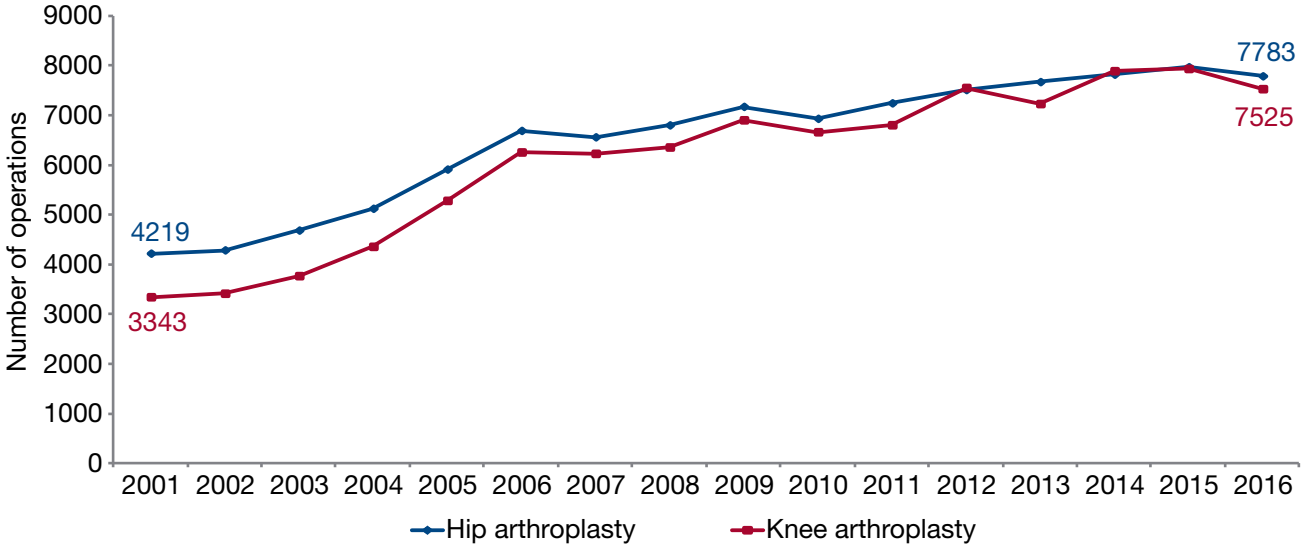
The number of Hip and Knee arthroplasties performed in 2016 has remained static and the graphs show a levelling off of activity, with 7527 primary knee and 7783 hip arthroplasties performed in 2016 (Figure 1a). Scotland has an estimated population of 5,373,000 with 17% under the age of 16 years. Countries of a similar socioeconomic status that have comprehensive Arthroplasty registries include England, Wales, Northern Ireland (and Isle of Man) and Australia. The populations of England, Wales, NI (and IoM) combined are 57,885,400 (19% under 16 years); Australia has an estimated population of 24,309,330 (19% under 16 years). It is difficult to extract exact numbers from the respective Arthroplasty registries for an equivalent time period. The latest Registries from these countries report similar rates of Hip Arthroplasty per head of population (AOANJRR 32,594 Hips and the NJR 83,886 Hips). In Scotland, there are less Knee arthroplasties performed than Hip arthroplasties, however this is not the case for Australia (approximately 53,115 Knees) and the rest of the United Kingdom (94,023 Knees) where Knee Arthroplasty is more commonly performed. When considering Hip and Knee Arthroplasty in Scotland there is no evidence that patients are operated on more often than in other equivalent countries and with respect to Knee Arthroplasty it is likely that on a population basis there are less Knee arthroplasties performed per head of population than in equivalent countries.

The number of elbow arthroplasties has remained roughly static at approximately 50 per year for Scotland over the last 15 years. The trend for Shoulder Arthroplasty shows a similar pattern to that of Hip and Knee Arthroplasty with an increase in numbers over the period 2003 to 2012 and then a levelling off in activity (441 in 2016). The greatest percentage increase in Arthroplasty activity is seen in Ankle Arthroplasty, with just 14 ankle arthroplasties performed in 2001 and 74 in 2016. This may reflect improvements in prosthesis design, instrumentation and increasing subspecialisation (Figure 1b).

The proportion of Primary Arthroplasties performed as an Emergency has remained static over time, with a significant proportion of Hip, Shoulder and Elbow Arthroplasties being performed as emergencies (mostly for treatment of fractures) and low numbers of Ankle and Knee arthroplasties performed on an emergency basis (Figure 1e). The adequate organisation of theatre time, referral pathways and surgical expertise to deal with Emergency Hip, Shoulder and Elbow Arthroplasty should be considered.

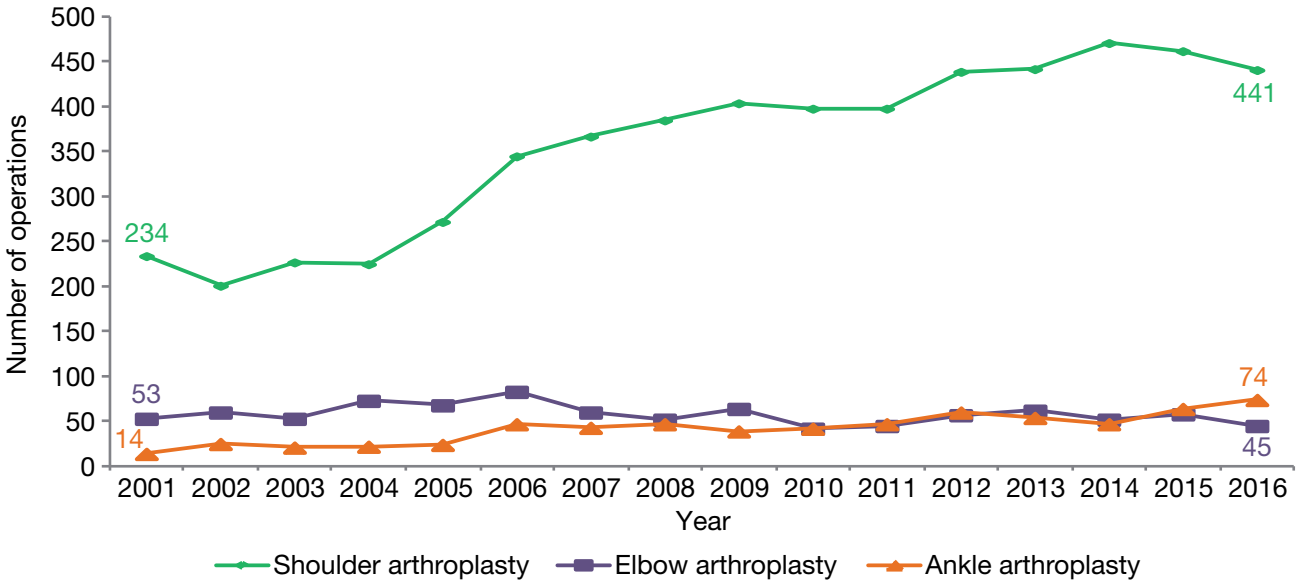
The number of Hip Revisions in 2016 continues to decrease, in 2013 there were 963 Hip Revisions carried out and in 2016 there were 781 Hip Revisions performed (Figure 1b). This may reflect the early failure rate of certain metal-on-metal hip implants that were used and have now been revised. The number of knee revisions remains approximately level. There has been an increase in the number of Shoulder and Ankle revision operations. Shoulder revisions are up to 42, from 25 in 2013 and Ankle Revisions up to 12, from 5 in 2013. Approximately 1/3rd of all Hip Revisions are carried out as an Emergency and this figure has risen year on year. This may reflect a reduction in the number of planned revisions (with the number of at risk metal-on-metal Hips reducing) and an increase in the number of periprosthetic fracture revisions. We do not have the data to analyse this further. The proportion of Knee Revisions performed as an Emergency remains static at 10.8%. The absolute numbers of Ankle, Shoulder and Elbow Revisions performed as an Emergency is very low (Figure 1f).

**Figure 1a** — Primary hip and knee arthroplasties per year (2001 - 2016)




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 1b** — Primary shoulder, elbow and ankle arthroplasties per year (2001 - 2016)




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 1c** — Revision hip and knee arthroplasties per year (2001 - 2016)

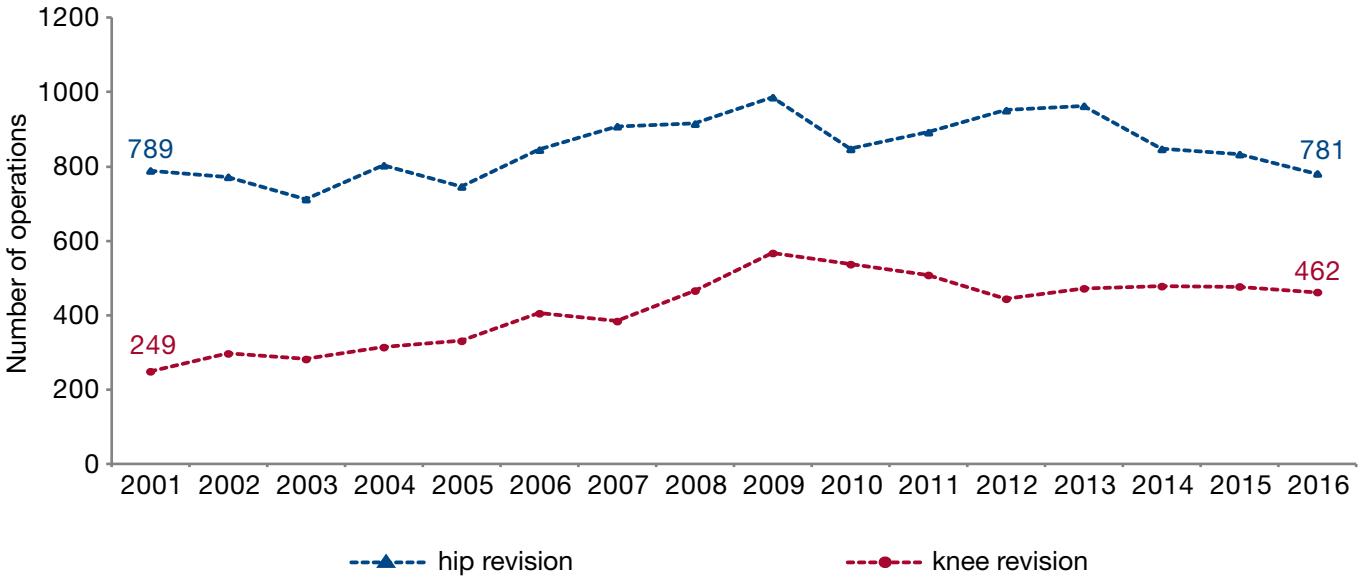



**Figure 1d** — Revision Shoulder, Elbow and Ankle arthroplasties per year (2001 - 2016)

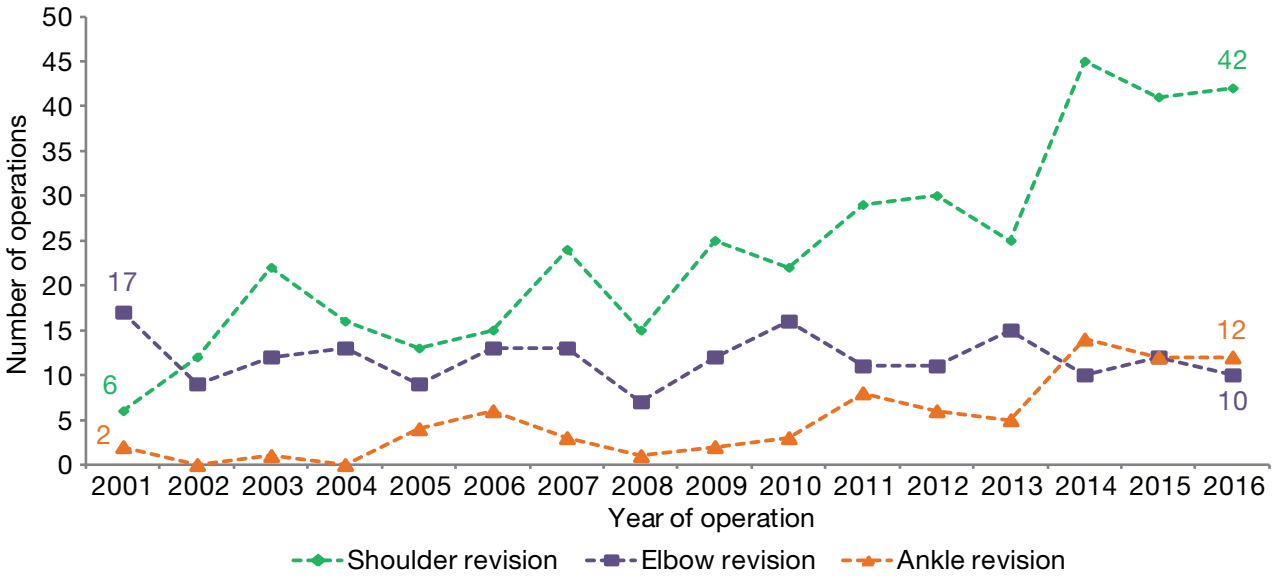
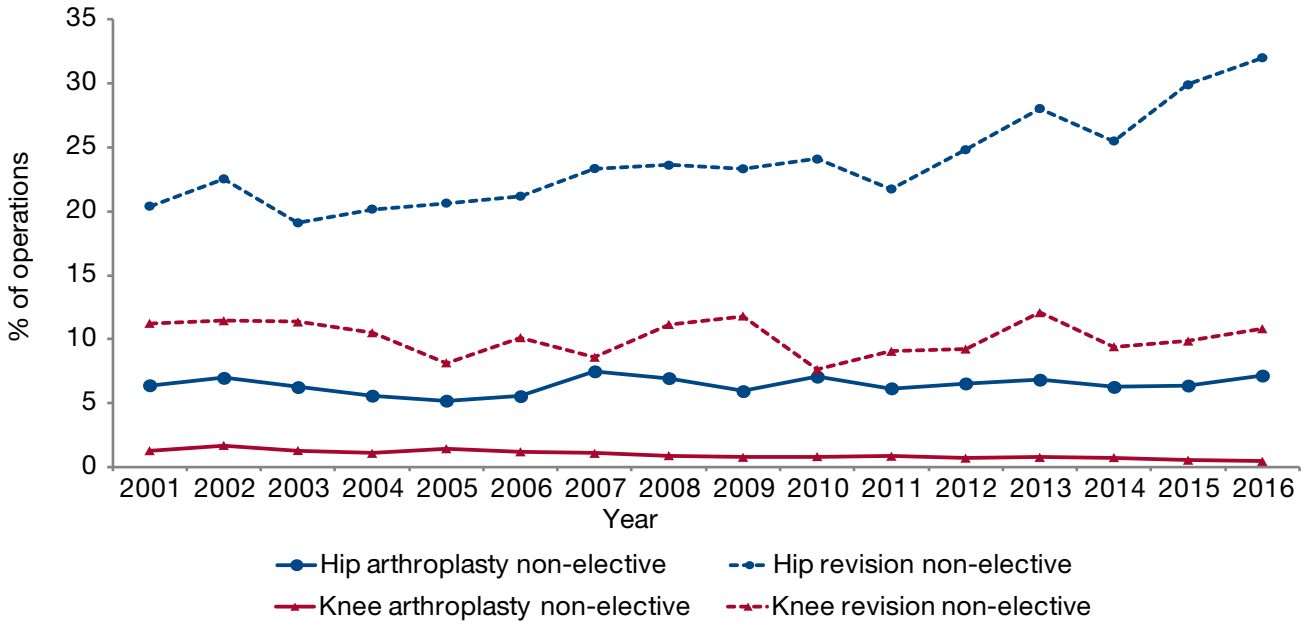
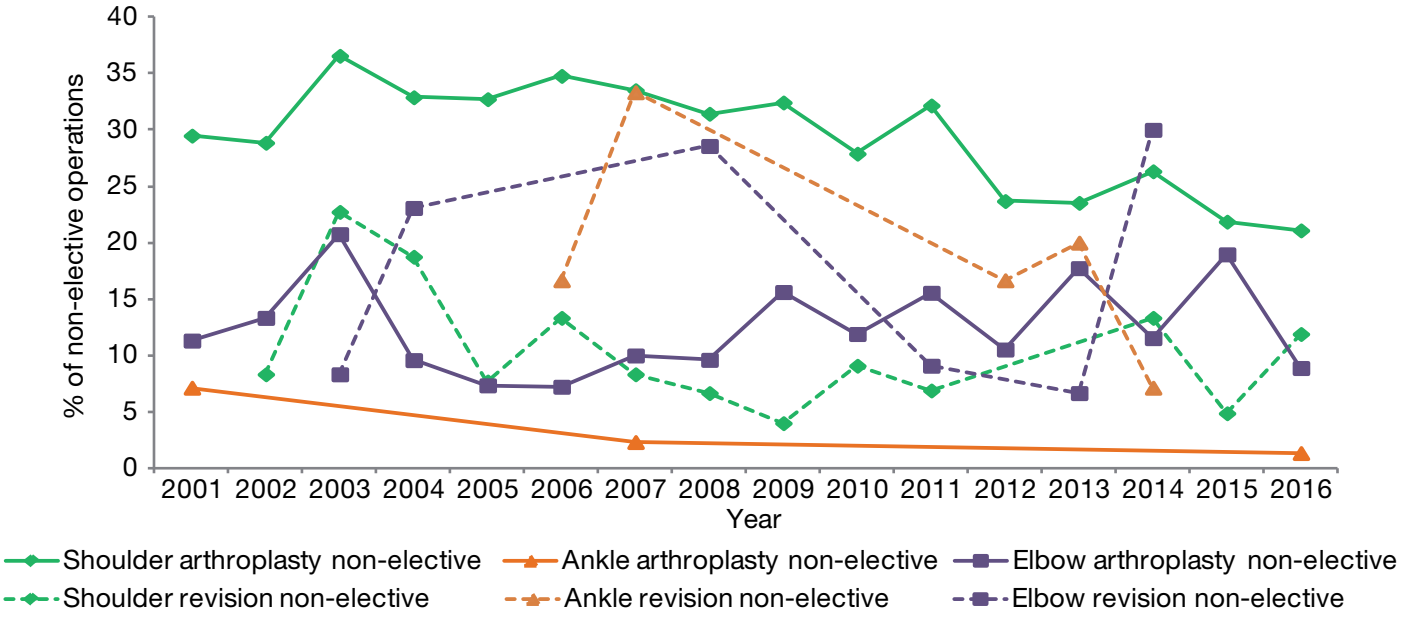


**Figure 1e** — Hip and knee arthroplasty, primary and revision: incidence of non-elective surgery




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 1f** — Shoulder, elbow and ankle arthroplasty, primary and revision: incidence of non-elective surgery



## 1.2 Number of arthroplasties by NHS Board

The numbers of patients undergoing Primary Joint Arthroplasty by Health Board of Treatment is given in Figures 2a to 2e.

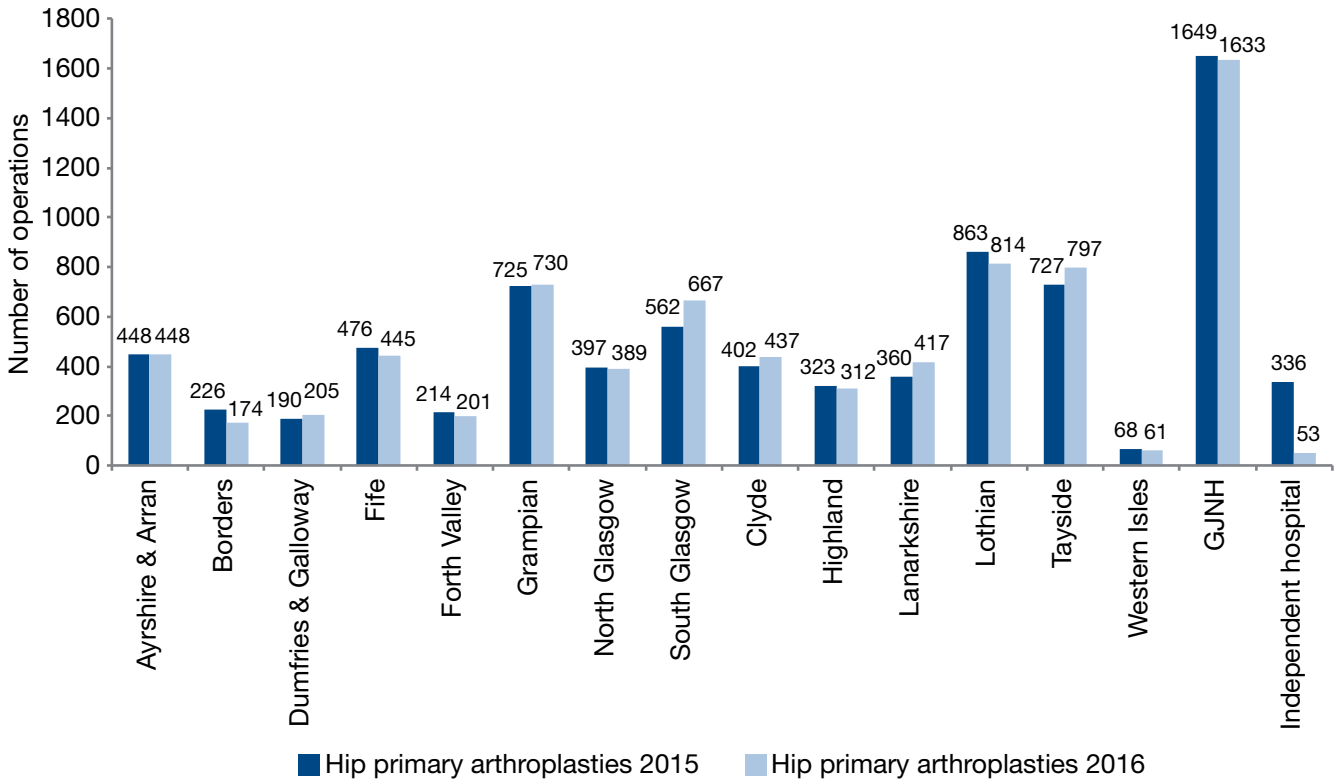
Tables 1a to 1j show the figures for Primary and Revision Joint Replacement for Health Board of Treatment and Health Board of residence.

A large number of patients undergoing primary Hip or Knee Arthroplasty are treated out with their Health Board of Residence (Tables 1a, 1f, 1b, 1g). This affects some Health Boards much more than others. In some Health Boards it is possible that this change, which has occurred over time, will have significantly altered the workload. This may have implications for staffing in certain Health Boards, in terms of the ability to recruit Consultants and the expertise that is required. This trend is not seen in Shoulder, Ankle or Elbow Replacement (Tables 1c,1h,1d,1i,1e,1j).

The migration patterns seen for Primary Hip and Knee Replacement are not replicated in the figures for Revision Hip and Knee Replacement. For example some Health Boards perform considerably less Primary Hip and Knee Replacement than would be expected given the number of Hip and Knee replacements performed by place of residence but perform more revisions than would be expected. The cause of this is likely to be multifactorial.

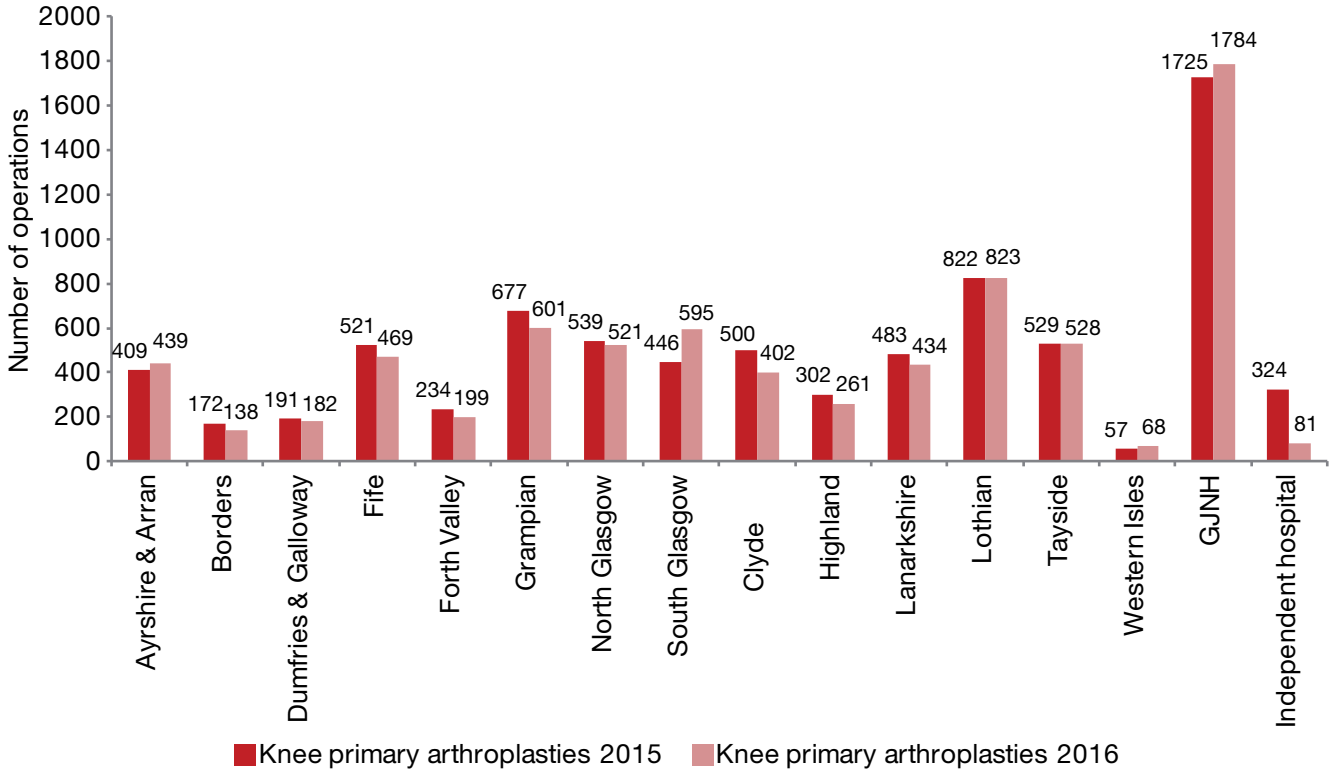
Please note that no arthroplasty procedures are undertaken within NHS Orkney and NHS Shetland therefore do not appear in the tables that follow. Patients who require joint replacement surgery and who live within these two boards have surgery under the care of a mainland health board.

**Figure 2a** — Number of primary hip arthroplasties 2015-2016 by NHS health board of treatment (NHS GG&C split)



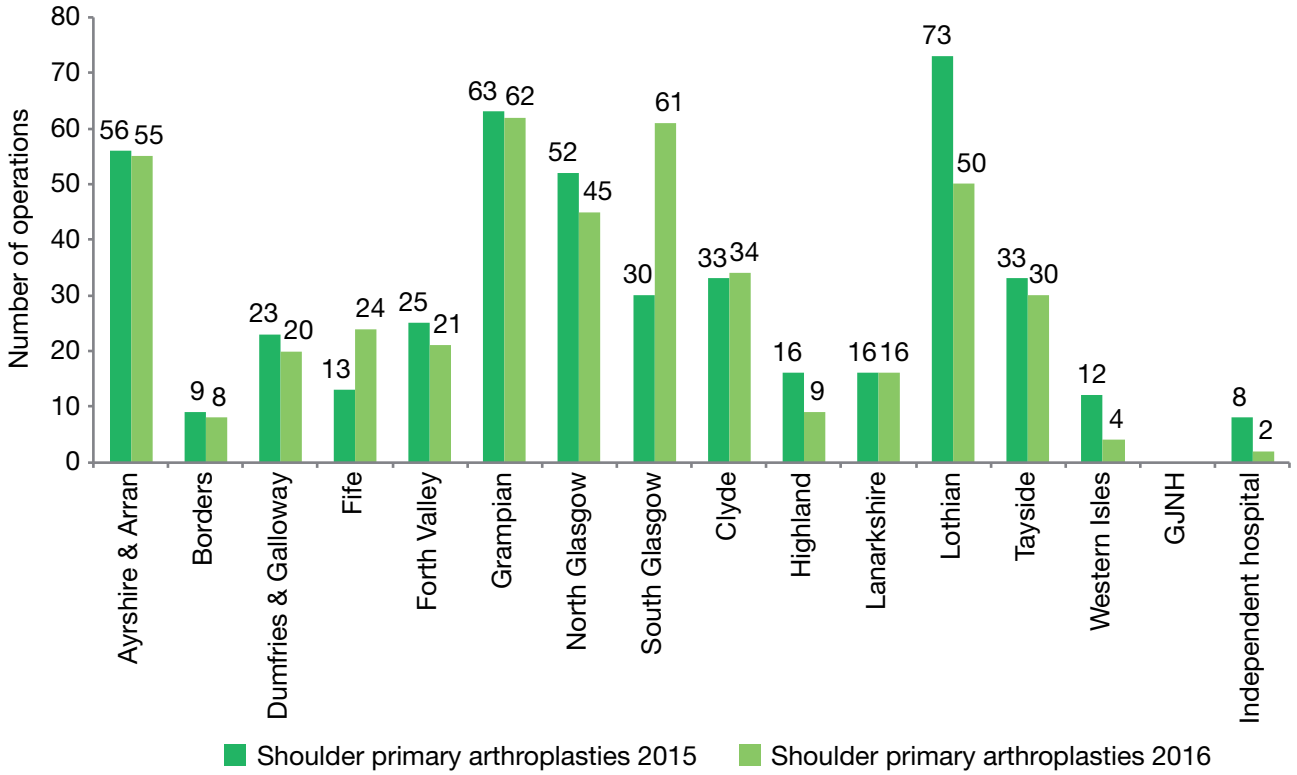

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 2b** — Number of primary knee arthroplasties 2015-2016 by NHS health board of treatment (NHS GG&C split)



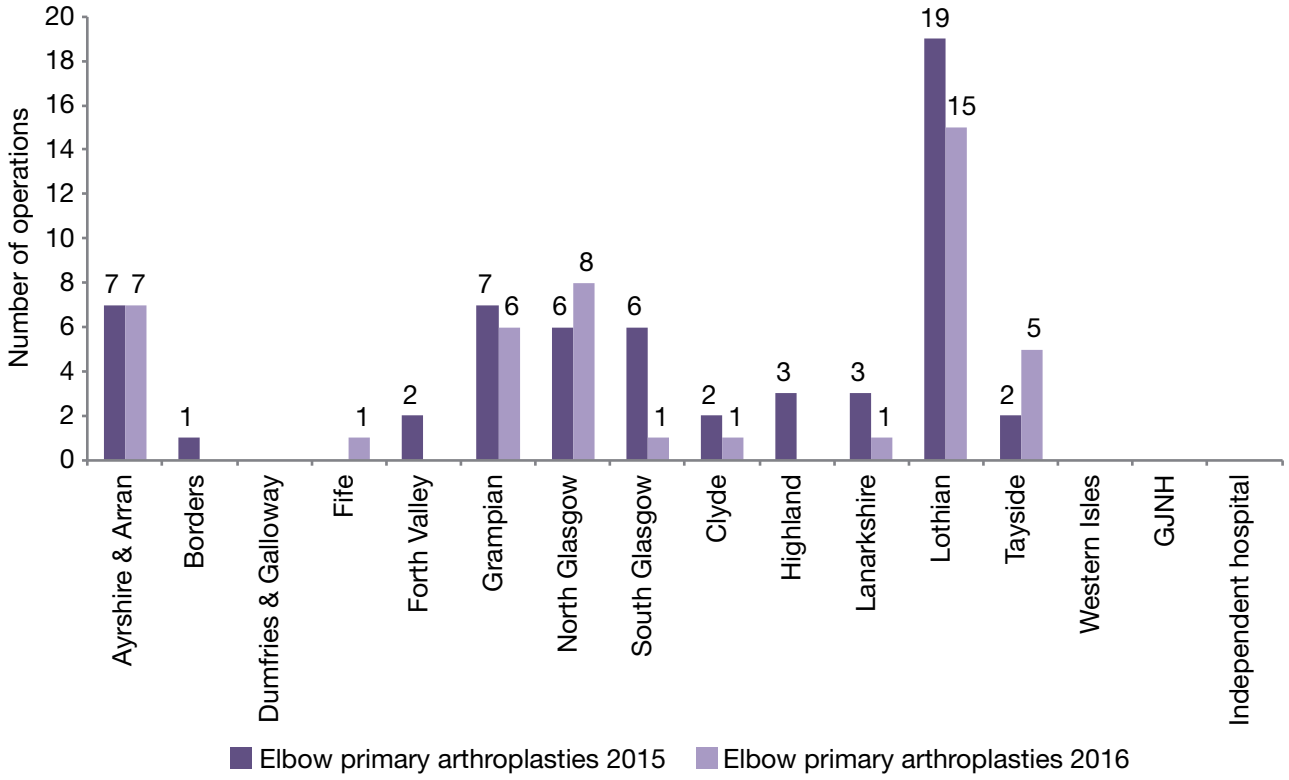

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 2c** — Number of primary shoulder arthroplasties 2015-2016 by NHS health board of treatment (NHS GG&C split)



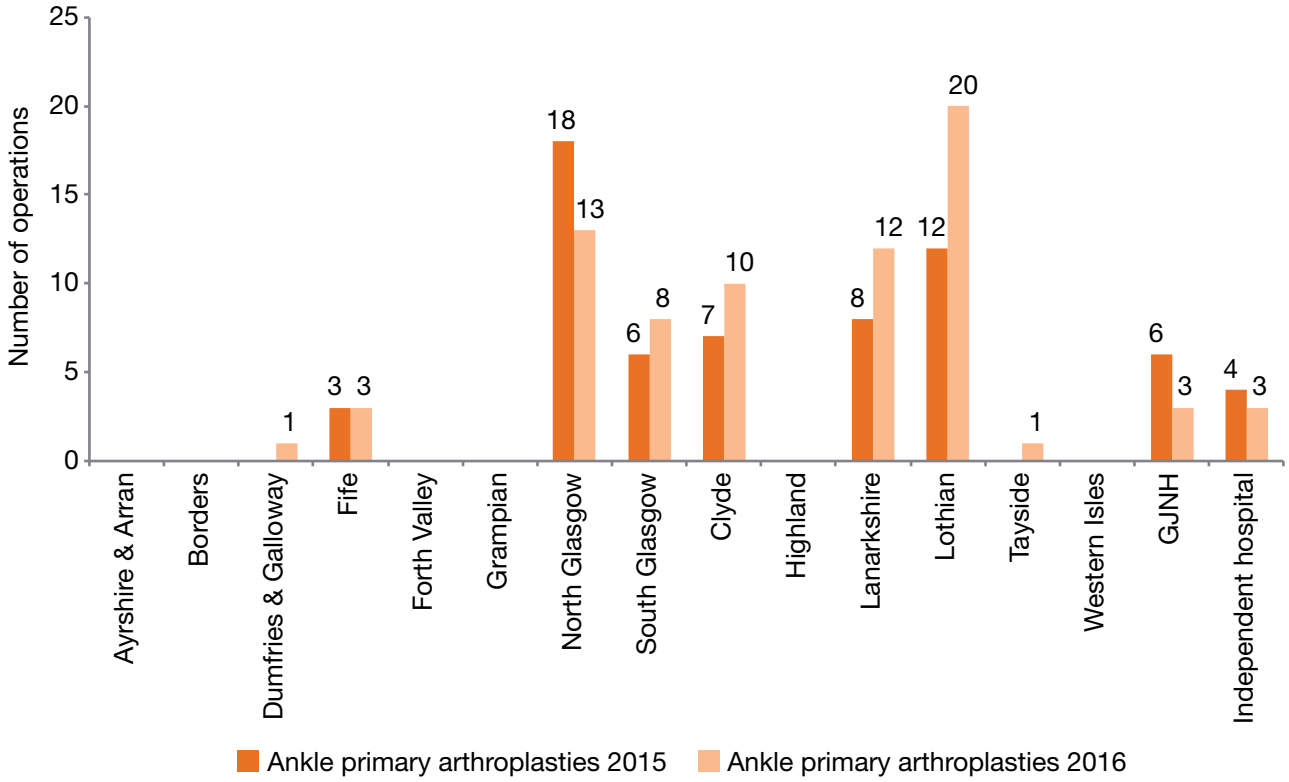

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 2d** — Number of primary elbow arthroplasties 2015-2016 by NHS health board of treatment (NHS GG&C split)




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 2e** — Number of primary ankle arthroplasties 2015-2016 by NHS health board of treatment (NHS GG&C split)




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1a** — Number of hip arthroplasties by NHS health board of treatment (NHS GG&C split)

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 424 | 448 | 448 | 59 | 44 | 38 |
| Borders | 187 | 226 | 174 | 7 | 11 | 6 |
| Dumfries & Galloway | 168 | 190 | 205 | 7 | 2 | 1 |
| Fife | 458 | 476 | 445 | 47 | 45 | 38 |
| Forth Valley | 204 | 214 | 201 | 35 | 27 | 29 |
| Grampian | 727 | 725 | 730 | 91 | 92 | 71 |
| North Glasgow | 691 | 397 | 389 | 112 | 56 | 32 |
| South Glasgow | 409 | 562 | 667 | 93 | 116 | 123 |
| Clyde | 384 | 402 | 437 | 54 | 34 | 39 |
| Highland | 376 | 323 | 312 | 37 | 29 | 28 |
| Lanarkshire | 420 | 360 | 417 | 47 | 62 | 44 |
| Lothian | 870 | 863 | 814 | 154 | 156 | 168 |
| Tayside | 810 | 727 | 797 | 94 | 66 | 68 |
| Western Isles | 43 | 68 | 61 | 3 | 1 | 2 |
| GJNH | 1164 | 1649 | 1633 | 74 | 92 | 94 |
| Independent hospital | 226 | 336 | 53 | 1 | 0 | 0 |
| **Total** | **7558** | **7966** | **7783** | **913** | **833** | **781** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1b** — Number of knee arthroplasties by NHS health board of treatment (NHS GG&C split)

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 464 | 409 | 439 | 40 | 41 | 28 |
| Borders | 170 | 172 | 138 | 5 | 8 | 3 |
| Dumfries & Galloway | 168 | 191 | 182 | 1 | 1 | 1 |
| Fife | 457 | 521 | 469 | 37 | 52 | 36 |
| Forth Valley | 217 | 234 | 199 | 21 | 11 | 24 |
| Grampian | 589 | 677 | 601 | 43 | 54 | 51 |
| North Glasgow | 784 | 539 | 521 | 55 | 49 | 39 |
| South Glasgow | 386 | 446 | 595 | 34 | 34 | 35 |
| Clyde | 412 | 500 | 402 | 34 | 20 | 24 |
| Highland | 287 | 302 | 261 | 16 | 12 | 12 |
| Lanarkshire | 462 | 483 | 434 | 34 | 42 | 37 |
| Lothian | 783 | 822 | 823 | 62 | 70 | 73 |
| Tayside | 696 | 529 | 528 | 51 | 31 | 36 |
| Western Isles | 42 | 57 | 68 | 1 | 1 | 1 |
| GJNH | 1227 | 1725 | 1784 | 42 | 48 | 62 |
| Independent hospital | 223 | 324 | 81 | 1 | 3 | 0 |
| **Total** | **7365** | **7931** | **7525** | **476** | **477** | **462** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1c** — Number of shoulder arthroplasties by NHS health board of treatment (NHS GG&C split)

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 57 | 56 | 55 | 4 | 11 | 6 |
| Borders | 2 | 9 | 8 | 0 | 0 | 0 |
| Dumfries & Galloway | 17 | 23 | 20 | 0 | 0 | 0 |
| Fife | 19 | 13 | 24 | 0 | 1 | 3 |
| Forth Valley | 18 | 25 | 21 | 1 | 2 | 2 |
| Grampian | 54 | 63 | 62 | 6 | 7 | 9 |
| North Glasgow | 59 | 52 | 45 | 6 | 5 | 4 |
| South Glasgow | 32 | 30 | 61 | 4 | 4 | 4 |
| Clyde | 33 | 33 | 34 | 4 | 2 | 2 |
| Highland | 20 | 16 | 9 | 0 | 1 | |
| Lanarkshire | 21 | 16 | 16 | 1 | 1 | 3 |
| Lothian | 63 | 73 | 50 | 3 | 5 | 8 |
| Tayside | 34 | 33 | 30 | 3 | 1 | 1 |
| Western Isles | 4 | 12 | 4 | 1 | 0 | 0 |
| GJNH | 0 | 0 | 0 | 0 | 1 | 0 |
| Independent hospital | 6 | 8 | 2 | 1 | 0 | 0 |
| **Total** | **438** | **462** | **441** | **32** | **41** | **42** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1d** — Number of elbow arthroplasties by NHS health board of treatment (NHS GG&C split)

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 5 | 7 | 7 | 0 | 0 | 0 |
| Borders | | 1 | | 0 | 0 | 0 |
| Dumfries & Galloway | 0 | | | 0 | 0 | 0 |
| Fife | 1 | | 1 | 0 | 0 | 0 |
| Forth Valley | 1 | 2 | | 1 | 0 | 0 |
| Grampian | 6 | 7 | 6 | 1 | 1 | 2 |
| North Glasgow | 6 | 6 | 8 | 2 | 4 | 0 |
| South Glasgow | 6 | 6 | 1 | 2 | 0 | 1 |
| Clyde | 2 | 2 | 1 | 0 | 0 | 0 |
| Highland | 2 | 3 | | 1 | 1 | 0 |
| Lanarkshire | 2 | 3 | 1 | 0 | 0 | 0 |
| Lothian | 16 | 19 | 15 | 5 | 6 | 7 |
| Tayside | 8 | 2 | 5 | 1 | 0 | 0 |
| Western Isles | 0 | 0 | 0 | 0 | 0 | 0 |
| GJNH | 0 | 0 | 0 | 0 | 0 | 0 |
| Independent hospital | 1 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **54** | **58** | **45** | **12** | **12** | **10** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1e** — Number of ankle arthroplasties by NHS health board of treatment (NHS GG&C split)

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 0 | 0 | 0 | 0 | 0 | 0 |
| Borders | 1 | 0 | 0 | 0 | 0 | 0 |
| Dumfries & Galloway | 2 | 0 | 1 | 0 | 0 | 0 |
| Fife | 5 | 3 | 3 | 1 | 0 | 0 |
| Forth Valley | 0 | 0 | 0 | 0 | 0 | 0 |
| Grampian | 1 | 0 | 0 | 0 | 0 | 0 |
| North Glasgow | 16 | 18 | 13 | 5 | 7 | 7 |
| South Glasgow | 3 | 6 | 8 | 0 | 2 | 1 |
| Clyde | 0 | 7 | 10 | 0 | 0 | 0 |
| Highland | 0 | 0 | 0 | 0 | 0 | 0 |
| Lanarkshire | 5 | 8 | 12 | 1 | 0 | 3 |
| Lothian | 12 | 12 | 20 | 2 | 3 | 1 |
| Tayside | 3 | 0 | 1 | 0 | 0 | 0 |
| Western Isles | 0 | 0 | 0 | 0 | 0 | 0 |
| GJNH | 1 | 6 | 3 | 0 | 0 | 0 |
| Independent hospital | 3 | 4 | 3 | 0 | 0 | 0 |
| **Total** | **52** | **64** | **74** | **8** | **12** | **12** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1f** — Number of hip arthroplasties by NHS health board of residence

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 608 | 628 | 650 | 79 | 52 | 49 |
| Borders | 231 | 286 | 232 | 24 | 27 | 26 |
| Dumfries & Galloway | 257 | 278 | 306 | 38 | 31 | 38 |
| Fife | 562 | 543 | 512 | 59 | 55 | 54 |
| Forth Valley | 406 | 504 | 400 | 52 | 39 | 34 |
| Grampian | 817 | 872 | 808 | 83 | 80 | 69 |
| GG&C | 1255 | 1282 | 1334 | 183 | 159 | 143 |
| Highland | 562 | 524 | 508 | 56 | 53 | 44 |
| Lanarkshire | 832 | 907 | 952 | 97 | 114 | 94 |
| Lothian | 1155 | 1289 | 1189 | 131 | 131 | 145 |
| Orkney | 43 | 51 | 40 | 7 | 13 | 4 |
| Shetland | 46 | 51 | 52 | 4 | 6 | 3 |
| Tayside | 689 | 643 | 705 | 86 | 62 | 57 |
| Western Isles | 68 | 86 | 74 | 11 | 4 | 12 |
| England/Wales/NI | 22 | 17 | 14 | 3 | 6 | 8 |
| Unknown | 3 | 1 | 2 | 1 | 0 | 1 |
| Outside UK | 5 | 4 | 5 | 0 | 1 | 0 |
| **Total** | **7558** | **7966** | **7783** | **913** | **833** | **781** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1g** — Number of knee arthroplasties by NHS health board of residence

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 664 | 651 | 685 | 45 | 45 | 44 |
| Borders | 201 | 219 | 188 | 10 | 13 | 10 |
| Dumfries & Galloway | 244 | 251 | 279 | 18 | 17 | 12 |
| Fife | 544 | 596 | 498 | 43 | 57 | 40 |
| Forth Valley | 427 | 553 | 475 | 26 | 16 | 34 |
| Grampian | 663 | 816 | 650 | 39 | 54 | 47 |
| GG&C | 1424 | 1434 | 1369 | 95 | 82 | 76 |
| Highland | 460 | 525 | 486 | 30 | 17 | 26 |
| Lanarkshire | 932 | 1065 | 1041 | 57 | 71 | 60 |
| Lothian | 1054 | 1190 | 1195 | 56 | 70 | 68 |
| Orkney | 37 | 44 | 34 | 2 | 3 | 5 |
| Shetland | 42 | 55 | 51 | 4 | 2 | 2 |
| Tayside | 597 | 453 | 478 | 45 | 26 | 34 |
| Western Isles | 62 | 68 | 85 | 4 | 3 | 4 |
| England/Wales/NI | 10 | 6 | 9 | 2 | 0 | 0 |
| Unknown | 3 | 1 | 1 | 0 | 0 | 0 |
| Outside UK | 2 | 4 | 1 | 0 | 1 | 0 |
| **Total** | **7365** | **7931** | **7525** | **476** | **477** | **462** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1h** — Number of shoulder arthroplasties by NHS health board of residence

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 60 | 55 | 55 | 5 | 11 | 6 |
| Borders | 6 | 13 | 9 | 0 | 1 | 0 |
| Dumfries & Galloway | 20 | 31 | 24 | 1 | 0 | 1 |
| Fife | 25 | 18 | 26 | 0 | 1 | 4 |
| Forth Valley | 23 | 28 | 21 | 2 | 4 | 3 |
| Grampian | 46 | 55 | 53 | 5 | 6 | 6 |
| GG&C | 91 | 88 | 109 | 10 | 7 | 8 |
| Highland | 34 | 23 | 22 | 2 | 2 | 2 |
| Lanarkshire | 31 | 29 | 33 | 2 | 3 | 3 |
| Lothian | 58 | 69 | 48 | 3 | 4 | 7 |
| Orkney | 3 | 4 | 3 | 1 | 0 | 0 |
| Shetland | 3 | 2 | 5 | 0 | 0 | 0 |
| Tayside | 31 | 31 | 28 | 3 | 2 | 2 |
| Western Isles | 6 | 15 | 4 | 1 | 0 | 0 |
| England/Wales/NI | 3 | 0 | 1 | 0 | 0 | 0 |
| Unknown | 0 | 0 | 0 | 0 | 0 | 0 |
| Outside UK | 0 | 1 | 0 | 0 | 0 | 0 |
| **Total** | **438** | **462** | **441** | **32** | **41** | **42** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1i** — Number of elbow arthroplasties by NHS health board of residence

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 6 | 8 | 7 | 0 | 0 | 0 |
| Borders | 3 | 2 | 1 | 1 | 0 | 0 |
| Dumfries & Galloway | 1 | 2 | 1 | 1 | 0 | 0 |
| Fife | 3 | 1 | 2 | 1 | 0 | 1 |
| Forth Valley | 2 | 2 | 3 | 1 | 0 | 0 |
| Grampian | 6 | 7 | 6 | 1 | 1 | 2 |
| GG&C | 8 | 9 | 6 | 2 | 1 | 1 |
| Highland | 2 | 3 | 1 | 1 | 1 | 0 |
| Lanarkshire | 5 | 4 | 2 | 2 | 3 | 0 |
| Lothian | 12 | 18 | 11 | 3 | 6 | 6 |
| Orkney | 0 | 0 | 0 | 0 | 0 | 0 |
| Shetland | 0 | 0 | 0 | 0 | 0 | 0 |
| Tayside | 7 | 2 | 5 | 1 | 0 | 0 |
| Western Isles | 0 | 0 | 0 | 0 | 0 | 0 |
| England/Wales/NI | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown | 0 | 0 | 0 | 0 | 0 | 0 |
| Outside UK | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **54** | **58** | **45** | **12** | **12** | **10** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Table 1j** — Number of ankle arthroplasties by NHS health board of residence

| NHS Board | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of revisions 2011-2014 | Number of revisions 2015 | Number of revisions 2016 |
|---|---|---|---|---|---|---|
| Ayrshire & Arran | 3 | 4 | 2 | 1 | 1 | 1 |
| Borders | 1 | 1 | 2 | 0 | 1 | 0 |
| Dumfries & Galloway | 3 | 0 | 2 | 0 | 0 | 1 |
| Fife | 6 | 3 | 3 | 1 | 0 | 0 |
| Forth Valley | 1 | 1 | 2 | 0 | 0 | 0 |
| Grampian | 1 | 1 | 1 | 0 | 0 | 0 |
| GG&C | 10 | 18 | 18 | 2 | 2 | 0 |
| Highland | 2 | 5 | 5 | 0 | 1 | 1 |
| Lanarkshire | 8 | 12 | 19 | 2 | 4 | 6 |
| Lothian | 14 | 17 | 18 | 1 | 3 | 1 |
| Orkney | 0 | 0 | 0 | 0 | 0 | 0 |
| Shetland | 0 | 0 | 0 | 0 | 0 | 0 |
| Tayside | 2 | 0 | 2 | 0 | 0 | 1 |
| Western Isles | 0 | 2 | 0 | 0 | 0 | 1 |
| England/Wales/NI | 0 | 0 | 0 | 1 | 0 | 0 |
| Unknown | 0 | 0 | 0 | 0 | 0 | 0 |
| Outside UK | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **52** | **64** | **74** | **8** | **12** | **12** |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

The Scottish Arthroplasty Project monitors rates for all types of arthroplasty; although hip and knee are by far the most common, other orthopaedic procedures are routinely undertaken in Scotland.

Table 2 gives data on the total number of arthroplasties performed and the number of Consultants recorded over the same time period that have performed at least one procedure. For Joint replacements performed at low volumes it can be seen that there is an increasing trend for multiple surgeons to perform low volumes of these operations, however the issue of low annual numbers of joint replacement for an individual consultant is not limited to arthroplasties performed in low volumes.

The issue of Low Volume Arthroplasty Surgery is dealt with separately in Section 1.3.

**Table 2** — Number of arthroplasties and operative consultants in 2015 and 2016

| | Mean number of operations 2011-2014 | Number of operations 2015 | Number of operations 2016 | Mean number of consultants performing operations 2011-2014 | Number of consultants performing operations 2015 | Number of consultants performing operations 2016 |
|---|---|---|---|---|---|---|
| Hip arthroplasty | 7558 | 7966 | 7783 | 224 | 231 | 231 |
| Hip revision | 913 | 833 | 781 | 144 | 148 | 145 |
| Knee arthroplasty | 7365 | 7931 | 7525 | 201 | 195 | 192 |
| Knee revision | 476 | 477 | 462 | 102 | 94 | 95 |
| Shoulder arthroplasty | 438 | 462 | 441 | 93 | 91 | 88 |
| Shoulder revision | 32 | 41 | 42 | 18 | 18 | 20 |
| Elbow arthroplasty | 54 | 58 | 45 | 23 | 24 | 17 |
| Elbow revision | 12 | 12 | 10 | 7 | 5 | 4 |
| Ankle arthroplasty | 52 | 64 | 74 | 12 | 9 | 11 |
| Ankle revision | 8 | 12 | 12 | 5 | 5 | 4 |
| Wrist arthroplasty | 17 | 9 | 9 | 8 | 5 | 8 |
| Wrist revision | 2 | 2 | 1 | 2 | 1 | 1 |
| Radial head replacement | 42 | 37 | 52 | 28 | 27 | 41 |
| Radial head revision | 1 | 3 | 2 | 1 | 2 | 2 |
| Finger arthroplasty | 70 | 73 | 78 | 19 | 20 | 21 |
| Finger revision | 4 | 2 | 4 | 4 | 2 | 3 |
| Thumb arthroplasty | 48 | 38 | 36 | 15 | 11 | 5 |
| Thumb revision | 0 | 0 | 0 | 0 | 0 | 0 |
| Toe arthroplasty | 30 | 15 | 11 | 13 | 8 | 9 |
| Excision* | 327 | 381 | 421 | 115 | 131 | 120 |
| Resurf. Of Patella* | 36 | 34 | 42 | 23 | 20 | 25 |
| Other knee resurfacing* | 23 | 16 | 43 | 16 | 9 | 23 |
| Other resurfacing* | 15 | 4 | 1 | 11 | 4 | 1 |
| Other | 90 | 64 | 54 | 51 | 40 | 41 |
| **Total** | **17611** | **18534** | **17929** | **1135** | **1100** | **1107** |

***Limited SMR01 coding generating a generalised description of clinical procedure*

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals*

## 1.3 Consultants performing low volumes

It is generally accepted that performing low volumes of any surgical procedure may be associated with poorer outcomes. There is increasing evidence for this within orthopaedic surgery.

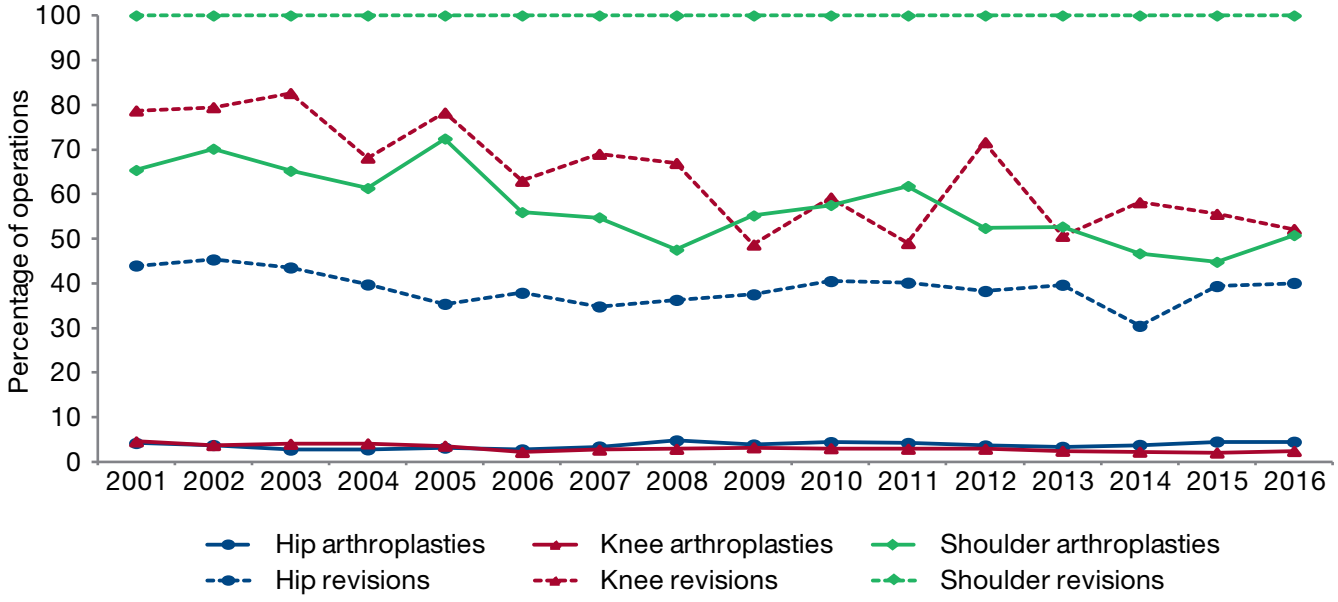
Over the last year the Scottish Arthroplasty Project has looked more closely at this issue. Our aims in doing this include informing the consultant body about what is happening within Scotland, encouraging debate and dialogue, and where appropriate facilitating change that may improve the outcomes for patients undergoing arthroplasty procedures. This is to some extent already happening with good examples of units where consultants have reflected on their practice and rationalised the procedures that they offer. There are also good examples of networking underway including the recent start-up of a National Knee Revision Network.

We want to make it clear that it is not our intention within the Scottish Arthroplasty Project to dictate to consultants/units what they should be doing; rather we feel our role is to provide information and an overview that will facilitate the debate/change locally and nationally. We hope that various national bodies such as the British Hip Society may provide further guidance/consensus on these matters.

Our first concern was which definition of low volume operators to use and where to "set the bar". It is more difficult to provide a precise number for every arthroplasty procedure. We hoped that setting the bar relatively low at 10 or fewer procedures would be uncontroversial and generally acceptable as a standard. We included primary and revision hip, knee, shoulder, elbow and ankle arthroplasty.

The process involved identifying consultants via their own hospital SMR01 data that fell into the categories above. This included over 200 consultants and it quickly became evident that it was a large logistical exercise. The consultants were contacted by e-mail, asked to check the data and where incorrect, notify their coding department. The process was then repeated to look at the verified data which is presented below (fig 3) & Map 1.

**Figure 3** — Recent trends in operations carried out by low-volume operators (i.e. Surgeons who perform such operations <=10 times in the calendar year)




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

With the “bar” set at 10 or fewer procedures per annum it is evident that only a small percentage of all primary hip and knee arthroplasty is performed by low volume operators but that all revision shoulder arthroplasty is done by surgeons in this category. The percentage of primary shoulder arthroplasty and knee revision work performed by low vol. surgeons has shown a downward trend over the last 16 years unlike revision hip surgery where about 40% of all procedures continue to be done by low volume surgeons. There is insufficient data to present in this fashion for elbow and ankle arthroplasty.

Map 1 below shows the numbers of surgeons performing low volume arthroplasty surgery by individual hospital and joint. This data should be looked at with recognition that much of it is simply incorrect. This is hospital level data that we have asked individual consultants to verify and correct in the process described above. Whilst going through this process we have had much communication from individual consultants, most of which had been extremely helpful and encouraging. We recognise that there are ongoing coding issues, cases being wrongly attributed to consultants etc. all of which contribute to the picture presented. We should again make it clear that this is **NOT** Scottish Arthroplasty Data. This is consultants own individual hospital data. We at the SAP cannot correct it. Any corrections must be done within each hospital coding dept. which will then become evident and visible to the SAP the following month. We have decided to publish the map to provide a reference which is visible and will hopefully change/improve as we move forward with a new process described at the end of this section.

**Map 1**—Number of low volume surgeons (10 or fewer) by hospital during 2016 (caution advised in interpreting data – see text)

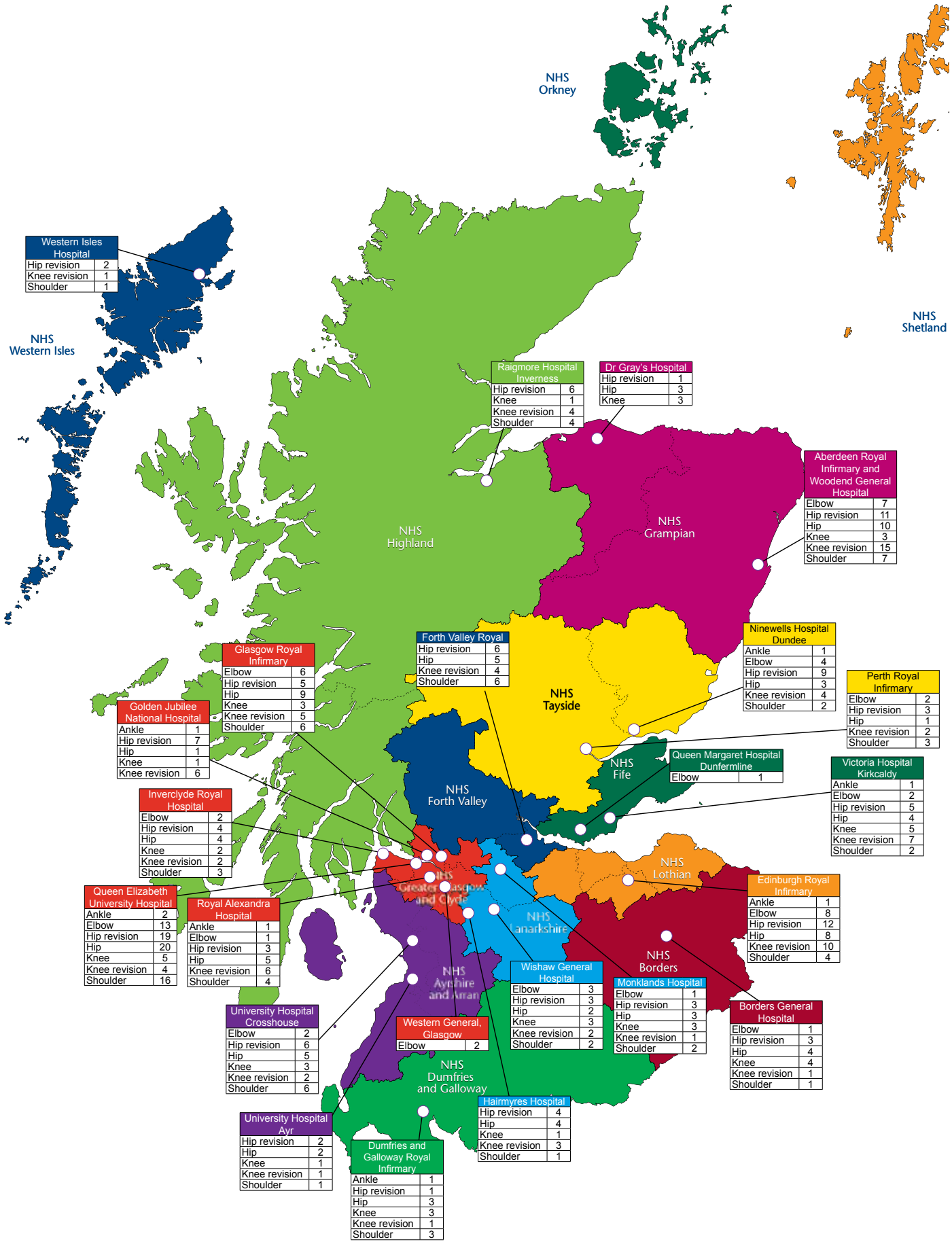


Table 3a demonstrates that in 2016, 41.1% of 231 surgeons doing primary THR did 10 or fewer procedures and contributed to 4.5% of the 7783 THR's in the country. In other words, 95 surgeons performed 350 THR's, with mean of 3.7 THR's.

### Table 3a — The number and percentage of hip arthroplasties by surgeon and performance activity 2012-2016

| Year | Total number of hip arthroplasties | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-30 operations per year | Percentage of operations by surgeons performing 11-30 operations per year | Percentage of surgeons performing 31-50 operations per year | Percentage of operations by surgeons performing 31-50 operations per year | Percentage of surgeons performing 51-80 operations per year | Percentage of operations by surgeons performing 51-80 operations per year | Percentage of surgeons performing 81-100 operations per year | Percentage of operations by surgeons performing 81-100 operations per year | Percentage of surgeons performing >100 operations per year | Percentage of operations by surgeons performing >100 operations per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 7507 | 227 | 34.8% | 3.7% | 26.0% | 15.3% | 18.9% | 22.7% | 7.0% | 14.1% | 5.7% | 15.8% | 7.5% | 28.4% |
| 2013 | 7667 | 217 | 35.9% | 3.4% | 21.2% | 11.9% | 17.5% | 19.3% | 11.5% | 21.0% | 5.1% | 12.6% | 8.8% | 31.9% |
| 2014 | 7816 | 232 | 37.1% | 3.8% | 26.7% | 15.7% | 12.1% | 14.0% | 10.8% | 21.1% | 6.5% | 17.1% | 6.9% | 28.2% |
| 2015 | 7966 | 231 | 39.8% | 4.5% | 19.5% | 11.2% | 17.7% | 20.8% | 12.6% | 25.0% | 3.5% | 8.8% | 6.9% | 29.6% |
| 2016 | 7783 | 231 | 41.1% | 4.5% | 16.5% | 9.2% | 18.2% | 21.5% | 10.8% | 20.2% | 5.6% | 14.8% | 7.8% | 29.7% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

Similarly, Table 3b demonstrates that in 2016, 21.9% of 192 surgeons doing primary TKR did 10 or fewer procedures and contributed to 2.4% of the 7525 TKR's in the country. In other words, 42 surgeons performed 181 TKR's, with a mean of 4.3 TKR's.

### Table 3b — The number and percentage of knee arthroplasties by surgeon and performance activity 2012-2016

| Year | Total number of knee arthroplasties | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-30 operations per year | Percentage of operations by surgeons performing 11-30 operations per year | Percentage of surgeons performing 31-50 operations per year | Percentage of operations by surgeons performing 31-50 operations per year | Percentage of surgeons performing 51-80 operations per year | Percentage of operations by surgeons performing 51-80 operations per year | Percentage of surgeons performing 81-100 operations per year | Percentage of operations by surgeons performing 81-100 operations per year | Percentage of surgeons performing >100 operations per year | Percentage of operations by surgeons performing >100 operations per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 7549 | 209 | 26.3% | 2.9% | 29.7% | 18.0% | 19.1% | 20.5% | 13.9% | 24.2% | 2.9% | 6.7% | 8.1% | 27.6% |
| 2013 | 7226 | 196 | 24.5% | 2.5% | 29.6% | 16.7% | 19.9% | 21.0% | 13.3% | 23.2% | 7.1% | 17.4% | 5.6% | 19.2% |
| 2014 | 7886 | 201 | 21.9% | 2.3% | 31.3% | 16.6% | 19.4% | 20.0% | 13.9% | 22.1% | 6.0% | 13.7% | 7.5% | 25.3% |
| 2015 | 7931 | 195 | 19.5% | 2.1% | 31.3% | 16.3% | 21.0% | 20.4% | 14.4% | 21.7% | 6.2% | 13.3% | 7.7% | 26.3% |
| 2016 | 7525 | 192 | 21.9% | 2.4% | 31.8% | 17.1% | 18.2% | 18.7% | 15.6% | 25.8% | 6.3% | 13.6% | 6.3% | 22.4% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*



Table 3c demonstrates that most of shoulder arthroplasty is performed in this country by consultants performing low numbers ie. 86.4% of 88

consultants do 50.8% of 441 shoulder replacements ie. 76 surgeons do 224 shoulder replacements with a mean of 3.

### Table 3c — The number and percentage of shoulder arthroplasties by surgeon and performance activity 2012-2016

| Year | Total number of shoulder arthroplasties | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-30 operations per year | Percentage of operations by surgeons performing 11-30 operations per year | Percentage of surgeons performing 31-50 operations per year | Percentage of operations by surgeons performing 31-50 operations per year | Percentage of surgeons performing 51-80 operations per year | Percentage of operations by surgeons performing 51-80 operations per year | Percentage of surgeons performing 81-100 operations per year | Percentage of operations by surgeons performing 81-100 operations per year | Percentage of surgeons performing >100 operations per year | Percentage of operations by surgeons performing >100 operations per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 439 | 92 | 88.0% | 52.4% | 12.0% | 47.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2013 | 442 | 85 | 87.1% | 52.7% | 11.8% | 38.2% | 1.2% | 9.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2014 | 471 | 95 | 85.3% | 46.7% | 12.6% | 38.6% | 2.1% | 14.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2015 | 462 | 91 | 85.7% | 44.8% | 12.1% | 40.5% | 2.2% | 14.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2016 | 441 | 88 | 86.4% | 50.8% | 13.6% | 49.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

Table 3d demonstrates a similar pattern in revision hip arthroplasty with 81.4% of 145 surgeons performing 40.1% of 781 revision hip replacements. Or 118 surgeons doing 313 procedures with a mean of 2.65 revisions each.

### Table 3d — The number and percentage of hip revisions by surgeon and performance activity 2012-2016

| Year | Total number of hip revisions | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-20 operations per year | Percentage of operations by surgeons performing 11-20 operations per year | Percentage of surgeons performing 21-80 operations per year | Percentage of operations by surgeons performing 21-80 operations per year |
|---|---|---|---|---|---|---|---|---|
| 2012 | 951 | 148 | 81.1% | 38.3% | 10.8% | 25.0% | 8.1% | 36.7% |
| 2013 | 963 | 152 | 80.9% | 39.7% | 11.2% | 26.5% | 7.9% | 33.9% |
| 2014 | 847 | 138 | 78.3% | 30.5% | 15.9% | 40.9% | 5.8% | 28.7% |
| 2015 | 833 | 148 | 82.4% | 39.4% | 12.2% | 32.9% | 5.4% | 27.7% |
| 2016 | 781 | 145 | 81.4% | 40.1% | 13.8% | 35.3% | 4.8% | 24.6% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

Table 3e looks at knee revisions. 86.3% of 95 surgeons perform 10 or fewer knee revisions and account for 52.2% of 462 revisions in 2016. In other words, 82 surgeons do 241 operations with a mean of 3.

### Table 3e — The number and percentage of hip revisions by surgeon and performance activity 2012-2016

| Year | Total number of knee revisions | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-20 operations per year | Percentage of operations by surgeons performing 11-20 operations per year | Percentage of surgeons performing 21-80 operations per year | Percentage of operations by surgeons performing 21-80 operations per year |
|---|---|---|---|---|---|---|---|---|
| 2012 | 444 | 101 | 92.1% | 71.6% | 5.9% | 18.2% | 2.0% | 10.1% |
| 2013 | 472 | 103 | 84.5% | 50.6% | 12.6% | 34.5% | 2.9% | 14.8% |
| 2014 | 478 | 101 | 88.1% | 58.2% | 9.9% | 31.6% | 2.0% | 10.3% |
| 2015 | 477 | 94 | 87.2% | 55.6% | 11.7% | 37.3% | 1.1% | 7.1% |
| 2016 | 462 | 95 | 86.3% | 52.2% | 9.5% | 28.8% | 4.2% | 19.0% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

Table 3f looks at shoulder revisions. There are only a small number of revision shoulder procedures per annum with a mean or 2 for the 20 surgeons recorded as performing this procedure, and all performing 10 or fewer.

The total numbers for ankle and elbow arthroplasty are very low nationally and there are significant numbers of surgeons doing 1-2 operations alone. Data at this level may make individual surgeons/patients identifiable and are not presented.

### Table 3f — The number and percentage of shoulder revisions by surgeon and performance activity 2012-2016

| Year | Total number of shoulder revisions | Total number of surgeons | Percentage of surgeons performing <=10 operations per year | Percentage of operations by surgeons performing <=10 operations per year | Percentage of surgeons performing 11-20 operations per year | Percentage of operations by surgeons performing 11-20 operations per year | Percentage of surgeons performing 21-80 operations per year | Percentage of operations by surgeons performing 21-80 operations per year |
|---|---|---|---|---|---|---|---|---|
| 2012 | 30 | 16 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2013 | 25 | 15 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2014 | 45 | 25 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2015 | 41 | 18 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2016 | 42 | 20 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

## The future

It remains clear that a relatively large number of arthroplasty procedures of all kinds are being performed by surgeons doing 10 or fewer operations. We hope that providing data in this fashion will help fuel the debate as to the appropriateness of this situation. It is our hope that some rationalisation/ re-organisation will be encouraged with a downward trend in these figures.

One of our main concerns at the SAP is the accuracy and validity of the data presented. This becomes increasingly important when we start to look at low volume procedures in joints other than hip and knee. It is our hope that the advent of online CUSUM data earlier this year for individual consultants will be a "game changer" in this regard. This provides information that is near real time for primary and revision hip and knee arthroplasty and their complications. We hope that we will be able to add in similar data on shoulder, elbow and ankle arthroplasty as we move forward. It should be very easy for consultants to look at their data on line, and if they are attributed a case that is clearly wrong, for example a lower limb surgeon doing a revision shoulder replacement, they will be able to correct that simply and quickly with a link provided to their hospital coding dept.

Minimum numbers for procedures are being discussed at various joint societies eg British Hip Society and British Association for Knee Surgery. It is hoped that they and other joint societies will provide further guidance on this issue.

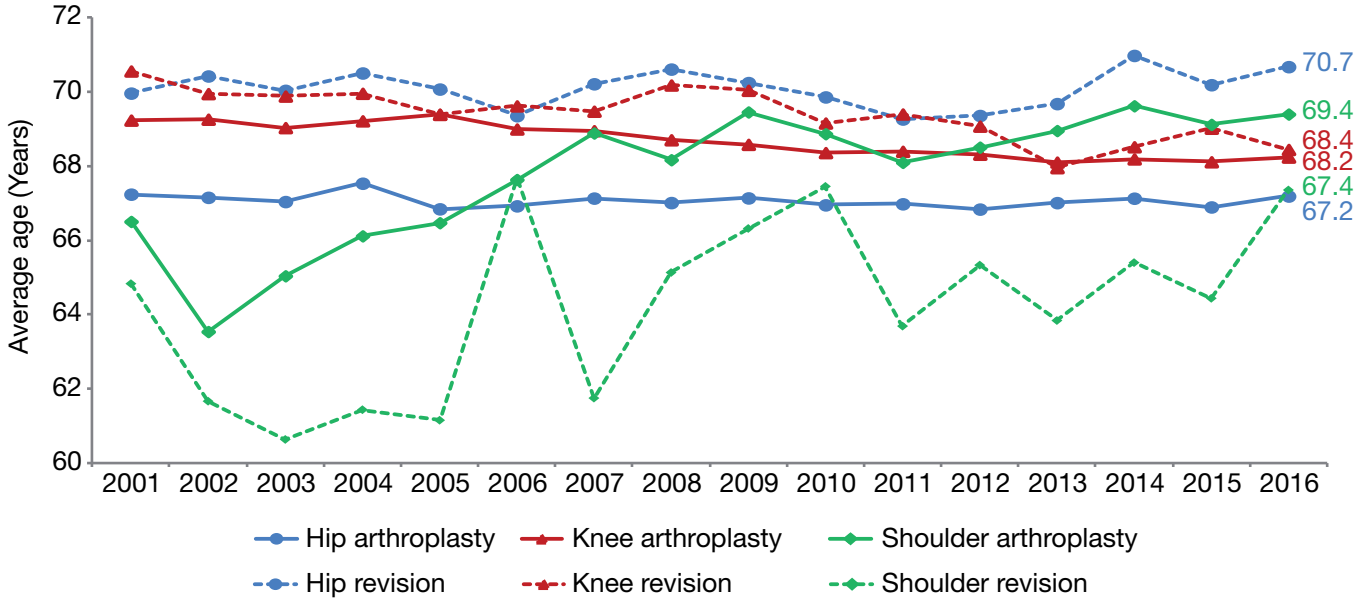
# 2. Patient Demographics

## 2.1 Age

Primary hip and knee arthroplasty operations are generally considered as a last choice in the treatment of advanced degenerative hip and knee diseases. Apart from a few conditions the patients who need these types of surgeries tend to be relatively elderly. The mean age for primary total hip arthroplasty in 2001 was 67.3 years, in 2015 it was 66.9 years and in 2016 it was 67.2 years. For primary knee arthroplasty the mean age in 2001 was 69.3 years, in 2015 it was 68.1 years and in 2016 it was 68.2 years. Although these are still not huge differences, it still appears to be a modest decrease in the mean age of primary knee arthroplasties compared to primary hip arthroplasties. In comparison to the NJR 2015 report, the median age of the patients for primary hip arthroplasty is 69 years and for primary knee arthroplasty it is 70 years. The average age for primary shoulder arthroplasty patients was 69.4 years, and this is higher than the average age of those patients who had primary hip and primary knee replacements.

Regarding revision hip surgery, the mean age for patients was 69.9 years in 2001, 70.2 years in 2015 and 70.7 years in 2016. There were years between 2011-2013 when the mean age for hip revisions was slightly reduced – the lowest being 69.3 in 2011. This may have reflected the increase of metal on metal revisions associated with the early failure of that bearing surface. With the decline of metal on metal bearings it is anticipated that in the long term these type of revisions will further decline. The mean age for knee revisions was 70.6 years in 2011, this reduced to 68.9 years to 2015 and further reduced to 68.4 years in 2016. This remained the biggest age reduction in the 4 lower limb arthroplasty groups, similar to the 2016 SAP Report. There may be many contributing factors to this, including the relatively higher revision rate in younger patients who had unicompartmental or total knee replacements at younger age, and this also may reflect that early revisions (such as infections, or technical errors) are relatively higher in knee arthroplasty compared to total hip replacement. The average age for primary shoulder arthroplasty was 69.4 years in 2016, and it was 67.4 age for revision shoulder arthroplasty. This may indicate the challenges and potential early failures for young patients in the primary shoulder arthroplasty group. As mentioned in the last report, recording other demographic data such as BMI or social deprivation index would be very useful to include and analyse but these data are still currently unavailable.

**Figure 4** — Recent trends in average age of hip, knee and shoulder arthroplasty patients

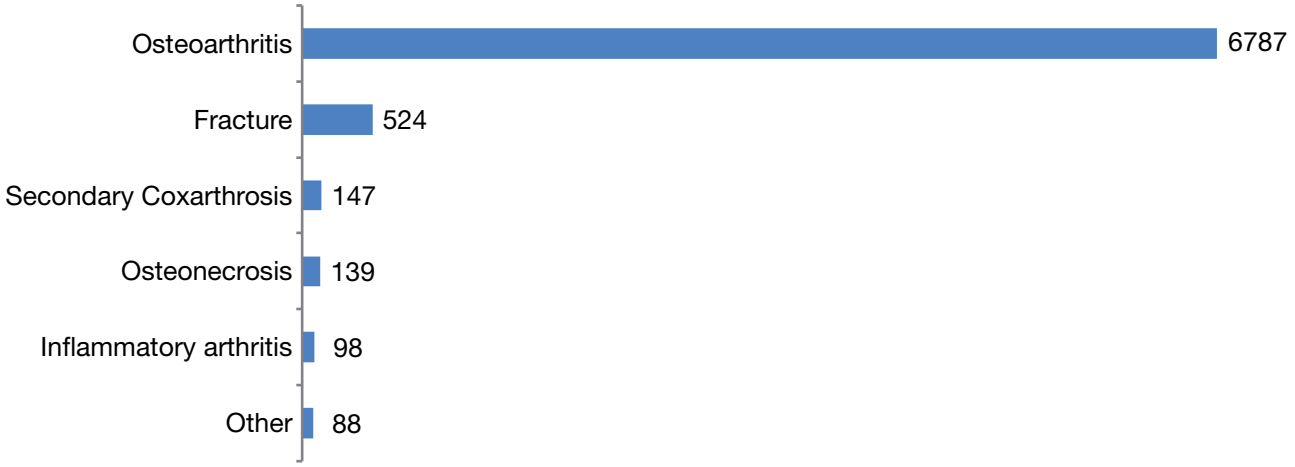



*Includes elective patients only; bilateral operations counted twice; includes known patients from independent hospitals*

## 2.2 Indication for surgery

Figure 5a, Figure 5b and Figure 5c give more detailed information on all diagnosis. Indications for primary total hip arthroplasties were mainly osteoarthritis (6787 cases), followed by fractures (524 cases), similar to the 2016 SAP report. In the primary knee arthroplasty group the main indication was also osteoarthritis (7316) followed by inflammatory knee arthritis (107). Indication for shoulder replacement was mainly primary osteoarthritis (194). Inflammatory arthritis was recorded in 55 cases, and fracture in 34 cases. The high number (148 cases) of "other" indication for shoulder arthroplasty suggest potential local coding challenges.

**Figure 5a** — Principal pre-operative conditions: hip arthroplasties in 2016

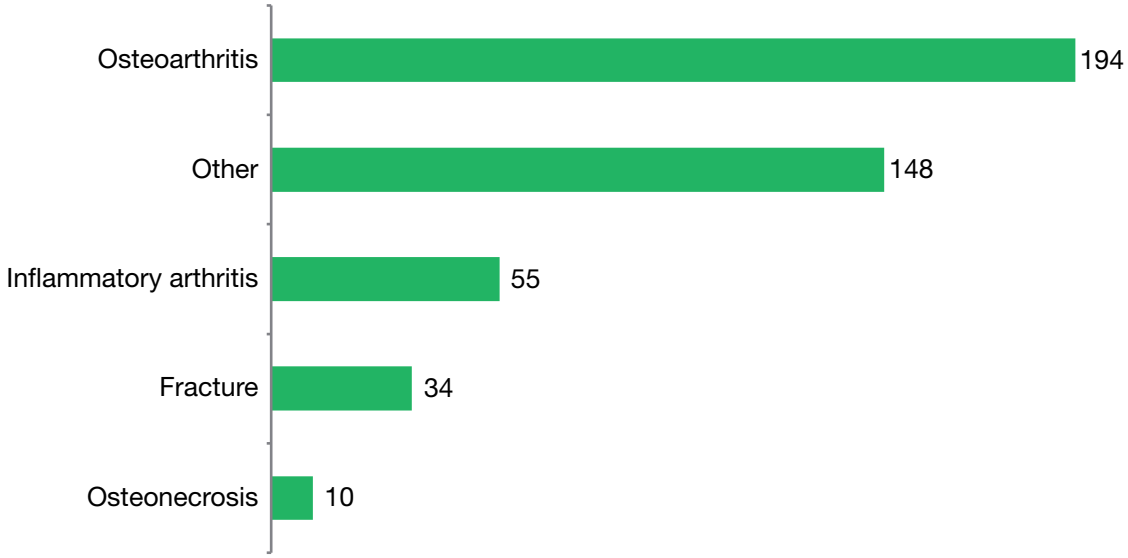



*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals*

**Figure 5b** — Principal pre-operative conditions: knee arthroplasties in 2016


*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

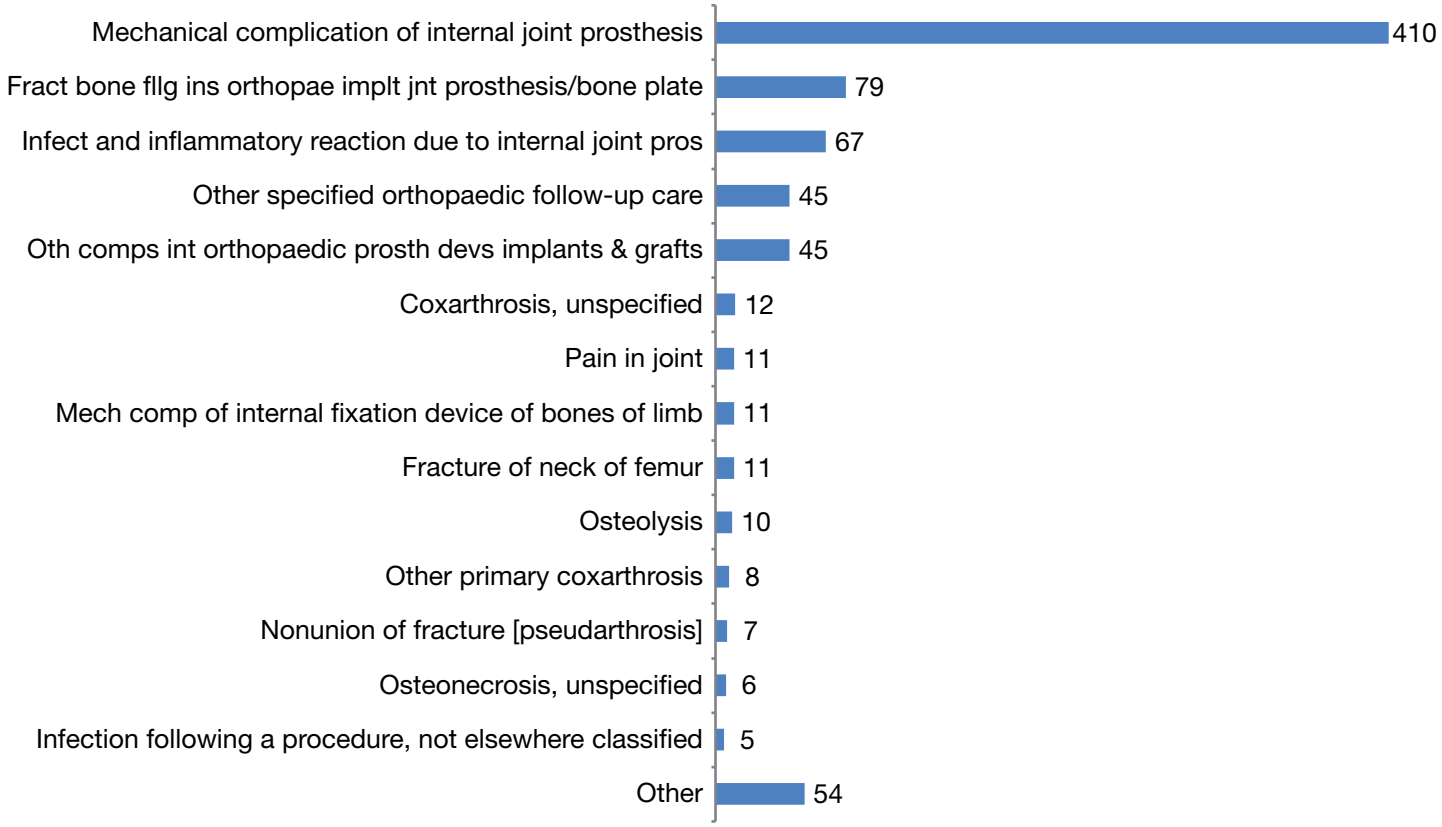
**Figure 5c** — Principal pre-operative conditions: shoulder arthroplasties in 2016




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

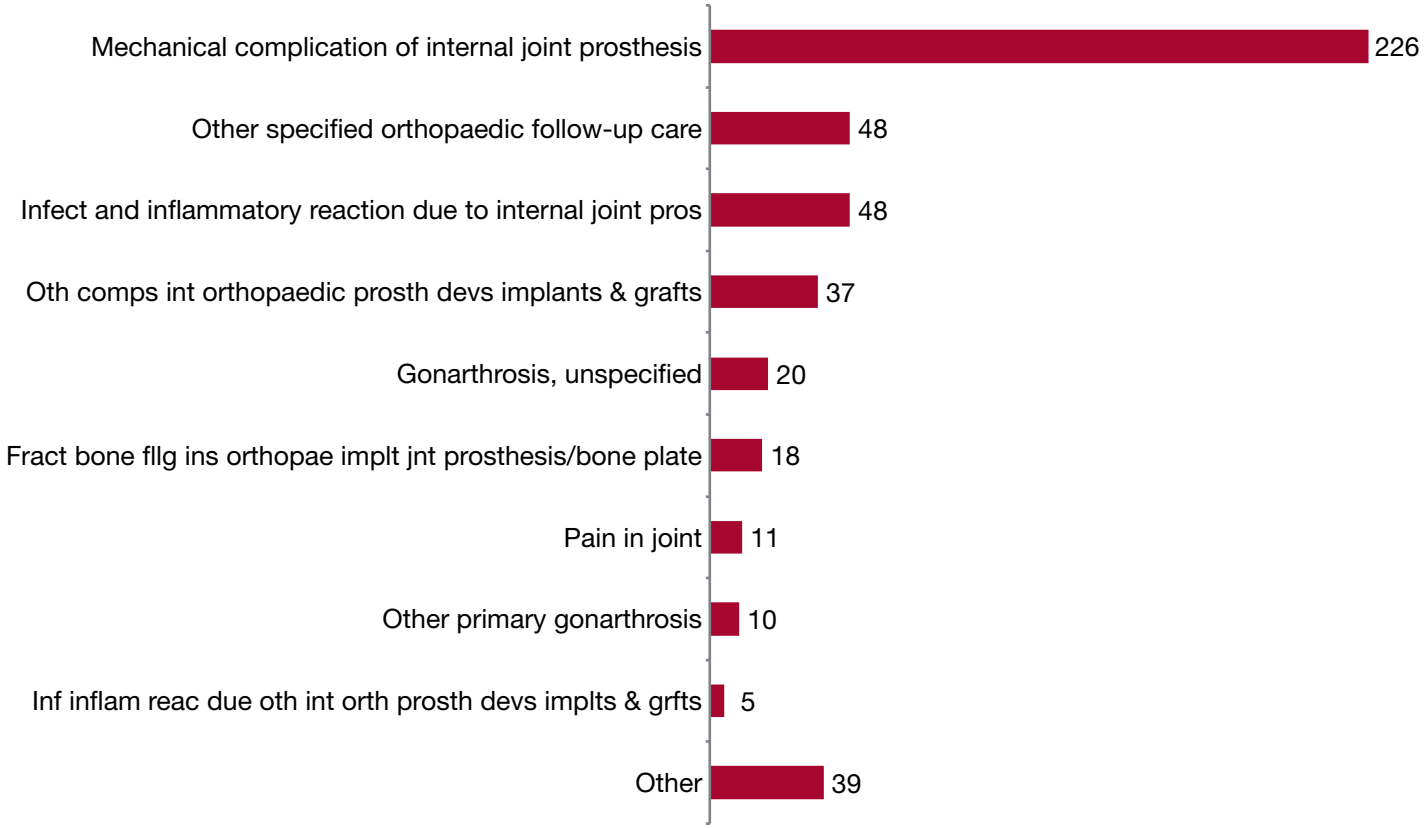
In revision hip surgery the main reason was mechanical complication – loosening – in most of the cases (410). This was followed by fracture (79), infection (67) and other causes (Figure 5d). In the revision knee group the main reason was also coded as mechanical complication – loosening – in 226 cases, followed by infection (48) and other causes (Figure 5e). The main indications for revision shoulder arthroplasty was aseptic loosening (22), with “other” complications (20). (Figure 5f).

**Figure 5d** — Principal pre-operative conditions: hip revision in 2016



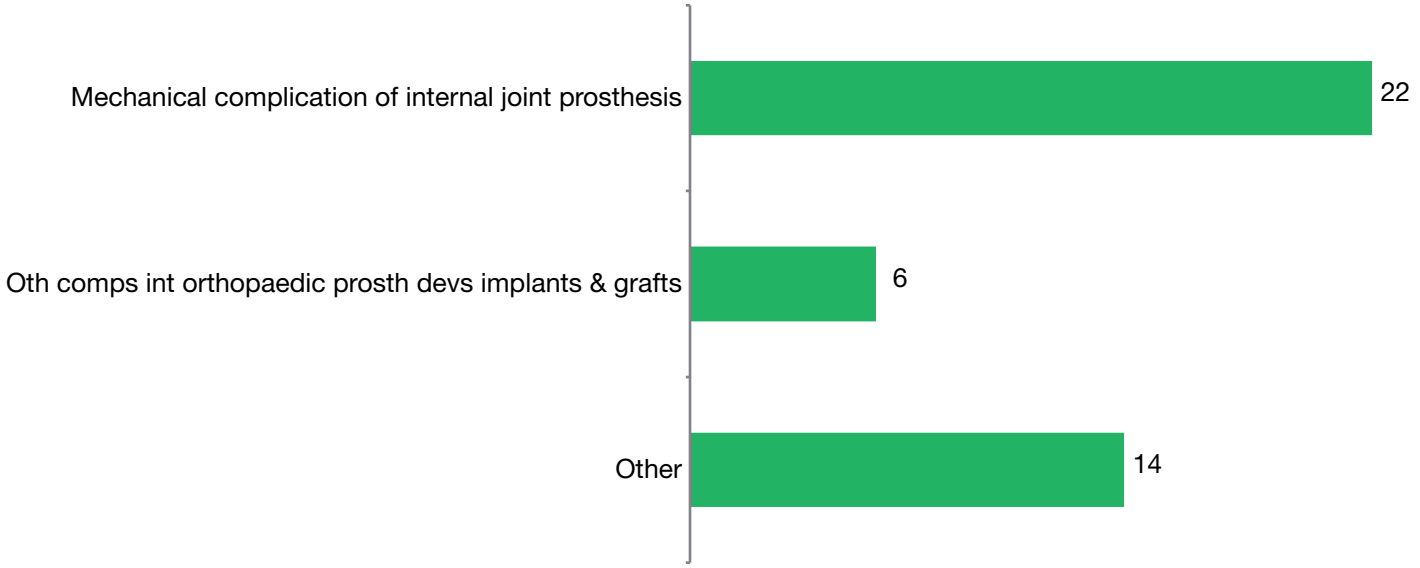

*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 5e** — Principal pre-operative conditions: knee revisions in 2016




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

**Figure 5f** — Principal pre-operative conditions: shoulder revisions in 2016




*Includes emergency admissions; bilateral operations counted twice; includes known patients from independent hospitals.*

As already mentioned in the 2016 SAP Report, indications for surgery - both for primary and also for revision operations - are taken from the local hospital's coding data. Due to the limitations of the available international coding system, indications for surgery (especially for revisions) are not recorded in such a format or using terminology that most surgeons would use or recognize. There is also an issue with potential errors in coding especially with revision cases. This area remains particularly challenging and highlights the need for future work including closer local collaboration within every hospital between surgeons and the coding departments. It has been recognised and identified as important future work for the Scottish Arthroplasty Project to provide clinically relevant and meaningful subcategories and better quality data on revisions. This is currently being actively discussed within the Steering Group and is considered one of the main priorities.

# 3. Inpatient Episodes

## 3.1 Length of stay

Since 2001 the length of stay for patients undergoing hip and knee arthroplasty has halved, from a mean of 10 days to 5 days. There has been a slowing down in improvements in length of stay and the graph (Figure 6) shows a gradual levelling off between 2011 and 2015.

There continues to be widespread variation across Scotland with regard to day of surgery admission to hospital (Figure 7a and 7b). Some centres, such as NHS Western Isles and NHS Grampian admitted patients to hospital on average on the day before surgery whereas other NHS Boards admitted patients on average on the day of surgery. Geographic isolation and patient travel times do not seem to fully explain this variation, which may be attributable to local arrangements. Admission to hospital on the day of surgery could save up to 5435 nights in hospital (mean pre-operative length of stay x number of arthroplasties).

There is a wide variation between NHS Boards in length of stay following hip arthroplasty (Figure 7a), with a two-fold difference in the best and worst performing NHS Boards (4 days versus 8 days total length of stay). If all NHS Boards were able to achieve a length of stay similar to the best performing centres then the mean length of stay for patients following hip arthroplasty would be further reduced.

The variation in length of stay after knee arthroplasty (Figure 7b) is similar to hip arthroplasty, with the best performing NHS Boards achieving a total length of stay of 4 days (versus 7 days for the worst performing board). Again, adoption of best practice could see a significant fall in length of stay following knee arthroplasty across Scotland.

In general NHS Boards that have a longer length of stay for hip arthroplasty have a longer length of stay for knee arthroplasty. Patient Care Pathway design and setting patient/staff expectations with respect to length of stay are important factors, as are local resources such as availability of physiotherapy. If all NHS Boards were able to match the shortest length of stay then more than 15300 nights in hospital could be saved (best versus mean total length of stay x number of arthroplasties).

The mean length of stay for knee and hip arthroplasty continues to decline at the same rate across Scotland during the last 10 years, with figures for 2016 showing 4.7 days for hip arthroplasty and 4.8 for knee arthroplasty. The figure for shoulder arthroplasty remains essentially unchanged from the previous 2 years at 3.3 days length of stay.

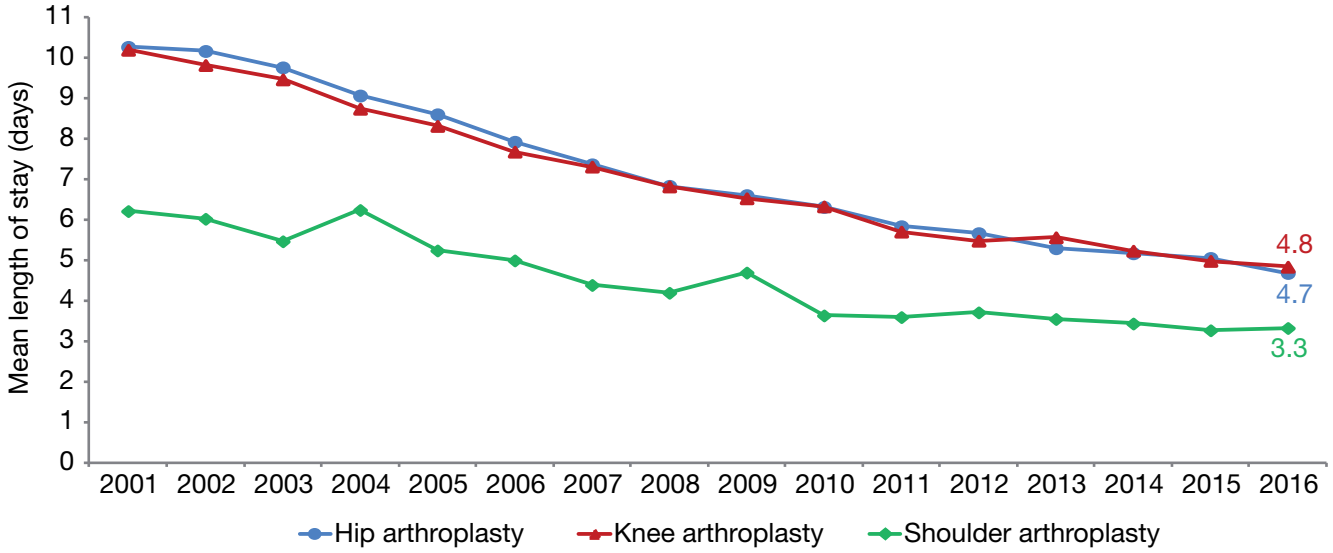
There remains significant variation between units, as was seen in previous years. In Hip arthroplasty, the lowest mean post-op stay is at GJNH, with 3.37 days; Lanarkshire has the highest post-op stay, with 5.84 days. Taking total length of stay, GJNH gives the lowest score at 3.92; Lanarkshire remains with the longest stay, with 5.88 days, though Grampian is close with 5.73 days, owing to an unusually high figure for mean pre-op stay, at 0.91 days.

This trend is mirrored when knee arthroplasty is considered, though the total length of stay is higher: a lowest figure at 4.25 days for GJNH and highest 6.5 for Lanarkshire.

The Western Isles unit shows a higher length of stay in all areas, though it is presumed there are matters of case number and infrastructure at play here.

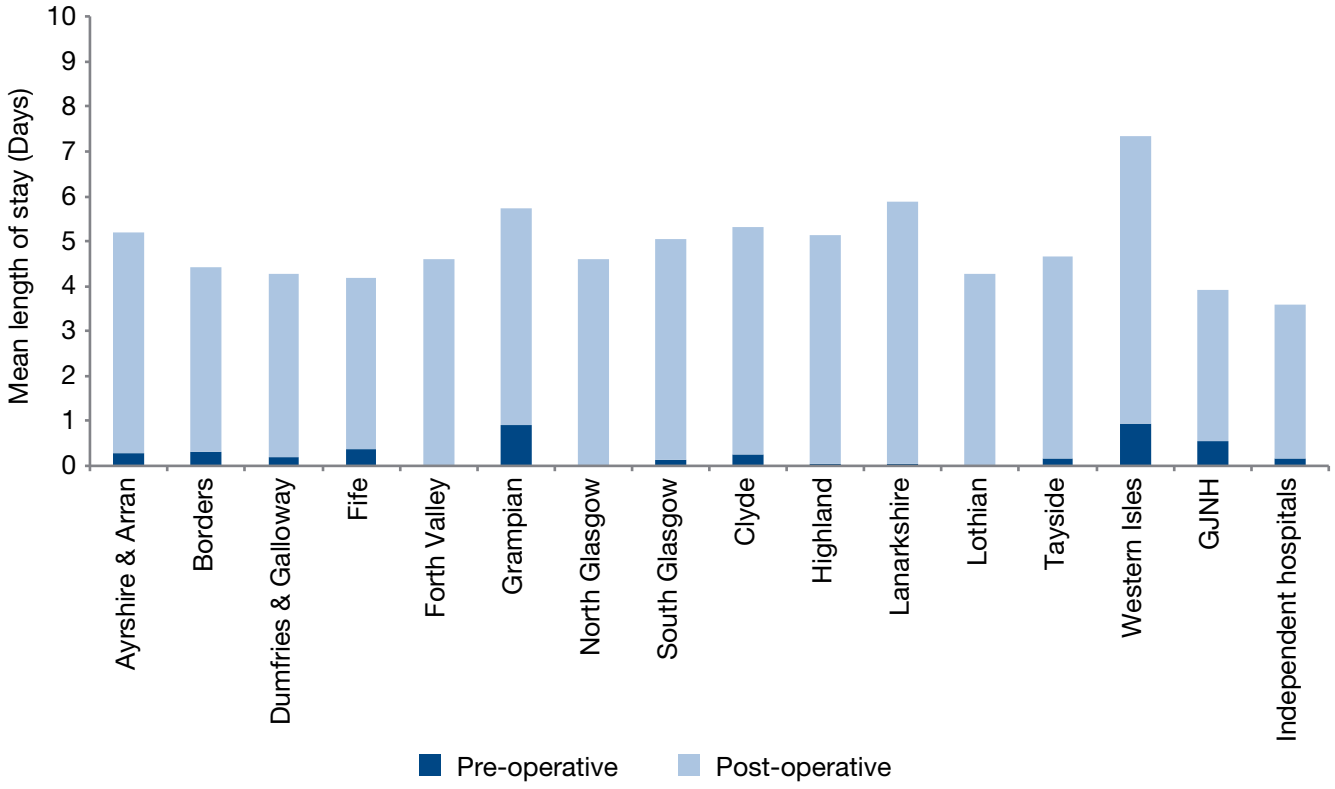
It is of note the category of Independent Hospitals is included, and shows a uniformly low total length of stay, with 4.01 days for knees and 3.58 for hips.

**Figure 6** — Recent trends in overall length of stay for elective hip, knee and shoulder arthroplasty




*Includes elective patients only; bilateral operations counted twice; includes known patients from independent hospitals.*

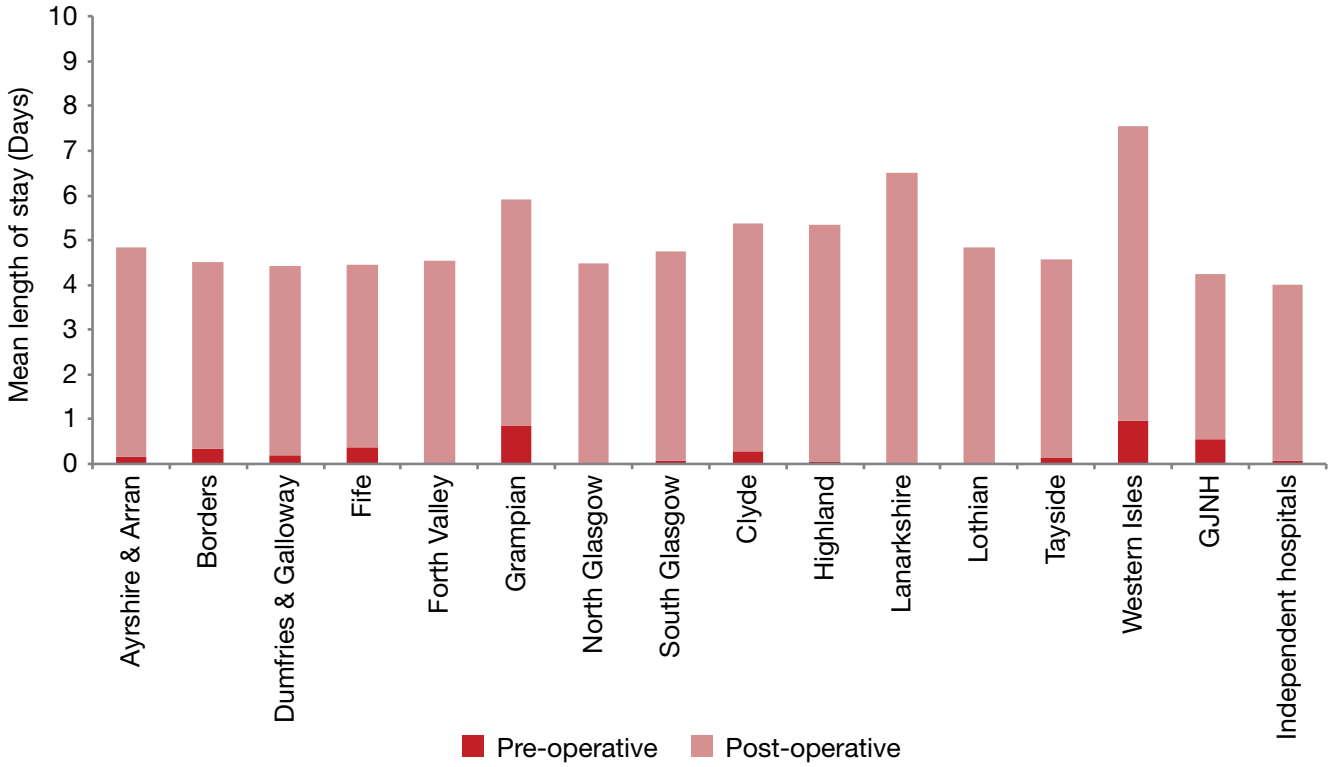
**Figure 7a** — Mean length of stay for hip arthroplasty in 2016 by NHS board of treatment (NHS GG&C split) (elective patients only)




*Note: pre-operative days counted as days from date of admission to date of operation; post-operative days calculated as the difference between the number of pre-operative days and the total length of stay in orthopaedic care (where short (<=7 days) transfers to other facilities were not considered to end the patient's orthopaedic care stay).*

*Includes elective patients only; bilateral operations counted twice.*

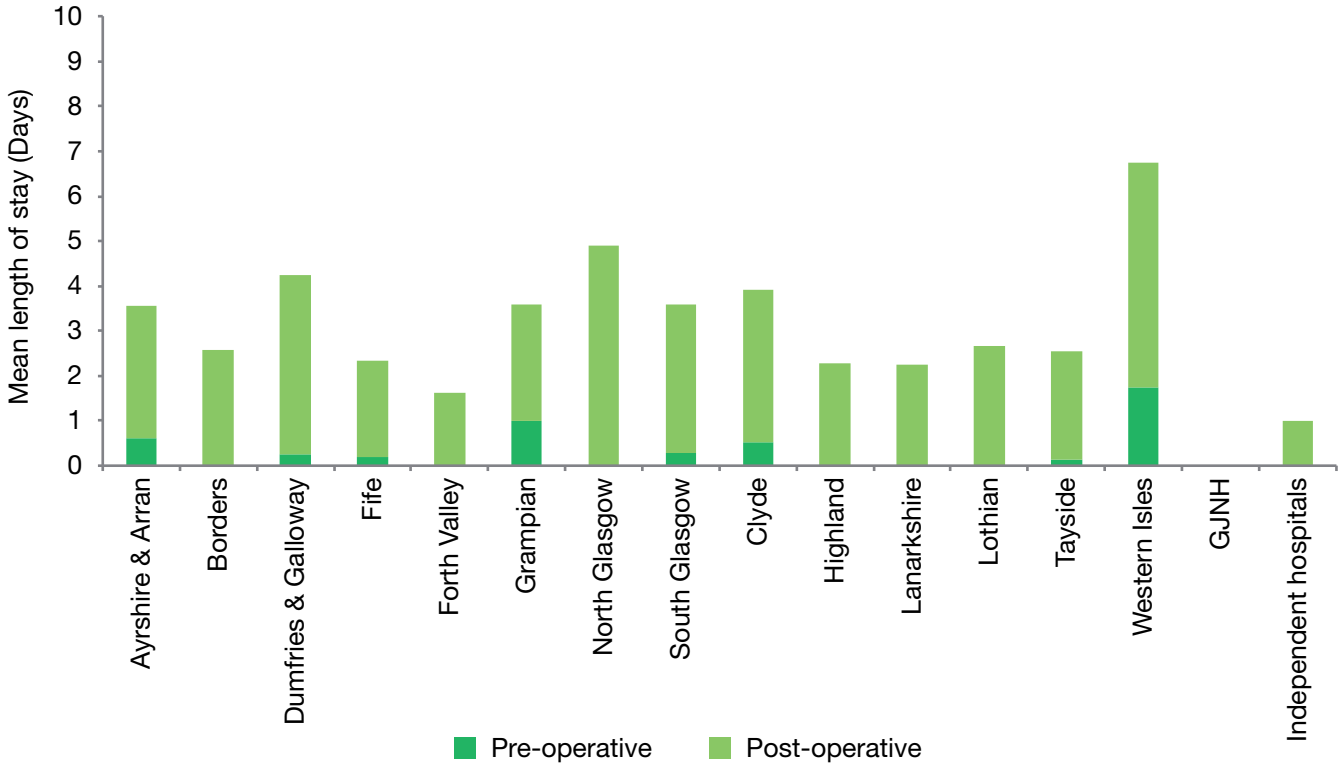
**Figure 7b** — Mean length of stay for knee arthroplasty in 2016 by NHS board of treatment (NHS GG&C split) (elective patients only)




*Note: pre-operative days counted as days from date of admission to date of operation; post-operative days calculated as the difference between the number of pre-operative days and the total length of stay in orthopaedic care (where short (<=7 days) transfers to other facilities were not considered to end the patient's orthopaedic care stay).*

*Includes elective patients only; bilateral operations counted twice.*

**Figure 7c** — Mean length of stay for shoulder arthroplasty in 2016 by NHS board of treatment (NHS GG&C split) (elective patients only)




*Note: pre-operative days counted as days from date of admission to date of operation; post-operative days calculated as the difference between the number of pre-operative days and the total length of stay in orthopaedic care (where short (<=7 days) transfers to other facilities were not considered to end the patient's orthopaedic care stay).*

*Includes elective patients only; bilateral operations counted twice.*

# 4. Complications arising from arthroplasty procedures

The major complications following elective primary hip or knee arthroplasty are:

- Dislocation (knee dislocation is extremely rare and data is not presented)
- Infection of the operated joint
- Deep vein thrombosis / pulmonary embolism (DVT/PE)
- Death
- Acute Myocardial Infarction (AMI)
- Acute Renal Failure
- Cerebrovascular Accident (CVA) or Stroke

Complication rates have been standardised for the type of operation. Figures show national complication rates over the years from 2000-2016 and there are other more detailed figures showing data from the years since the last report (2015 and 2016), broken down into Health Boards.

## 4.1 National trends

### DVT/PE

The national rate for DVT/PE has fallen from 2.2% in 2000 to 0.7% in 2016 for hip arthroplasty. This is shown in Figure 8a and is pleasing to see the rates continuing to fall year on year. The rates are the same for knee arthroplasty and again it is good to see the rates reducing.

### Death Rate

The rate of death following hip and knee arthroplasty continues to be low at less than 0.5% as in the last report. The rate following hip arthroplasty in 2016 was 0.3% and following knee arthroplasty was 0.3% in 2016. This has fallen since 2000 from 0.8% and 0.6% respectively which is great progress. (Figure 8a)

### Dislocation after Hip Arthroplasty

Dislocation within one year of hip arthroplasty has been falling since the beginning of data collection in 2000. The rate of dislocation in 2015 was 0.8% and in 2000 was 1.2%, so the overall trend is down which is very pleasing. (Figure 8b)

### Infection

The rates of infection following hip arthroplasty remain low at less than 1%, but the 2015 figures were the lowest recorded since the beginning of the data collection, at 0.7%. Following knee arthroplasty, the incidence of infection within a year also remains at less than 1%, and has fallen to the lowest rate recorded of 0.9% in 2015 data. The rate was 1.4% in 2000. (Figure 8b)

### Acute Myocardial Infarction (AMI)

The rate of AMI after hip and knee arthroplasty remains very low in Scotland and data is comparable to the last report.

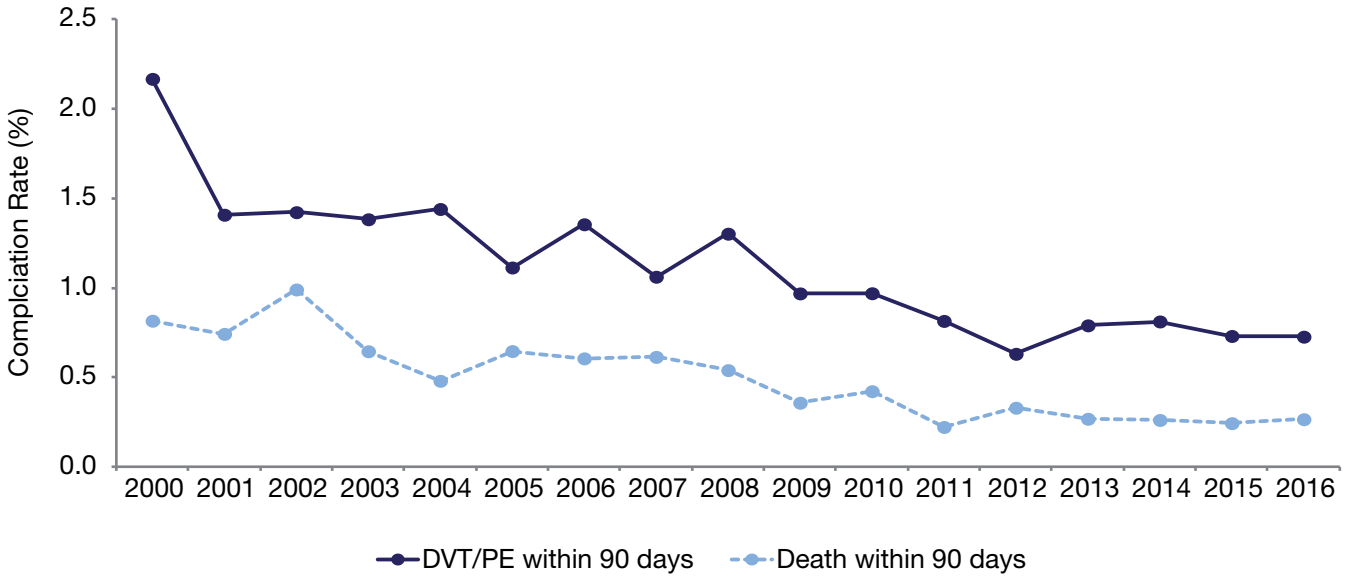
## Acute Renal Failure

The last two reports have highlighted the rising incidence of acute renal failure following hip and knee arthroplasty. The national data presented in Figure 8e shows the gradual rise in incidence from 2000, with a definite change from 2009 onwards. Rates are now at their highest levels since SAP began reporting, which is concerning. Boards across Scotland should take this data seriously and monitor carefully to address remedial causes. Rates for Acute Renal Failure following hip arthroplasty are 2.3% and following knee arthroplasty are 2.4%. In 2000 the figures were 0.2% and 0.3% respectively.

## Cerebrovascular Accident or Stroke

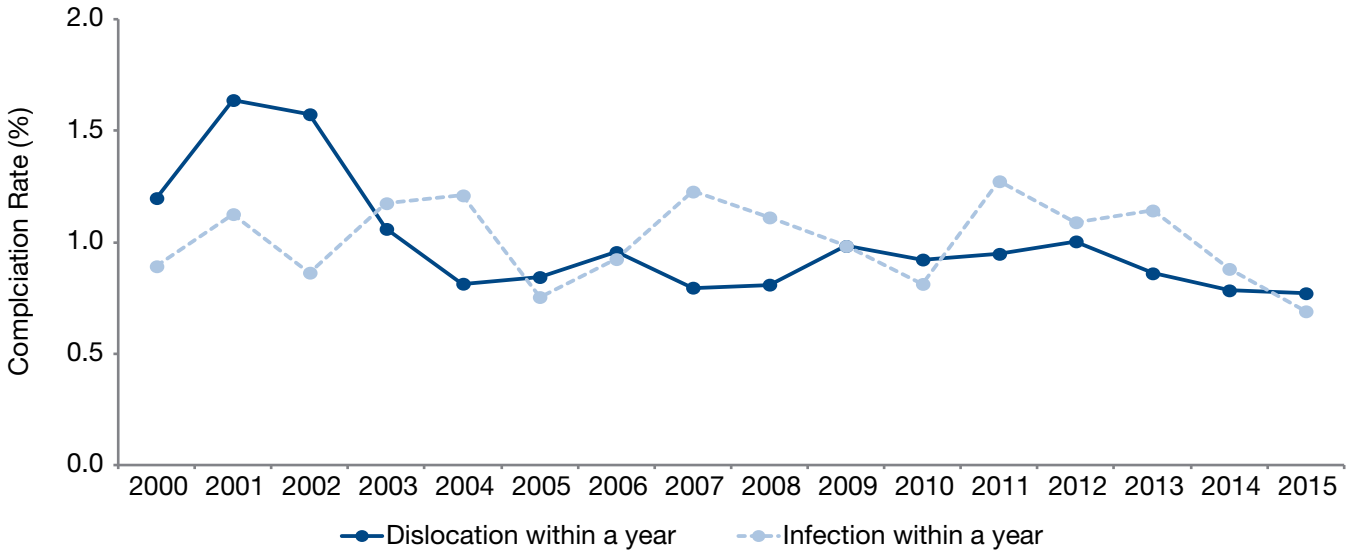
The national average of CVA or stroke following hip and knee arthroplasty remains low at less than 0.4% over the years 2012-2016.

**Figure 8a** — National rates for complications within 90 days: hip arthroplasty



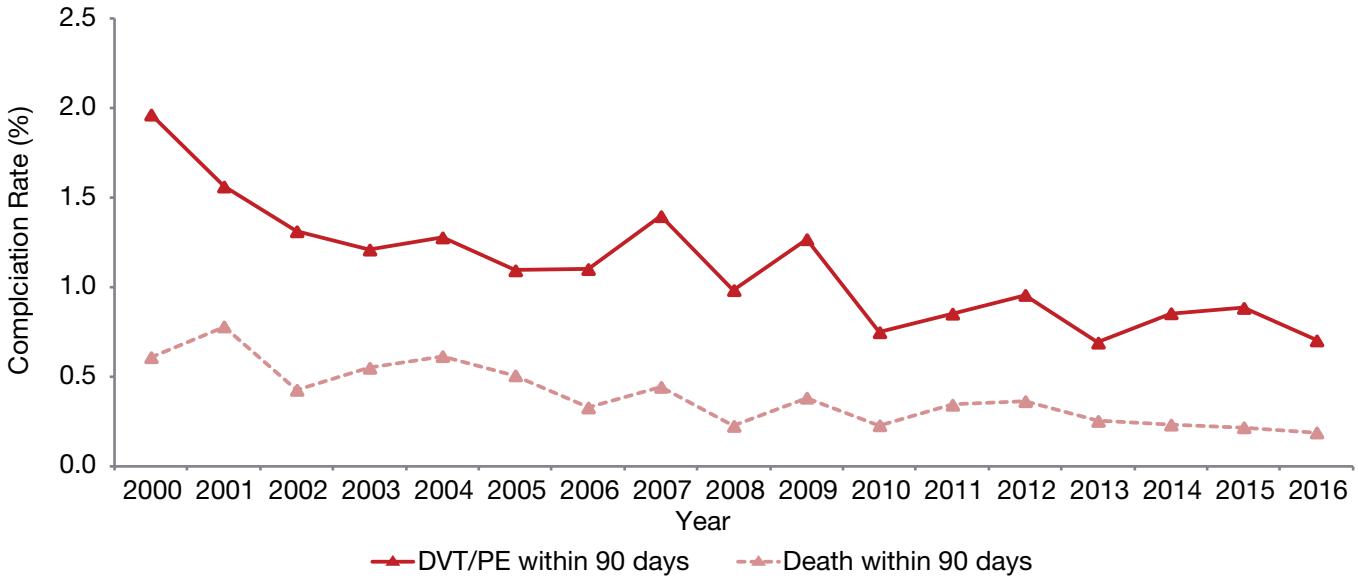

*Includes emergency admissions; bilateral operations counted only once; includes known patients from independent hospitals.*

**Figure 8b** — National rates for complications within 1 year: hip arthroplasty



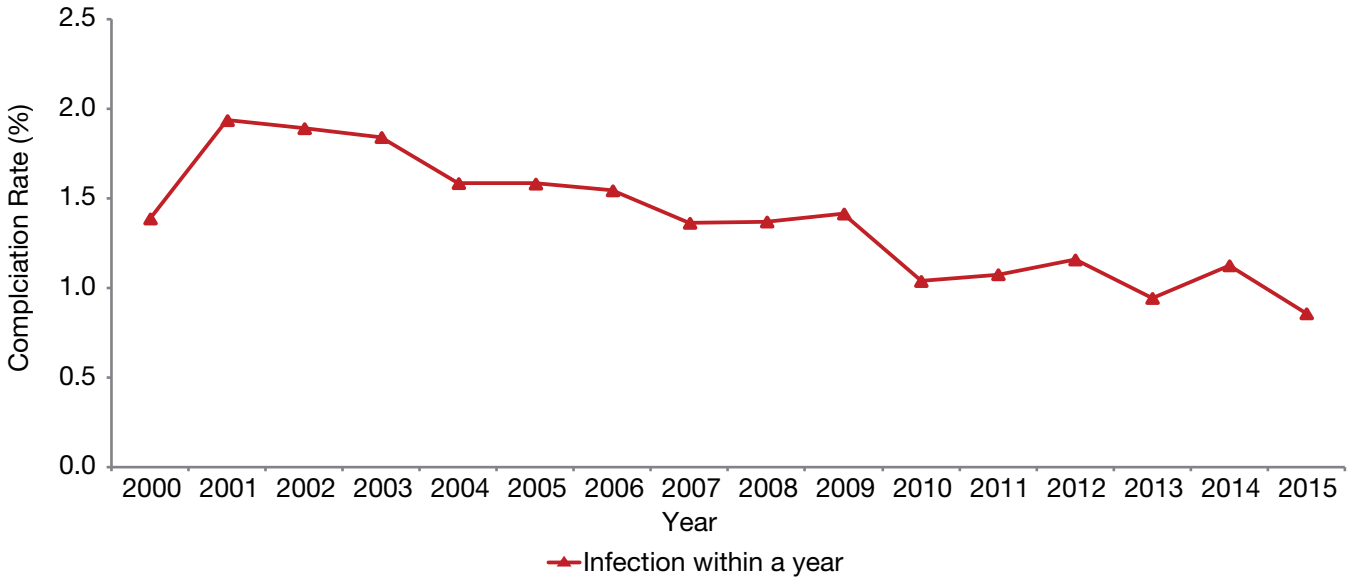

*Includes emergency admissions; bilateral operations counted only once; includes known patients from independent hospitals.*

**Figure 8c** — National rates for complications within 90 days: knee arthroplasty



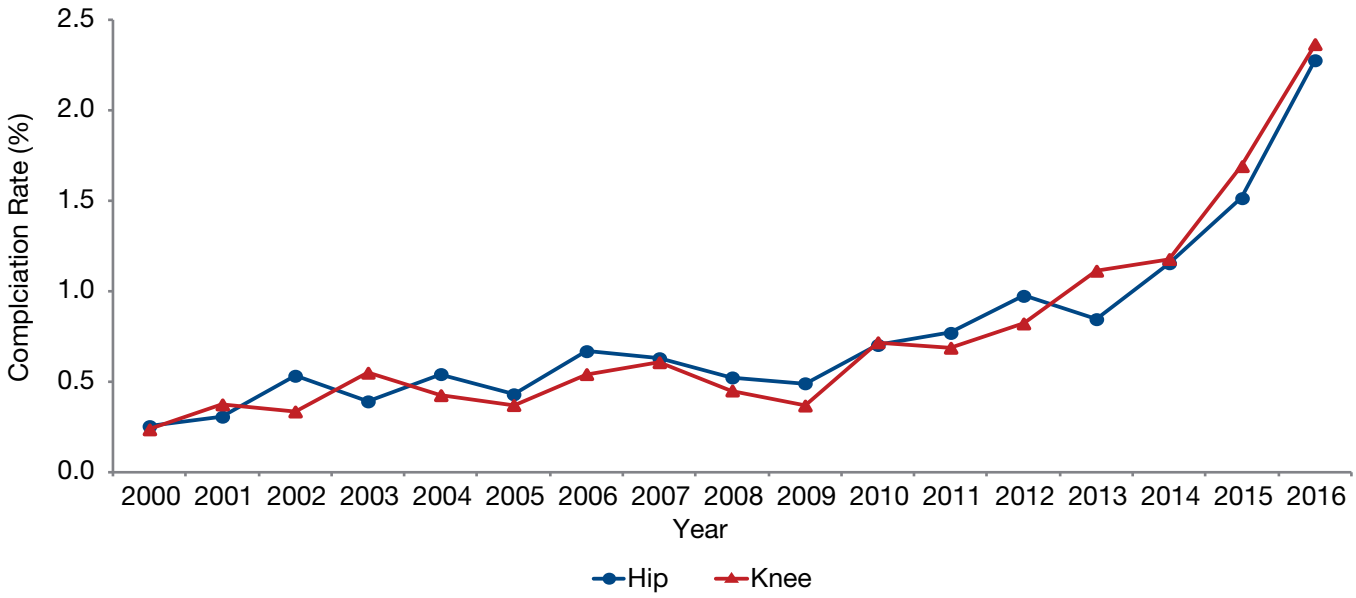

*Includes emergency admissions; bilateral operations counted only once; includes known patients from independent hospitals.*

**Figure 8d** — National rates for complications within 1 year: knee arthroplasty




*Includes emergency admissions; bilateral operations counted only once; includes known patients from independent hospitals.*

**Figure 8e** — National rates for acute renal failure within 30 days: hip and knee arthroplasty




*Includes emergency admissions; bilateral operations counted only once; includes known patients from independent hospitals.*

## 4.2 Complication funnel charts

The following data are presented as funnel charts where the upper confidence limit is shown as an upper curved line on the plot, and this represents a warning threshold derived from the national rate and numbers of operations occurring.

Rates of complication which appear above this line are a possible cause for concern and should be investigated by the Health Board or Boards concerned.

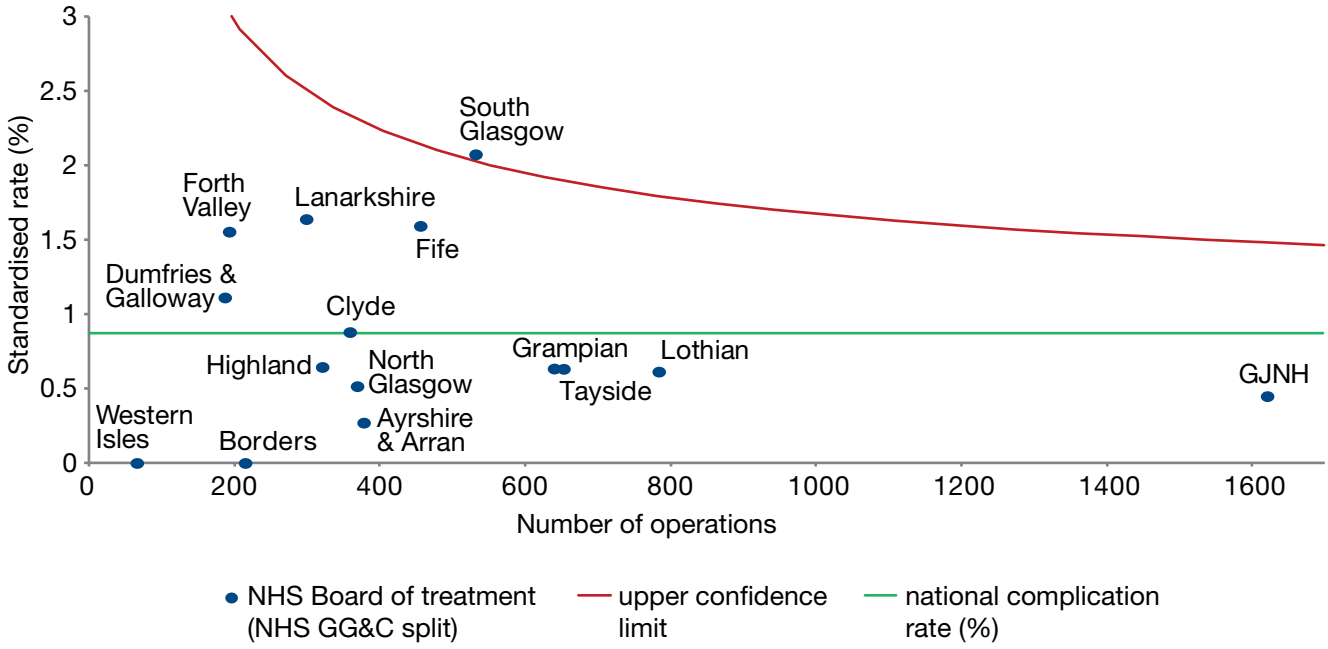
The straight line coloured in green is the national rate to allow comparisons between centres.

These funnel plots are looking at a complication over a five year range.

### 4.2.1 Dislocation within one year

Only one board was an outlier for dislocation. The national average rate was just under the 1% mark.

**Figure 9** — Percentage of 2015 primary hip arthroplasty patients with subsequent dislocation within 1 year

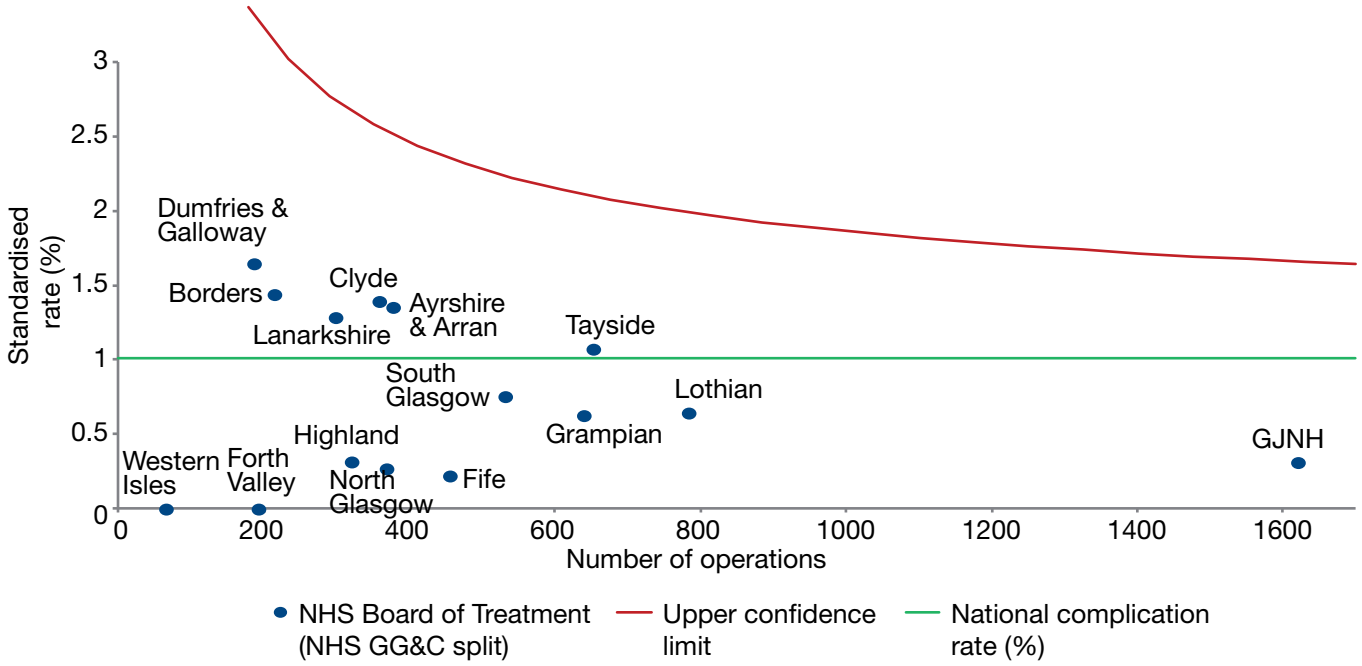



*Scottish Rate averaged over 5 years 2011-2015.*

### 4.2.2 Infection within one year

Infection of primary hip arthroplasty within one year showed no outliers over the time period 2011-2015. This is identical to the last report. For hip arthroplasty, 6 NHS Boards were above the national average and nine below.

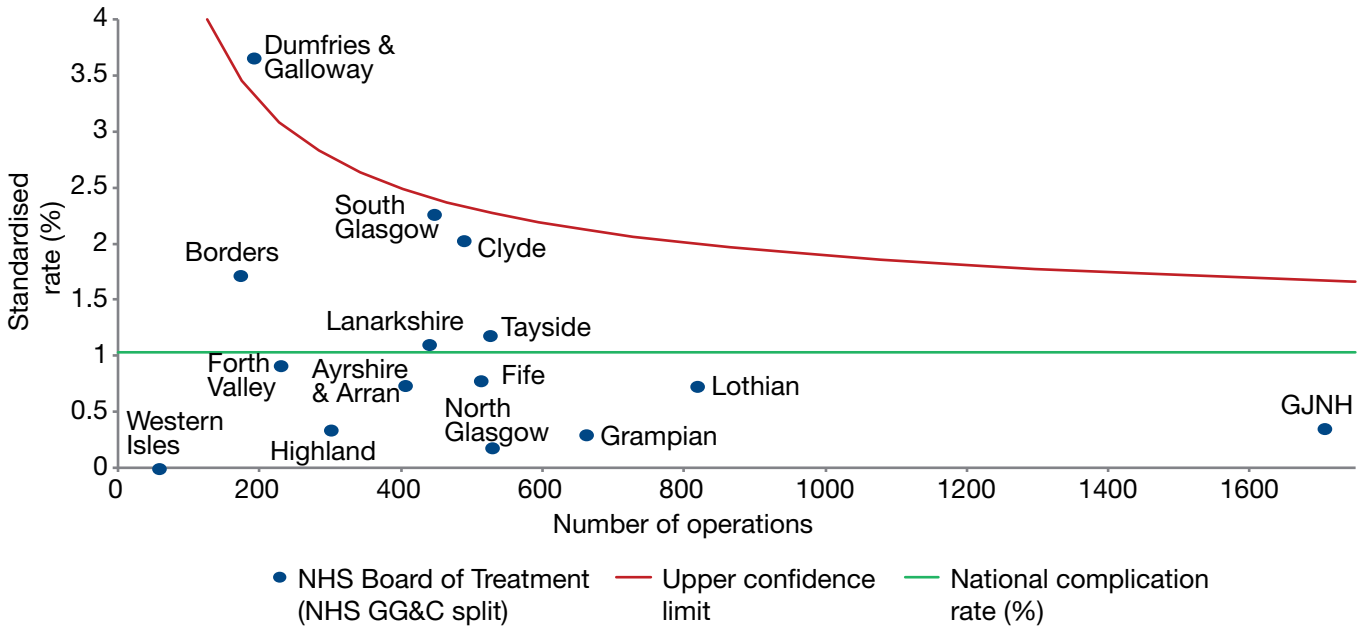
**Figure 10** — Percentage of 2015 primary hip arthroplasty patients with subsequent infection within 1 year




*Scottish Rate averaged over 5 years 2011-2015.*

There was one outlying NHS Board for infection after primary knee arthroplasty. Five boards were above the national average and nine below. This is very similar data to the last report

**Figure 11** — Percentage of 2015 primary knee arthroplasty patients with subsequent infection within 1 year

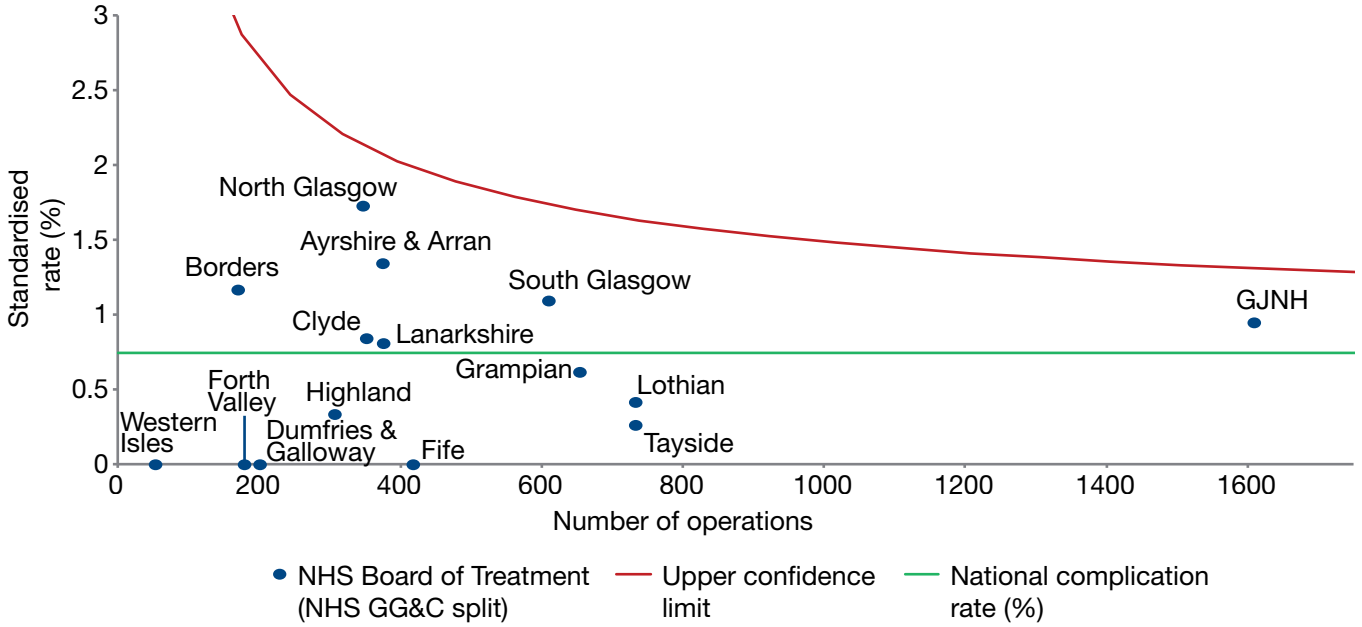



*Scottish Rate averaged over 5 years 2011-2015.*

### 4.2.3 Deep vein thrombosis/pulmonary embolism (DVT/PE) within one year

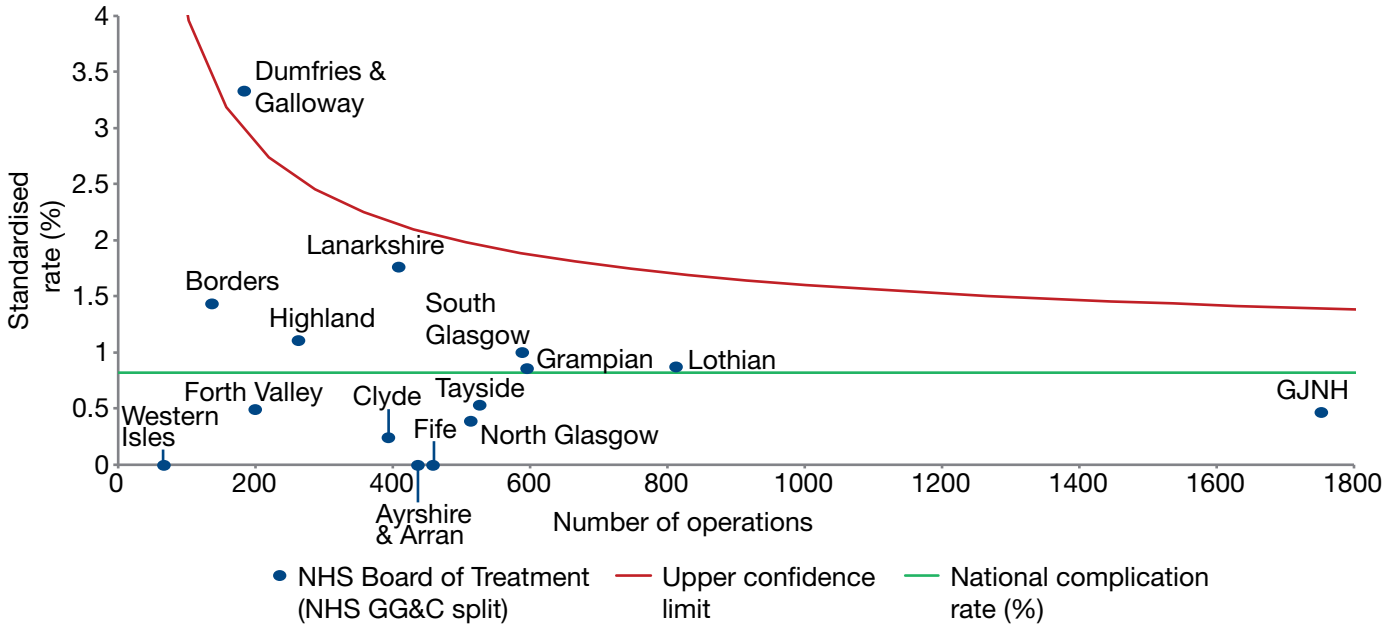
There were no outliers for DVT/PE after primary hip arthroplasty which is identical to the data in the last report. Seven NHS Boards were above the national average. There was one NHS Board outlier for DVT/PE after primary knee arthroplasty. Again seven Boards were above the national average, but overall rates are quite low for this complication.

**Figure 12**—Percentage of 2016 primary hip arthroplasty patients with subsequent DVT/PE within 90 days




*Scottish Rate averaged over 5 years 2012-2016.*

**Figure 13**—Percentage of 2016 primary knee arthroplasty patients with subsequent DVT/PE within 90 days

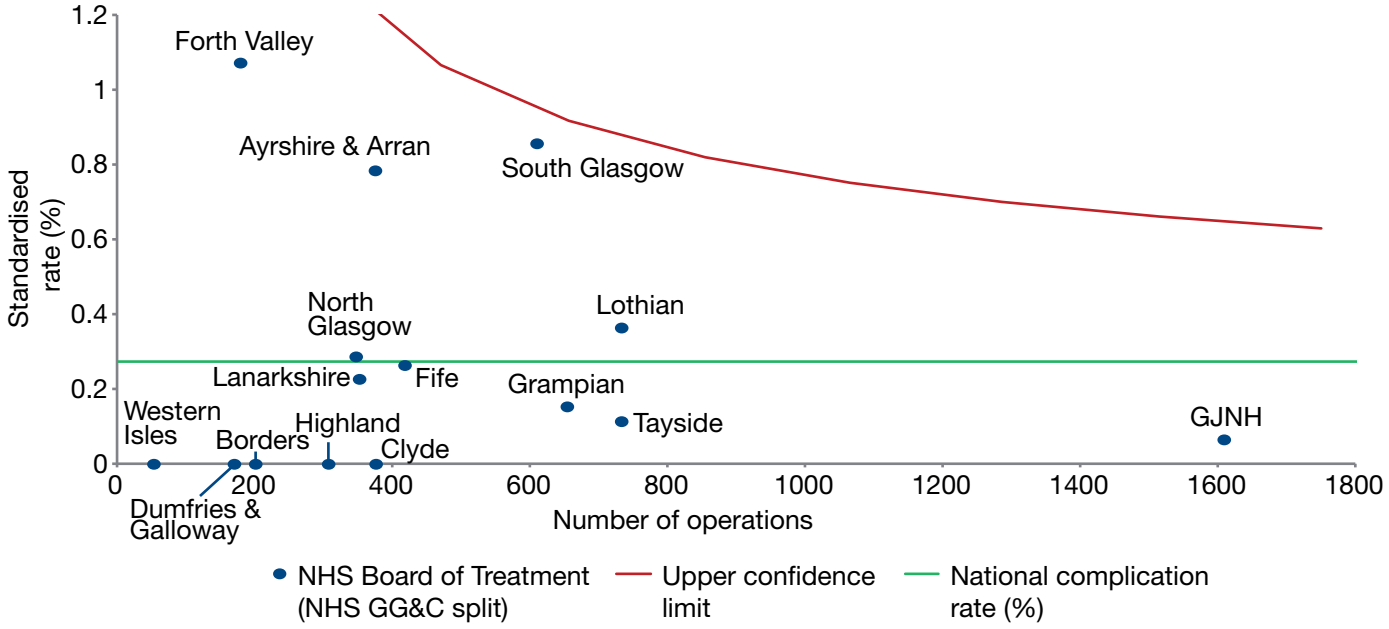



*Scottish Rate averaged over 5 years 2012-2016.*

### 4.2.4 Death within 90 days

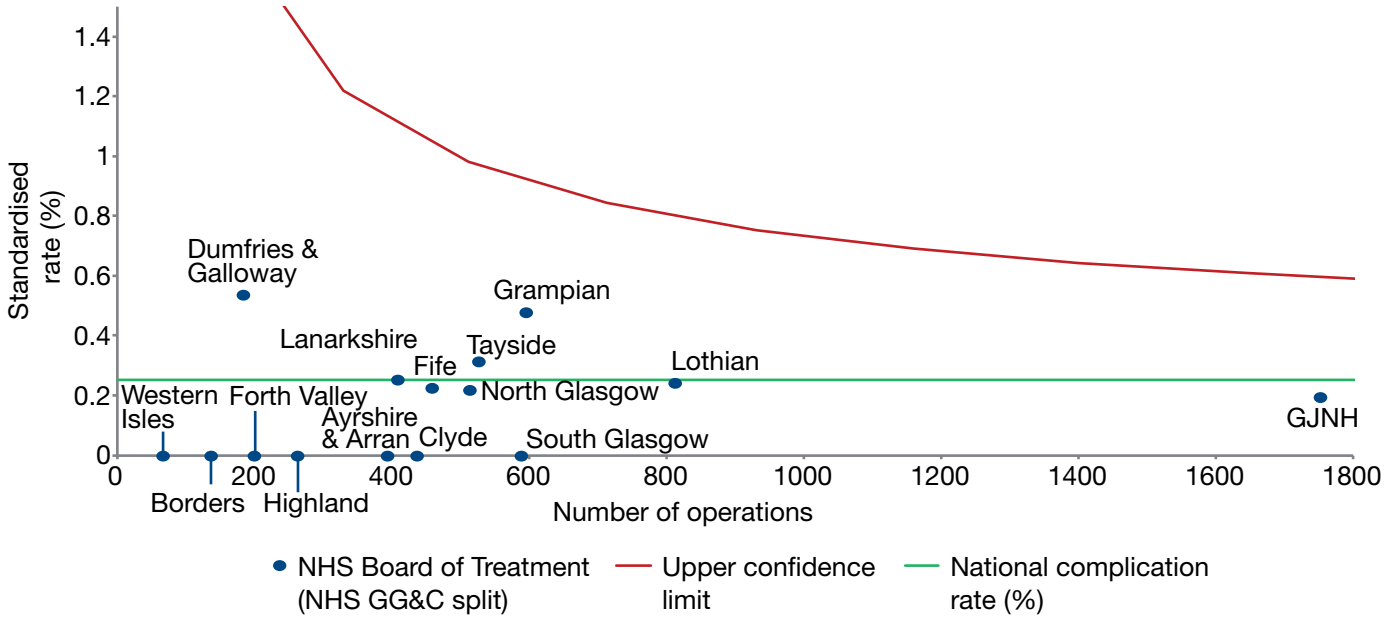
There were no outlying NHS Boards in the data from 2012-2016 for primary hip arthroplasty. Four Boards were above the national average, but rates remain low. Following primary knee replacement, there were no outliers and only three boards above the national average. Again the rates remain very low.

**Figure 14** — Percentage of primary 2016 hip arthroplasty patients who died within 90 days




*Scottish Rate averaged over 5 years 2012-2016.*

**Figure 15** — Percentage of primary 2016 knee arthroplasty patients who died within 90 days

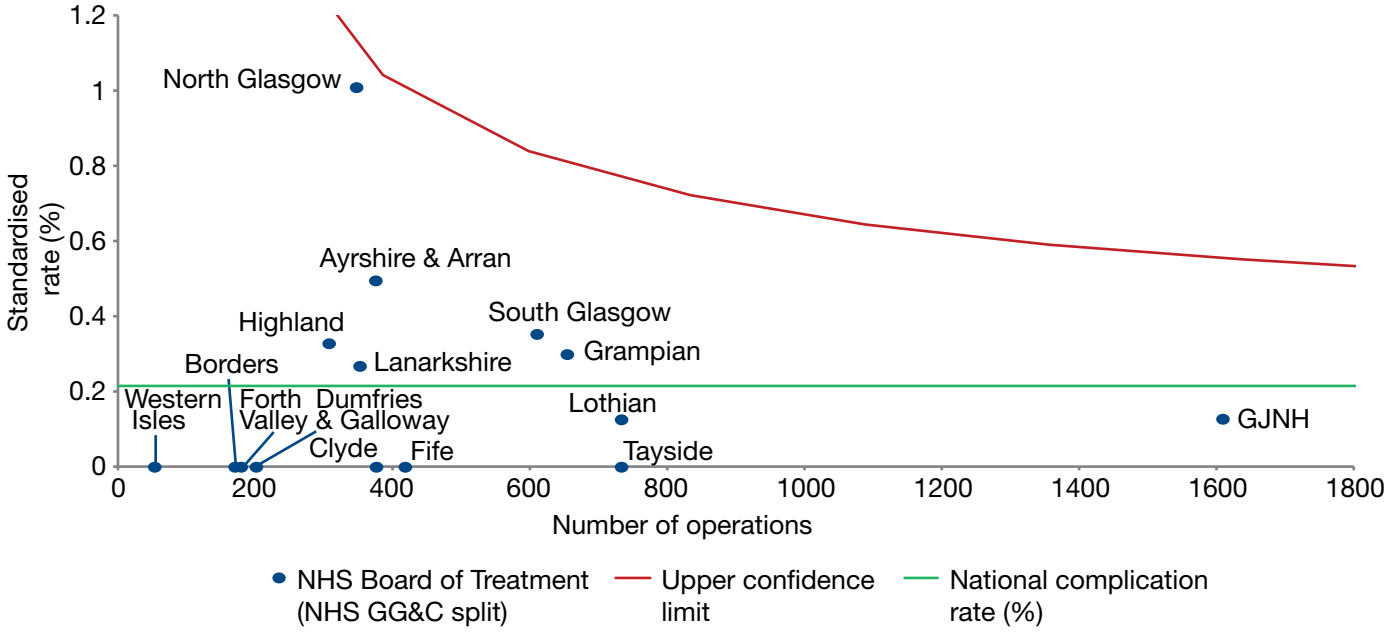



*Scottish Rate averaged over 5 years 2012-2016.*

## 4.2.5 Acute Myocardial Infarction (AMI) within 30 days

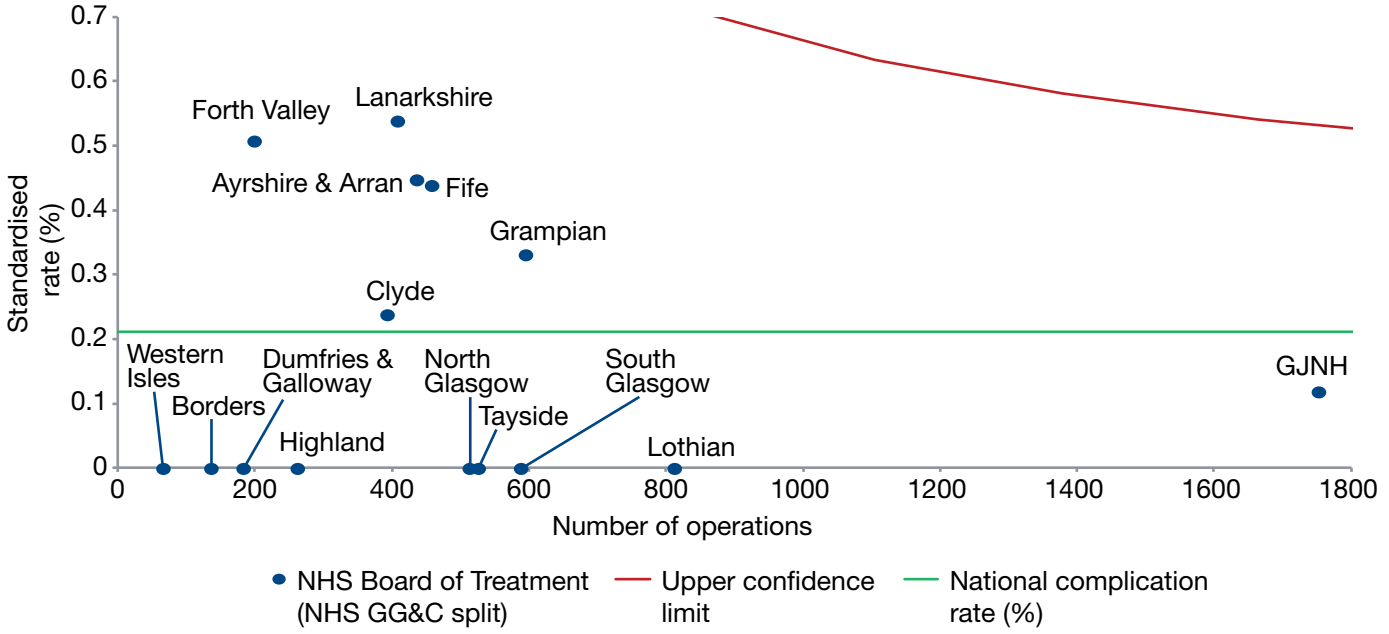
There were no outliers amongst all of the NHS Boards for primary hip and knee arthroplasty. Six Boards were above the national average for AMI after primary hip arthroplasty and following primary knee arthroplasty. The national average over this time period from 2012-2016 was reassuringly low at just over 0.2%.

**Figure 16** — Percentage of 2016 primary hip arthroplasty patients with subsequent AMI within 30 days




*Scottish Rate averaged over 5 years 2012-2016.*

**Figure 17** — Percentage of 2016 primary knee arthroplasty patients with subsequent AMI within 30 days

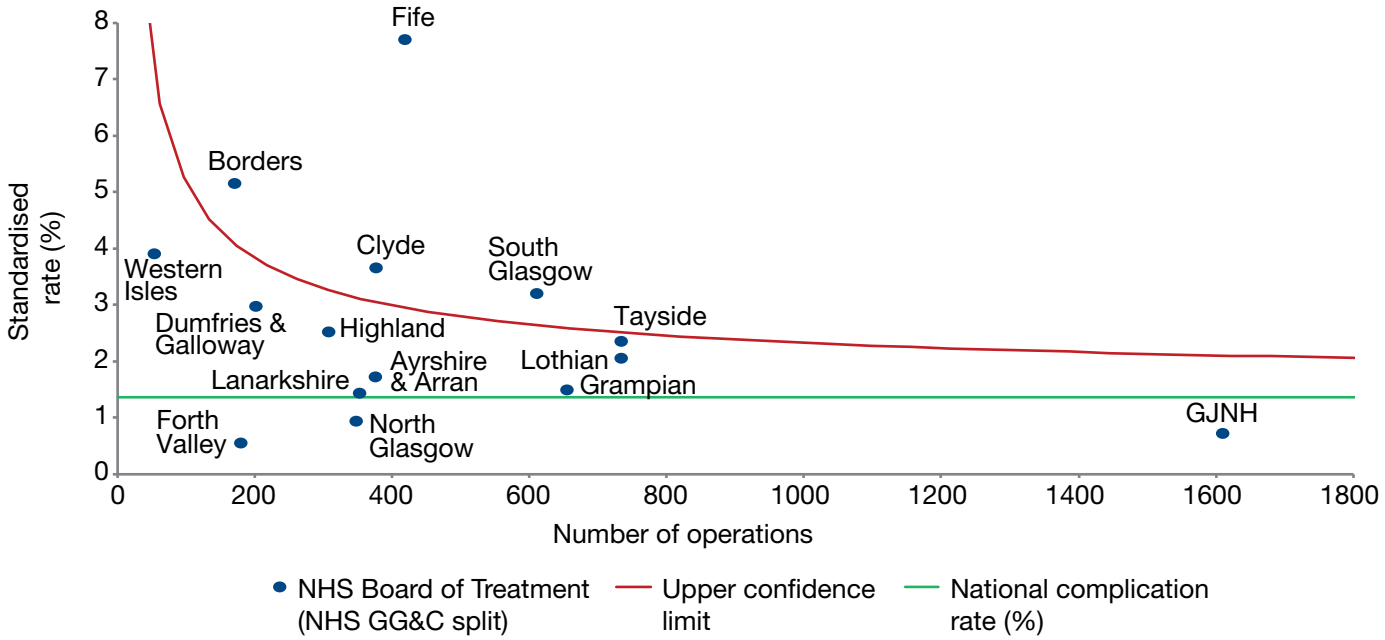



*Scottish Rate averaged over 5 years 2012-2016.*

### 4.2.6 Acute renal failure within 30 days

The incidence of acute renal failure after arthroplasty is definitely rising. Figure 18 shows the incidence of acute renal failure after primary hip arthroplasty. There were four NHS Boards identified as outliers in the period 2012-2016. Their incidence is above 3%. Two of these Boards were also outliers in the last report.

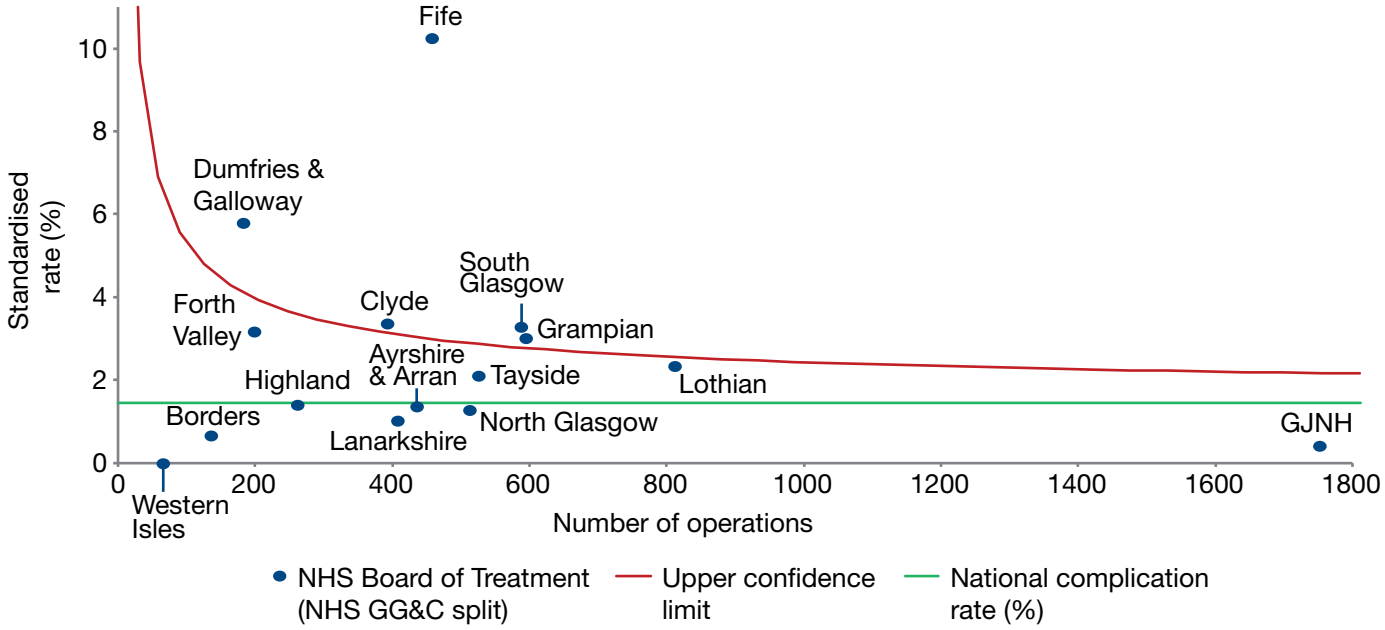
**Figure 18** — Percentage of 2016 primary hip arthroplasty patients with subsequent acute renal failure within 30 days




*Scottish Rate averaged over 5 years 2012-2016.*

Five NHS Boards were outliers for their rates of acute renal failure following primary knee arthroplasty. Two of these boards were outliers in the last report showing the data from 2011-2016. One Board in particular had a very high incidence of around 10%, which was a large change from the last report where their incidence was around 0.5%

**Figure 19** — Percentage of 2016 primary knee arthroplasty patients with subsequent acute renal failure within 30 days

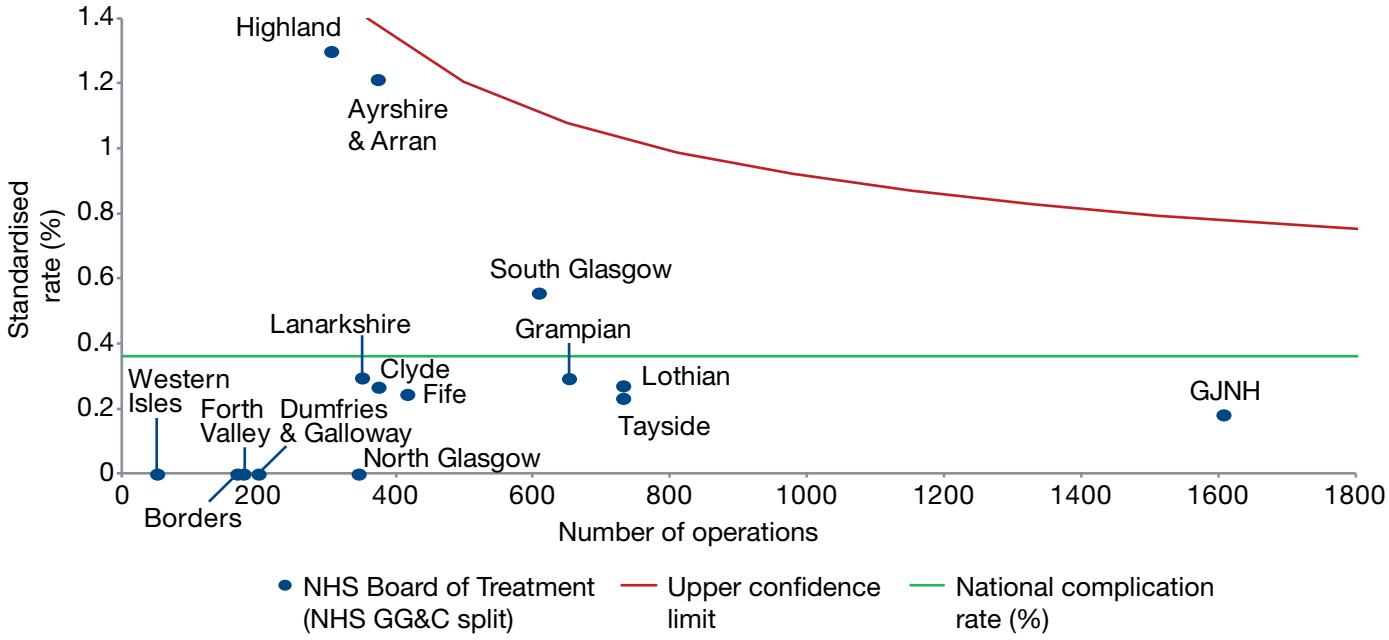



*Scottish Rate averaged over 5 years 2012-2016.*

## 4.2.7 CVA/Stroke within 30 days

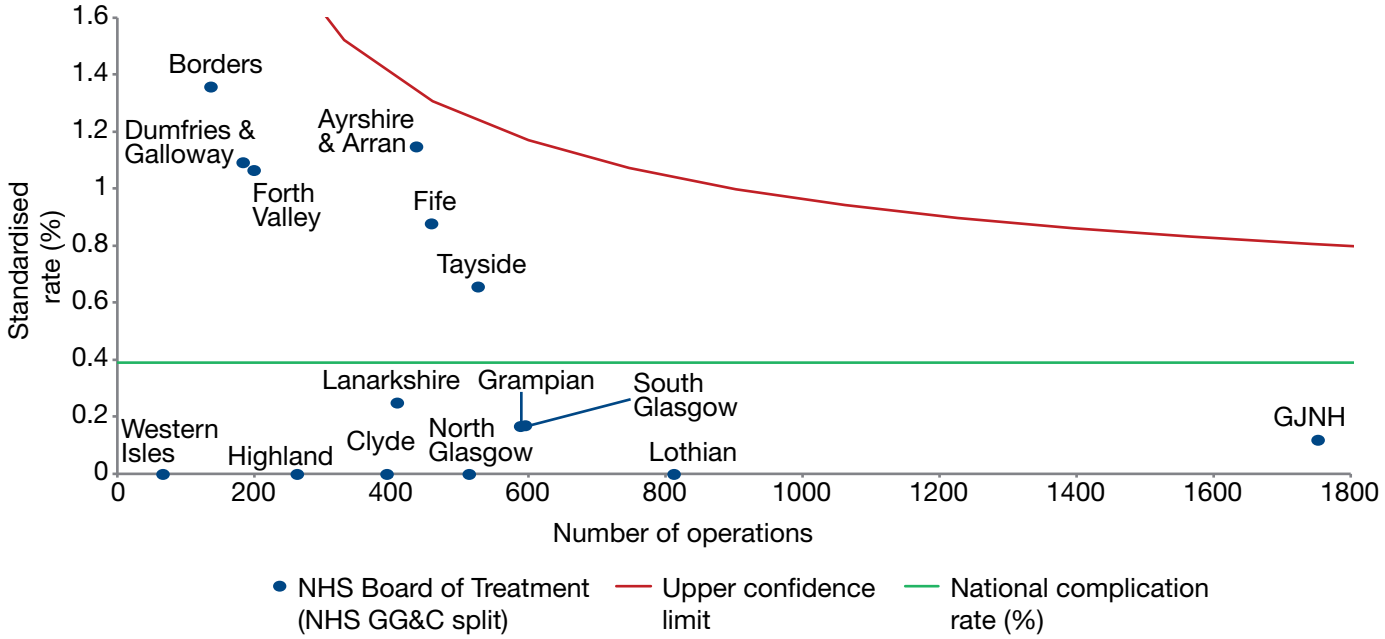
No NHS Boards were classed as outliers for CVA/Stroke after primary hip and knee arthroplasty. Three boards were above the national average following hip arthroplasty, and six following knee arthroplasty. However rates remain quite low, with the highest incidence being around the 1.5% mark and lowest 0%.

**Figure 20** — Percentage of 2016 primary hip arthroplasty patients with subsequent stroke within 30 days




*Scottish Rate averaged over 5 years 2012-2016.*

**Figure 21** — Percentage of 2016 primary knee arthroplasty patients with subsequent stroke within 30 days




*Scottish Rate averaged over 5 years 2012-2016.*

# 5. Revision Rates

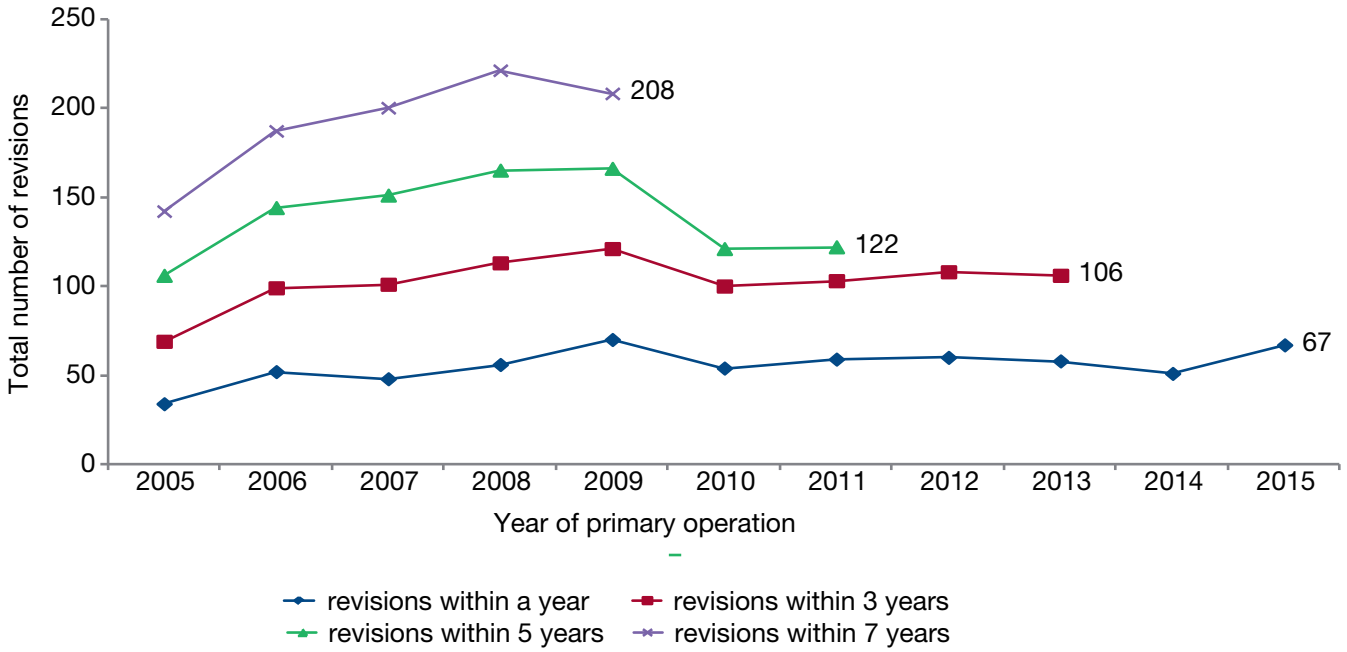
Revisions are calculated within 1 year, 3 years, 5 years and 7 years.

The national rate for hip arthroplasty with subsequent revision within 1 year shows a continued upward trend whereas the trend for knee arthroplasty is downward (Figures 22a and 23a). This may reflect problems with large metal on metal bearings including hip resurfacing arthroplasties. Revision of hips with these bearings may have caused a bulge in national revision numbers over the last decade (Figure 1b).

## 5.1 Hips

Data for revision within 1,3,5 and 7 years of primary hip replacement may point towards a “bulge” in revision numbers from 2006 (Fig 22a).

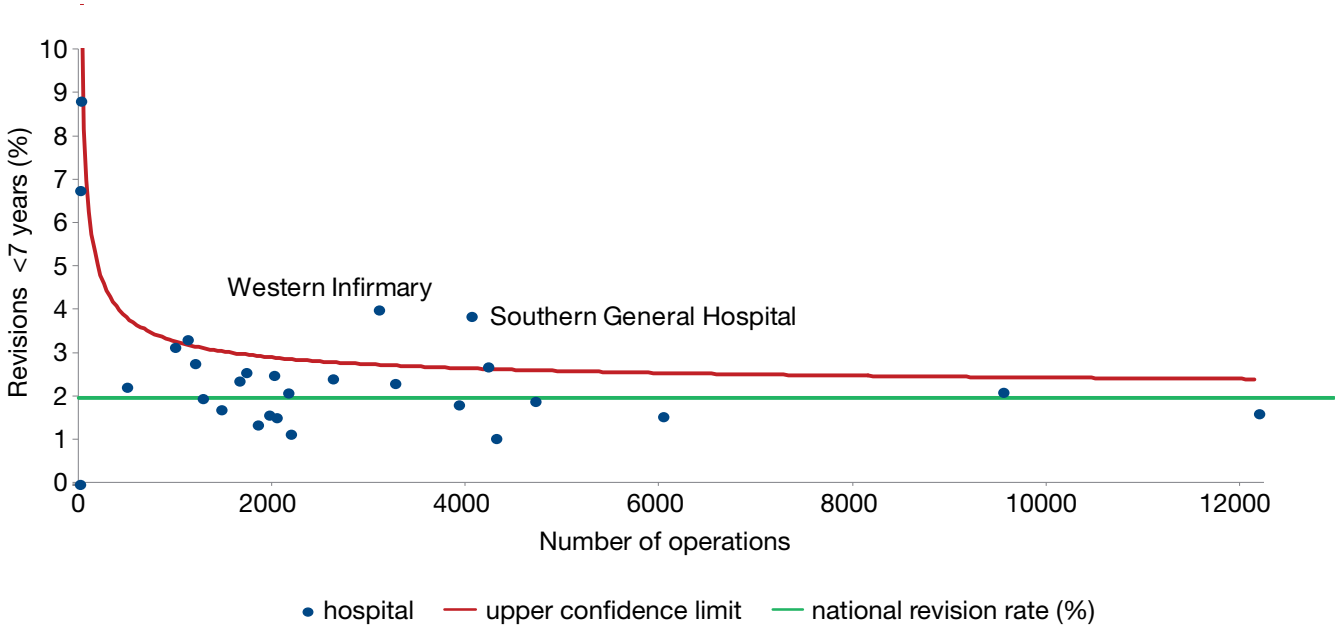
**Figure 22a** — Total number of revisions to primary hip arthroplasties in Scotland per year




*Includes elective patients only; bilateral operations counted twice; includes known patients from independent hospitals.*

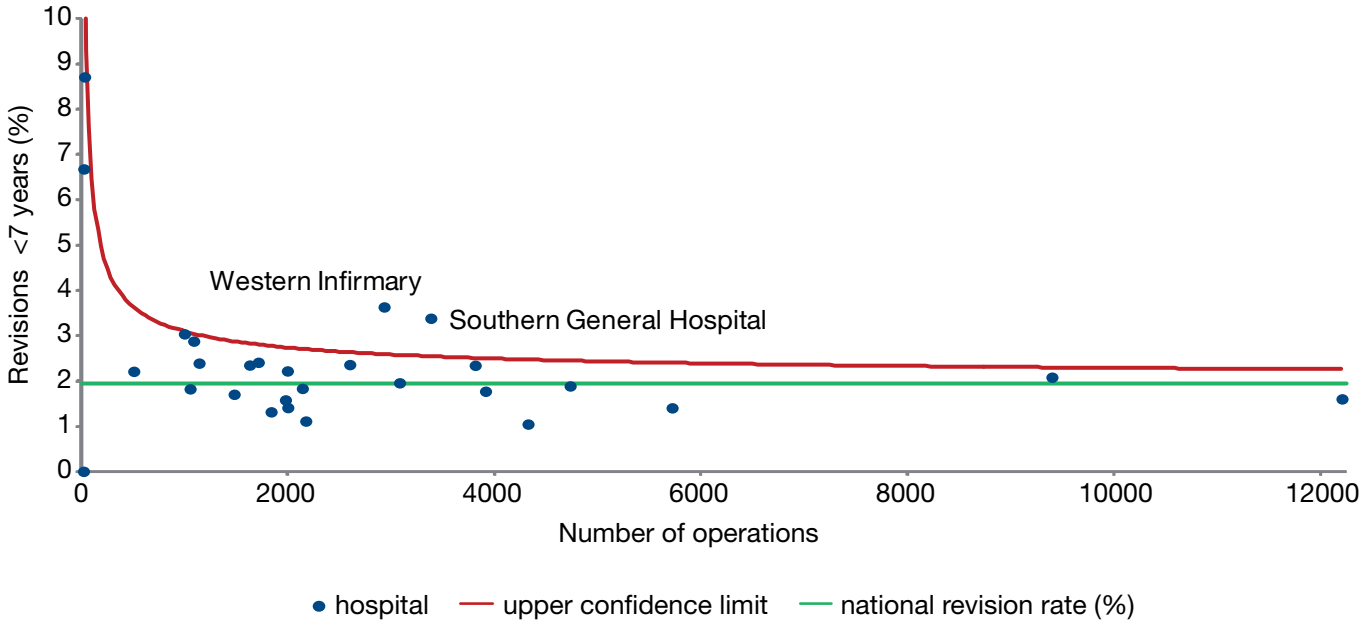
Figures 22b and 22c, below, show the total number of revisions to metal-on-metal hip resurfacings in Scotland per year and as a percentage. The number of hip resurfacing procedures peaked around 2007-8 and then declined dramatically. The number of early revisions of these implants has also fallen steadily, in keeping with the declining number performed. They accounted for 15-16% of all revisions at 5 years for primary hip replacements between 2006-9.

**Figure 22b** — Percentage of primary hip arthroplasty patients from 2005 - 2016 with subsequent revision within 7 years up to 31st December 2016: THR + resurfacing




*Note: Please see supplementary excel tables for more detailed information*

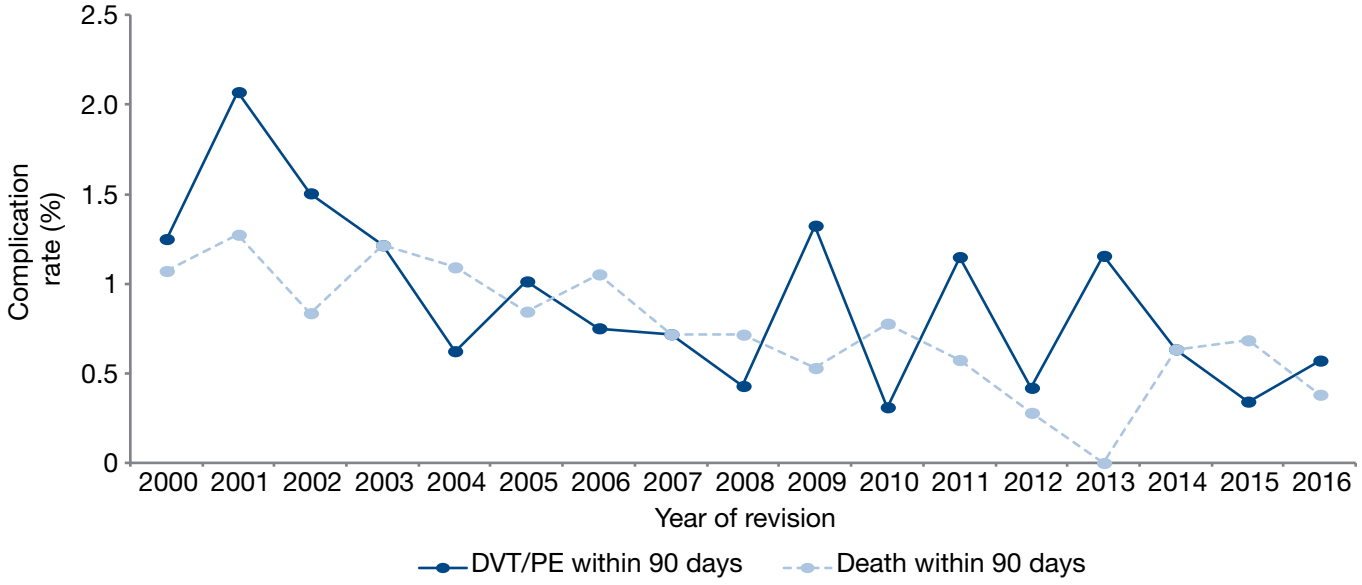
**Figure 22c** — Percentage of primary hip arthroplasty patients from 2005 - 2016 with subsequent revision within 7 years up to 31st December 2016: THR only




*Note: Please see supplementary excel tables for more detailed information*

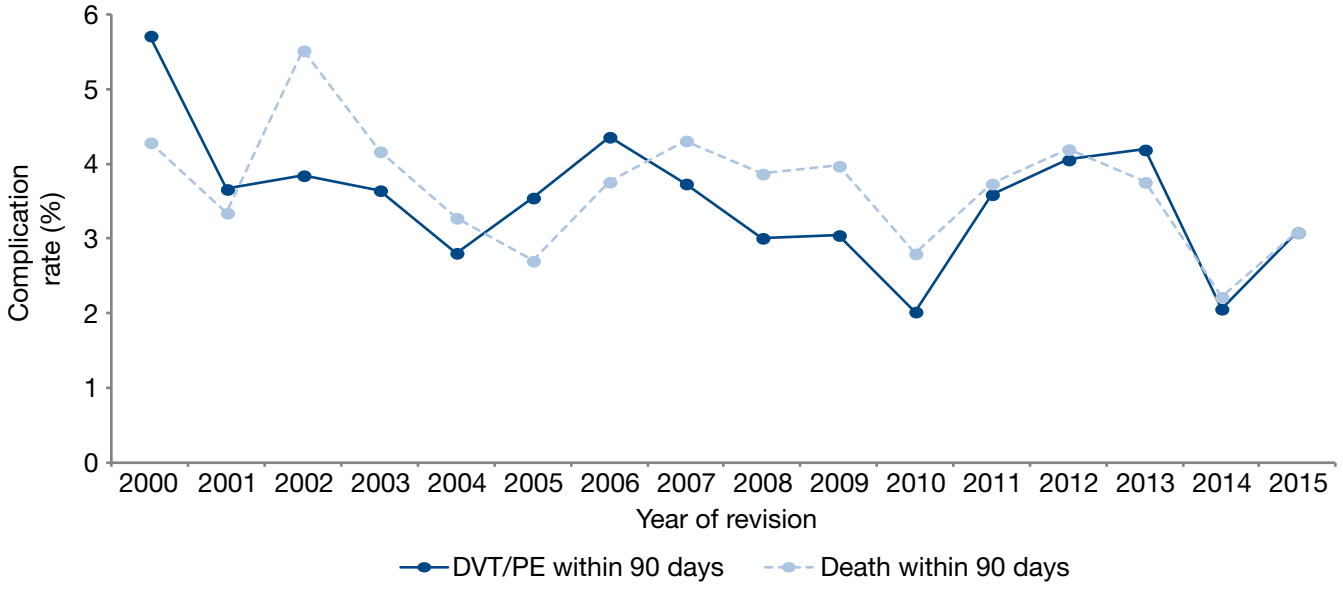
Revision of primary hip replacements performed within individual hospitals demonstrates wide variation in practice across the country. Data at 1, 3, 5 and 7 years gives an indication of the varying revision burden individual hospitals have had to cope with (Figures 22d, e, h, i, j).

**Figure 22d** — National rates for complications within 90 days: hip revisions




*Bilateral operations counted only once.*

**Figure 22e** — National rates for complications within 1 year: hip revisions




*Bilateral operations counted only once*

The wide variation between best and worst performing units was noted in last year's report.

Last year's report demonstrated a fall in complication rates after revision hip arthroplasty. Unfortunately, data this year shows an increase in rates of VTE, dislocation and infection. Death rates have continued to fall.

# 5.2 Complication funnel charts – hips

## 5.2.1 Revision within one year.

No NHS Boards were above the upper confidence limit (Figure 22f).

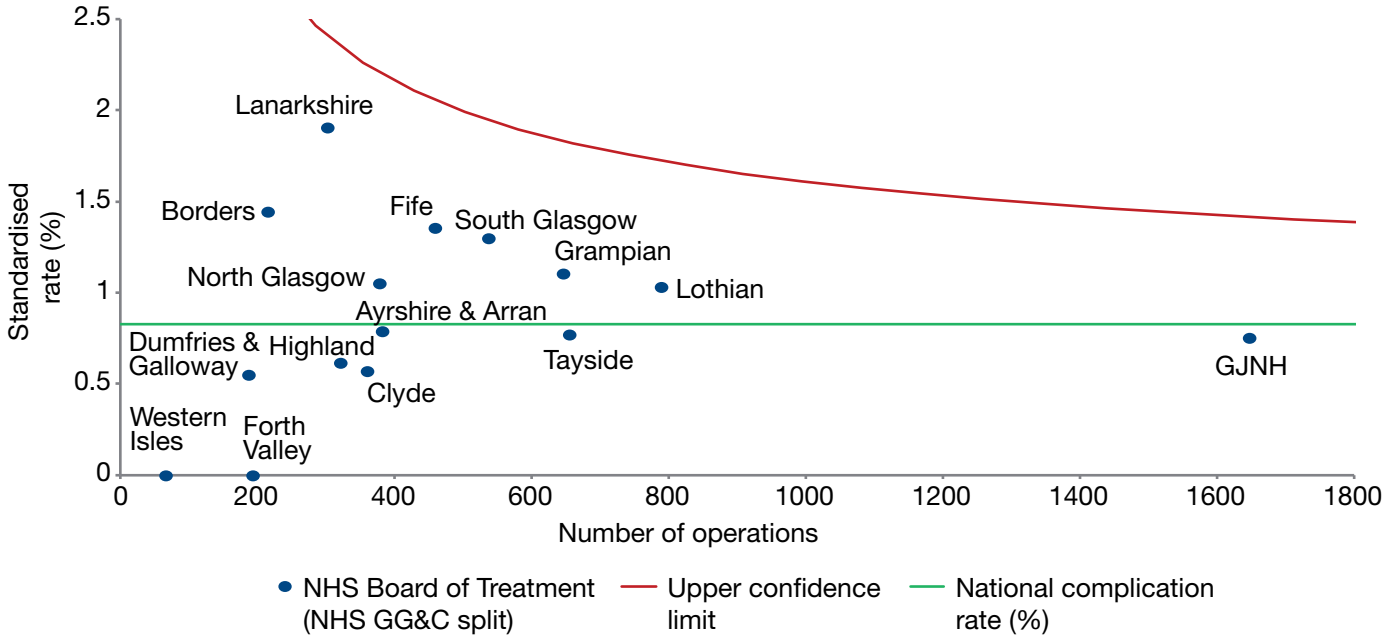
## 5.2.2 Revision within three years.

No boards were above the upper confidence limit. Dumfries and Galloway, which was an outlier in last year's report, is now below average (Figure 22g).

## 5.2.3 Revision within five years.

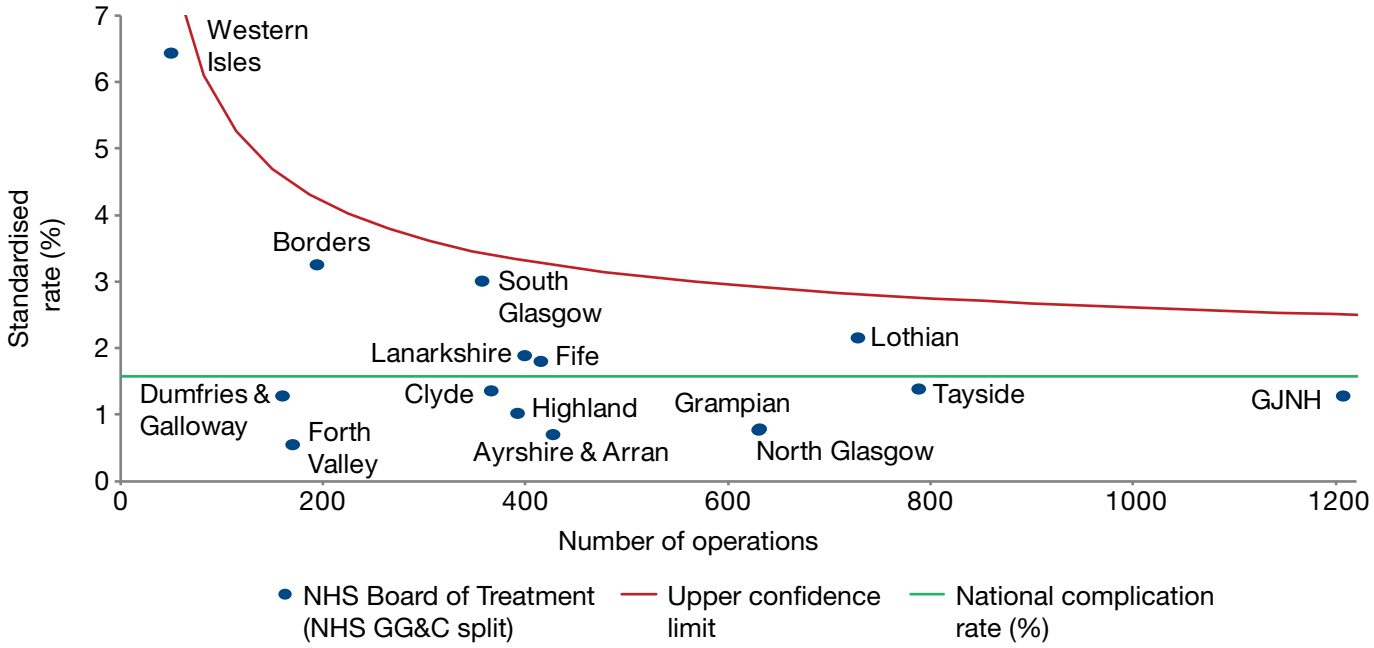
No NHS Boards were above the confidence limit (Figure 22h).

**Figure 22f** — Percentage of 2014 primary hip arthroplasty patients with subsequent revision within 1 year.



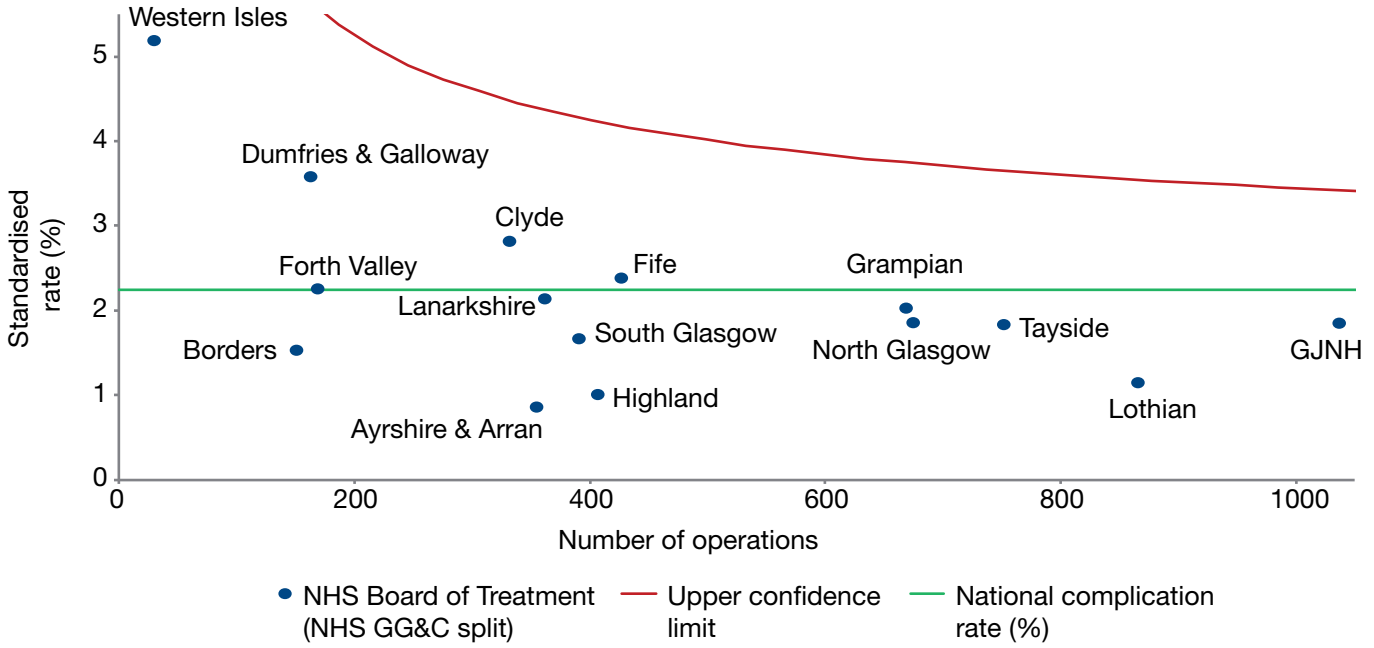

*Scottish Rate averaged over 5 years 2011-2015; Bilateral operations counted twice.*

**Figure 22g** — Percentage of 2013 primary hip arthroplasty patients with subsequent revision within 3 years.




*Scottish Rate averaged over 5 years 2009-2013; Bilateral operations counted twice.*

**Figure 22h** — Percentage of 2011 primary hip arthroplasty patients with subsequent revision within 5 years.

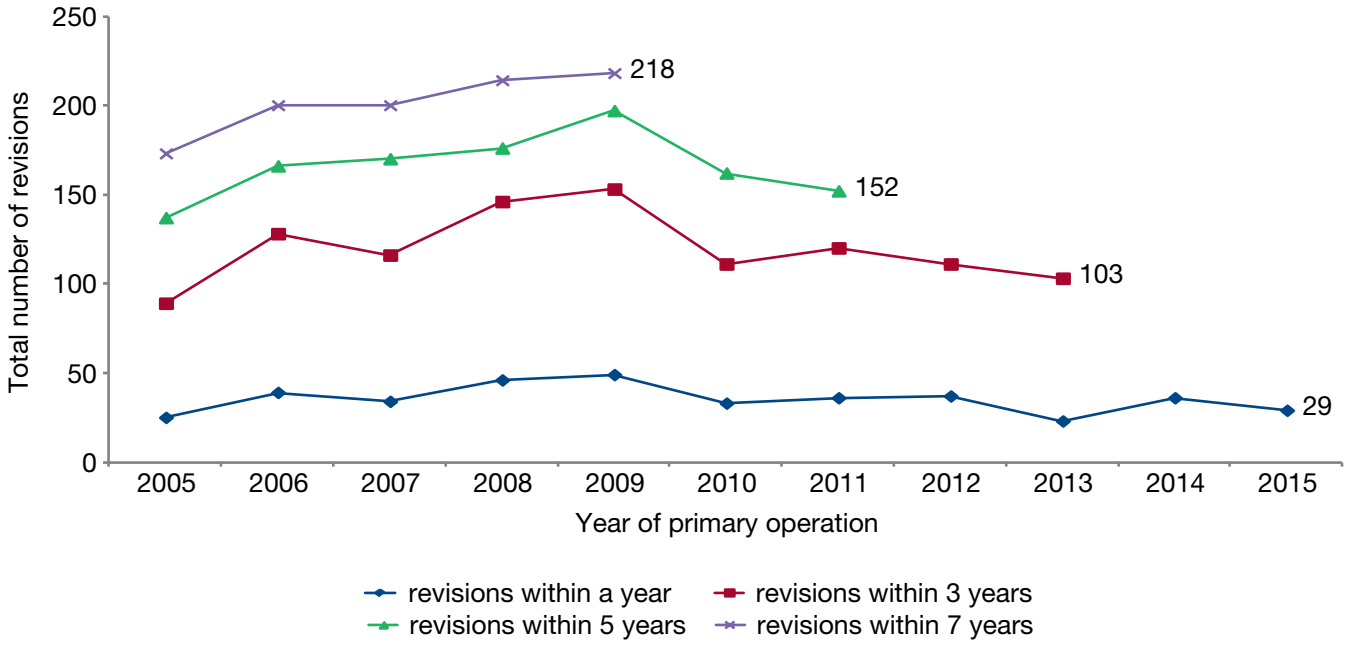



*Scottish Rate averaged over 5 years 2007-2011; Bilateral operations counted twice.*

## 5.3 Knees

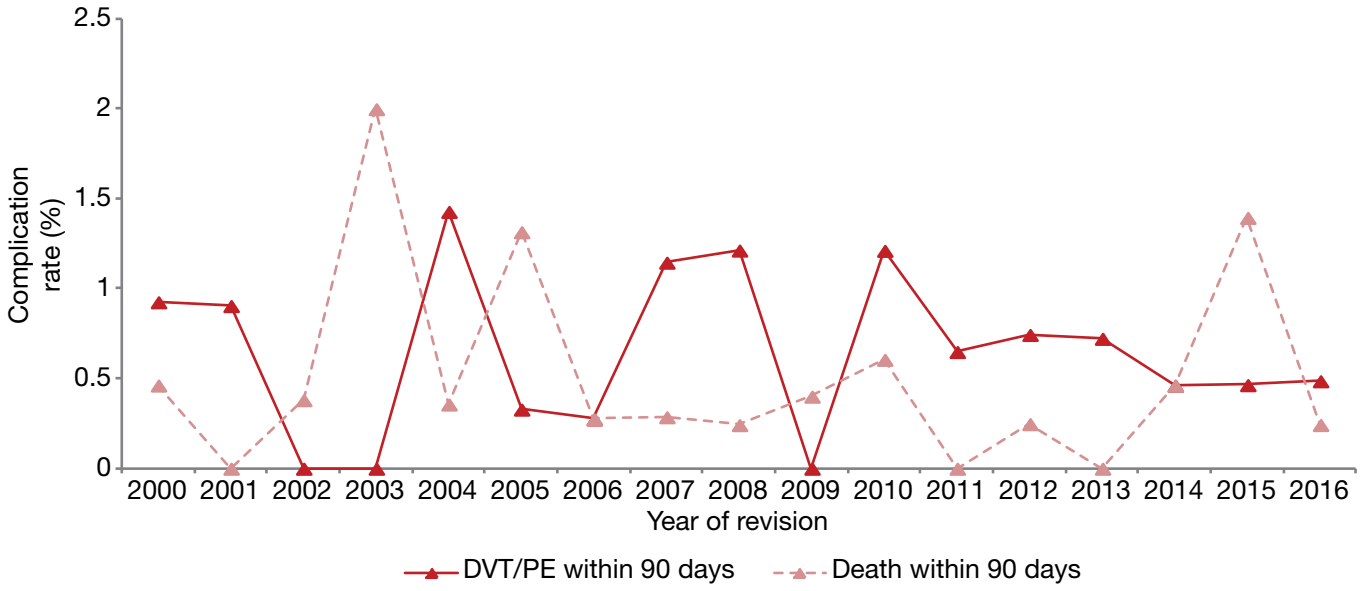
The number of knee arthroplasties being revised remains relatively static from 2005 onwards. The rate of revisions at 3 and 5 years has continued to fall from 2009 onwards (Figure 23a).

**Figure 23a** — Total number of revisions to primary knee arthroplasties in Scotland per year




*Elective patients only; Includes known patients from private hospitals; bilateral operations counted twice.*

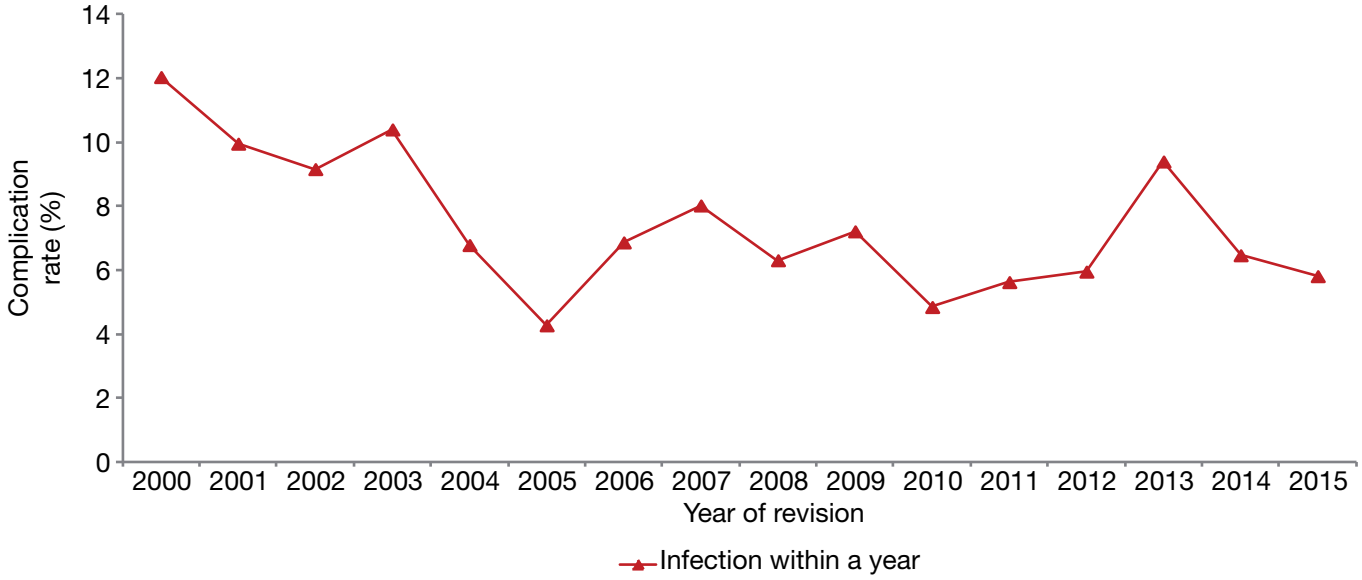
**Figure 23b** — National rates for complications within 90 days: knee revisions




*Bilateral operations counted only once*

The death rate at 90 days has fallen from 1.4% back to 0.2%. Rates for VTE and infection have fallen slightly.

**Figure 23c** — National rates for complications within 1 year: knee revisions




*Bilateral operations counted only once.*

The national rate of infection within 1 year following a knee revision reduced from a high 12% in 2000 to 4.3% in 2005. However the rate of infection has remained more or less static, around 7% since then (Figure 23c).

# 5.4 Complication funnel charts

## 5.4.1 Revision within one year.

No board was an outlier above the upper confidence limit for revision of primary knee arthroplasty within 1 year (Figure 23d).

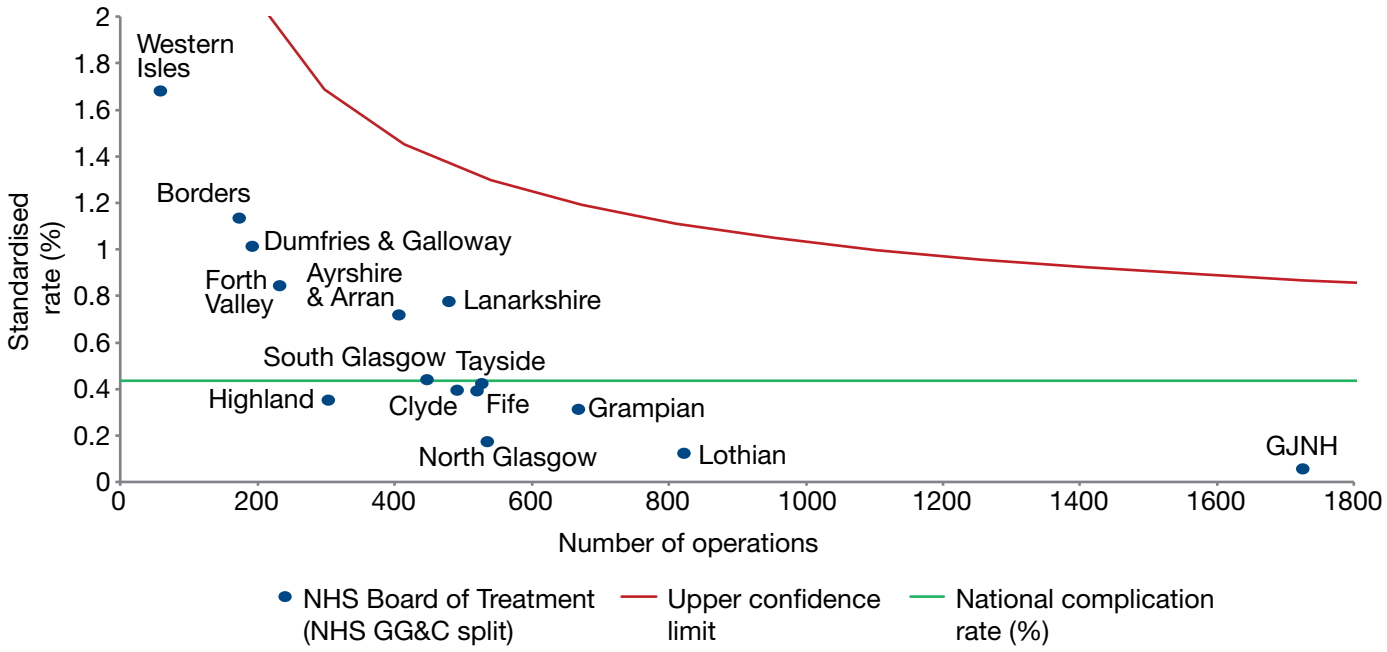
## 5.4.2 Revision within three years.

No Health Boards were “outliers” for revision within three years after knee arthroplasty (Fig 23e).

## 5.4.3 Revision within five years (Figure 23f).

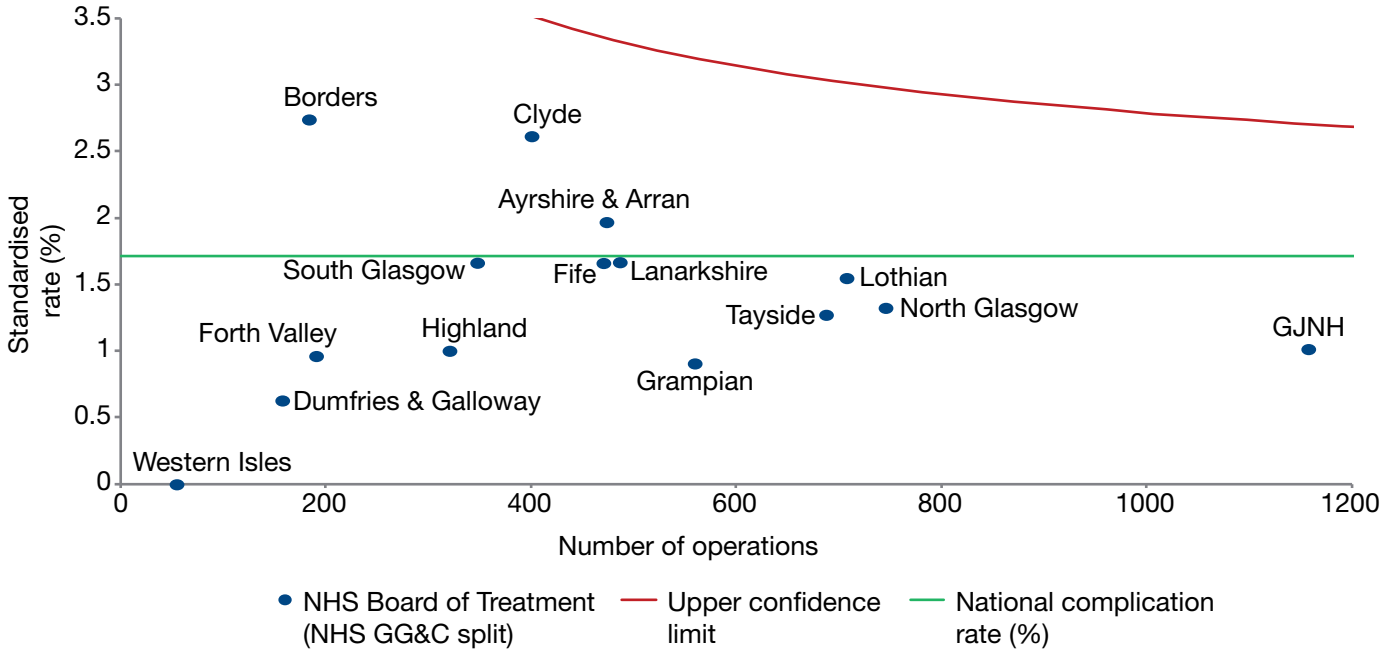
No Health Boards were “outliers” for revision within five years after knee arthroplasty (Fig 23f).

**Figure 23d** — Percentage of 2015 primary knee arthroplasty patients with subsequent revision within 1 year



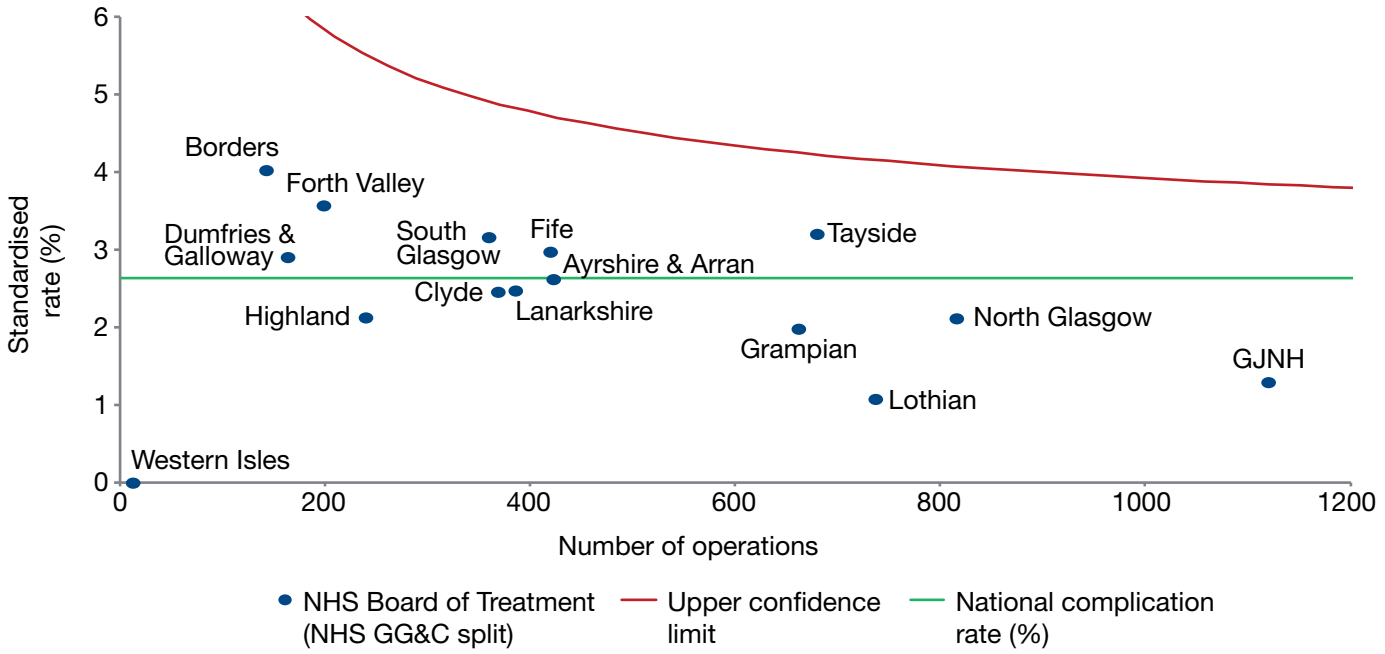

*Scottish Rate averaged over 5 years 2011-2015; Bilateral operations counted twice.*

**Figure 23e** — Percentage of 2013 primary knee arthroplasty patients with subsequent revision within 3 years



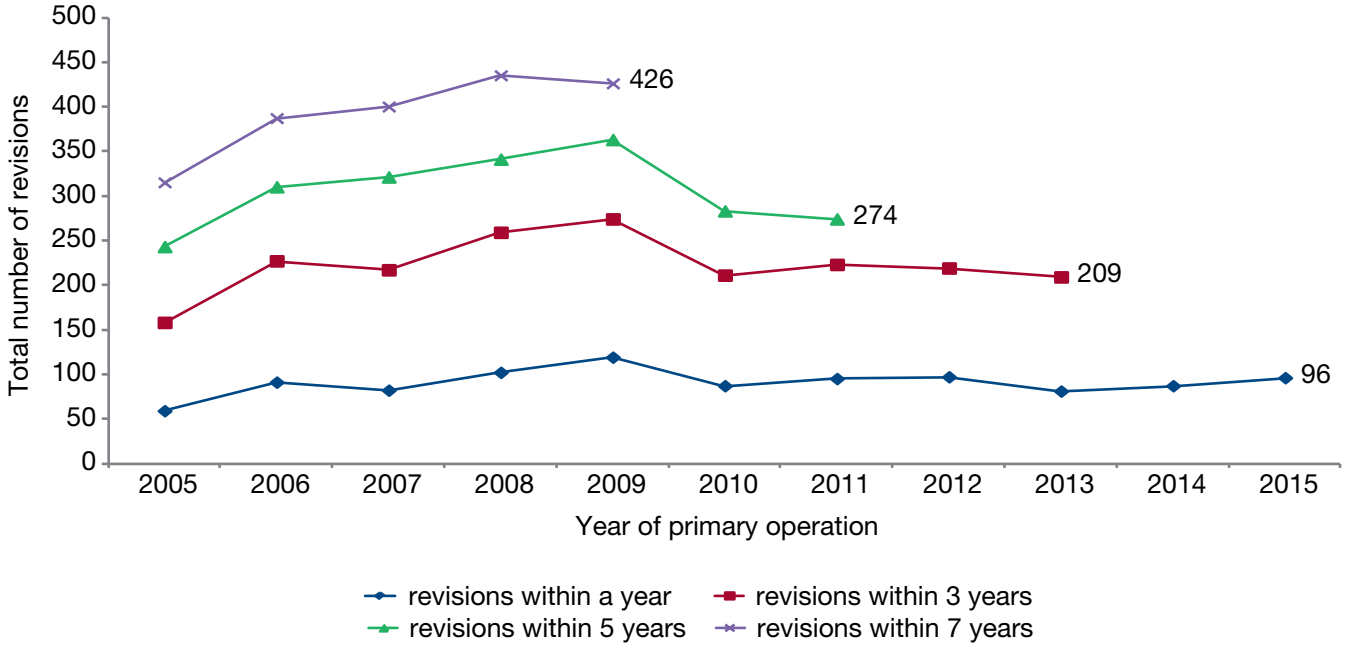

*Scottish Rate averaged over 5 years 2009-2013; Bilateral operations counted twice.*

**Figure 23f** — Percentage of 2011 primary knee arthroplasty patients with subsequent revision within 5 years



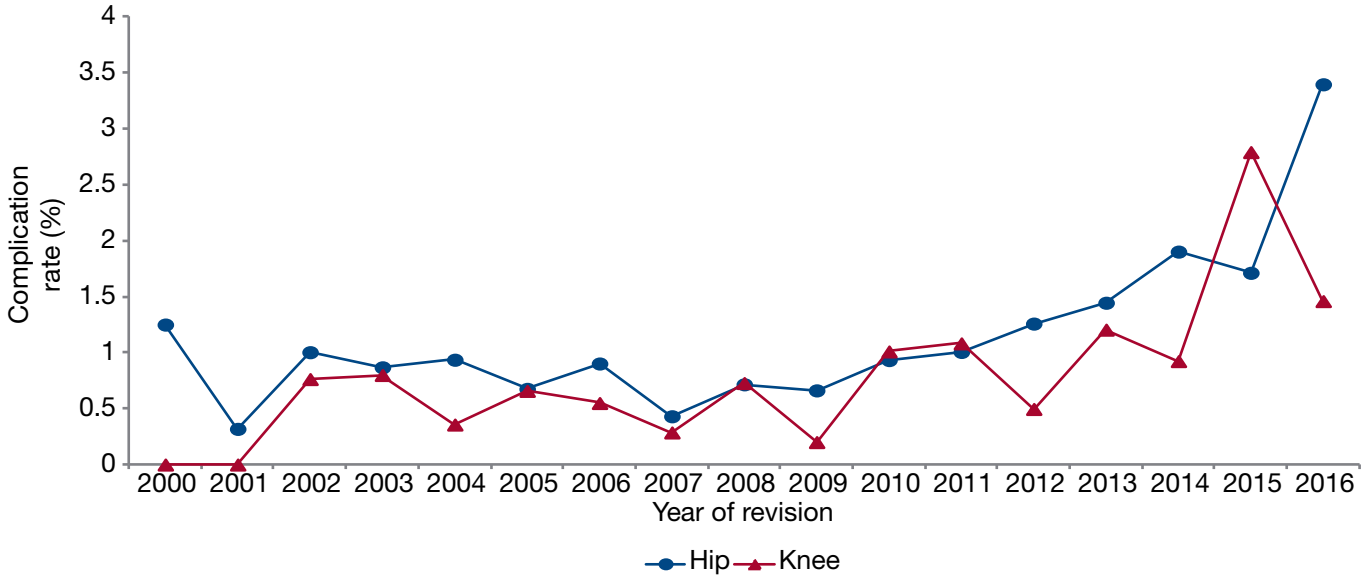

*Scottish Rate averaged over 5 years 2007-2011; Bilateral operations counted twice.*

**Figure 24a** — Total number of revisions of primary hip and knee arthroplasties in Scotland per year




*Elective patients only; Includes known patients from private hospitals; bilateral operations counted twice.*

**Figure 24b** – National rates for acute renal failure within 30 days: hip and knee revisions




There is an apparent upward trend in the rate of renal failure after revision surgery. This should be interpreted with caution as the underlying reason is unclear and may be related to change in definition of renal failure, coding practice, enhanced recovery, changes in prophylactic antibiotic usage. We will continue to observe future trends.

# 6. Clinical Governance

## 6.1 What is clinical governance?

Clinical Governance: 'A framework through which NHS organisations are accountable for continually improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence in clinical care will flourish.'[1]

Clinical Governance is the system used by NHS organisations to monitor and review the quality of healthcare provided so that high standards of care are maintained and patient safety improved. Since 2004, with the support of the Scottish Committee for Orthopaedics and Trauma (SCOT), the policy of the Scottish Arthroplasty Project (SAP) has been to provide high quality data on activity and complications that can be used at a local level to promote quality improvement. Simple monitoring of activity and quality may influence clinical practice but can be insufficient to create significant change. With the support of the SCOT committee, the SAP operates a feedback and review system at consultant level to identify potential quality issues.

## 6.2 Statistical analysis of complication rates associated with arthroplasty

Each month analysts within NSS Information and Intelligence Services calculate the complication rates for all consultants carrying out arthroplasty operations on NHS patients in Scotland.

Since 2010, SAP has used CUSUM (CUmulative SUMmation) methodology to allow us to identify increasing complication rates amongst surgeons with an excellent visual impact when displayed graphically. It has been in use in the UK from as early as 1954 for industrial quality control analysis[2]. In clinical disciplines it has been used in cardiothoracic surgery during the past 15 years[3] and has been shown to be a superior form of statistical analysis for identifying complications[4].

In simple terms, operations are plotted on a graph as a rate over time. If an operation has an associated complication, the CUSUM rate increases markedly. Subsequent operations without known complications bring the rate down by smaller increments. Three of these 'jumps' for the same type of complication in close succession, will raise the CUSUM rate over an agreed control limit and the consultant will be identified as an "outlier". In practice the limit is usually breached over longer periods of time, which include more 'jumps' but also many incremental decreases through successful operations. Two examples are presented in *Appendix C*.

## 6.3 Quality Improvement through *Case Review and Action Plan*

When outliers are identified, recipients are asked to undertake local review and audit to investigate the reasons for the increased rate in complications and to develop an action plan to reduce their recurrence. The introduction of a new technique, a new implant or particular case mix issues may be identified as reasons for an apparent rise.

Comments, case reviews and audit finding are returned to SAP analysts within NHS Information and Intelligence Services. The review process is administered by analysts within NHS Information and Intelligence Services and is subject to NHS confidentiality policy – individual consultant responses are anonymised before being passed onto the SAP committee for review.

Clinical members of the Scottish Arthroplasty Project Steering Committee (SAPSC) grade these reviews and provide feedback. In the very rare occasions when a the response is viewed as less than

satisfactory, a resubmission is requested and the issue may be transferred to senior management within the appropriate NHS Board.

The purpose of reviewing outliers is to emphasise quality improvement, rather than to attribute blame. The aim of the review process is to continue to encourage local review of clinical practice and data quality, both of which contribute to the continual improvement of patient care.

**Figure 25** — CUSUM outlier notifications during 2015-2016.

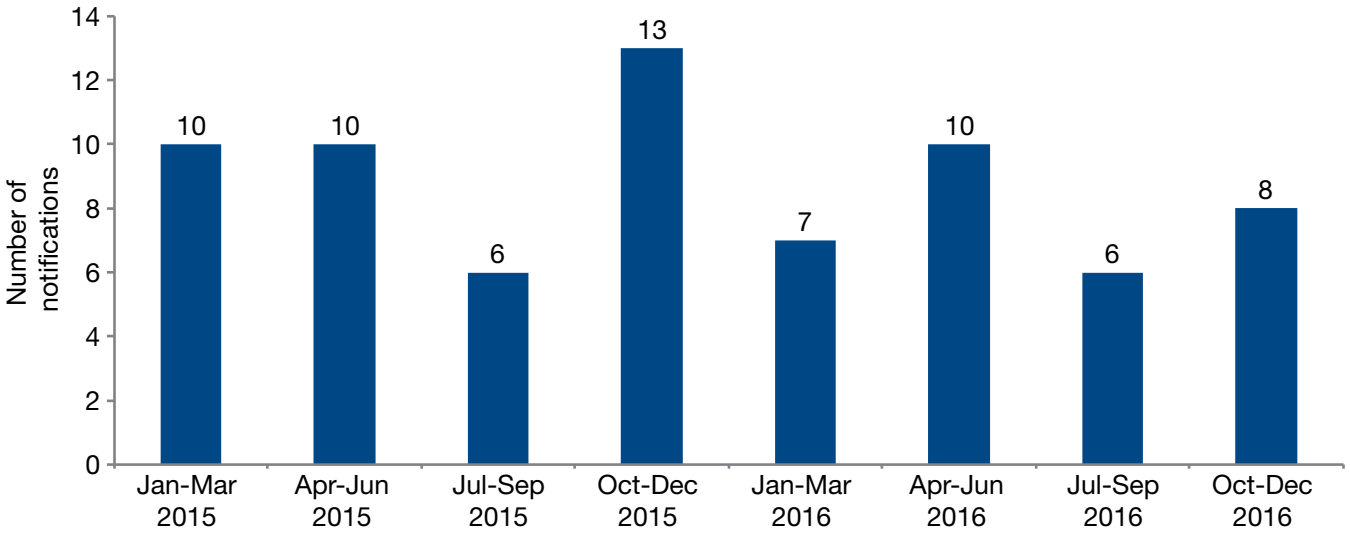
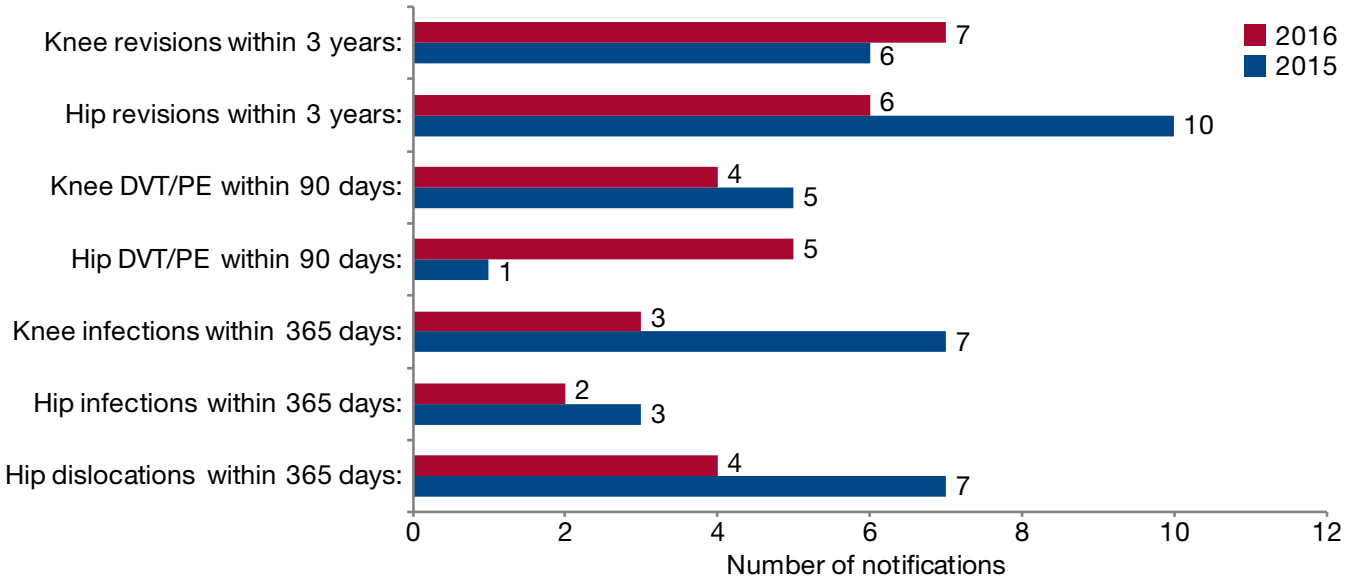



**Figure 26** — CUSUM outlier notification by complication type during 2015-2016.



# References


1. Scally G and Donaldson LJ (1998) Clinical governance and the drive for quality improvement in the new NHS in England. British Medical Journal. 317 (7150) 4 July pp.61-65.
2. Page ES (1954). Continuous inspection schemes. Biometrika. 41:100 –115.
3. de Leval MR et al. (1994). Analysis of a cluster of surgical failures. Application to a series of neonatal arterial switch operations. J Thorac Car- diovasc Surg. 107:914–24
4. Novick R, et al.(2003). Analysis of the learning curve in telerobotic, beating heart coronary artery bypass grafting: a 90 patient experience. Ann Thor Surg. 76:749–53.
5. Comparing contemporary revision burden among hip and knee joint replacement registries McGrory, Brian J. et al. Arthroplasty Today, Volume 2 , Issue 2, 83 - 86

# Appendix A

### Data Sources

The Scottish Arthroplasty Project is administrated by the Information Services Division (ISD) of National Services Scotland (NSS), a special NHS Health Board. ISD use information submitted by Scottish hospitals (known as SMR01 data) to calculate statistical information related to NHS arthroplasty operations in Scottish hospitals.

Information on SMR01 is available here:
http://www.isdscotland.org/Products-and-Services/Hospital-Records-Data-Monitoring/.

### Data Completeness

All SMR01 data are required to be securely submitted to ISD no later than six weeks after the end of the month of discharge. Although Medical Records departments within hospitals and NHS Boards make every effort to comply, circumstances outwith their control may mean that this target is not always met. SMR01 data required for the analyses in this report are considered to be 100% complete.

Information on SMR01 data completeness is available here:
http://www.isdscotland.org/Products-and-Services/Hospital-Records-Data-Monitoring/.

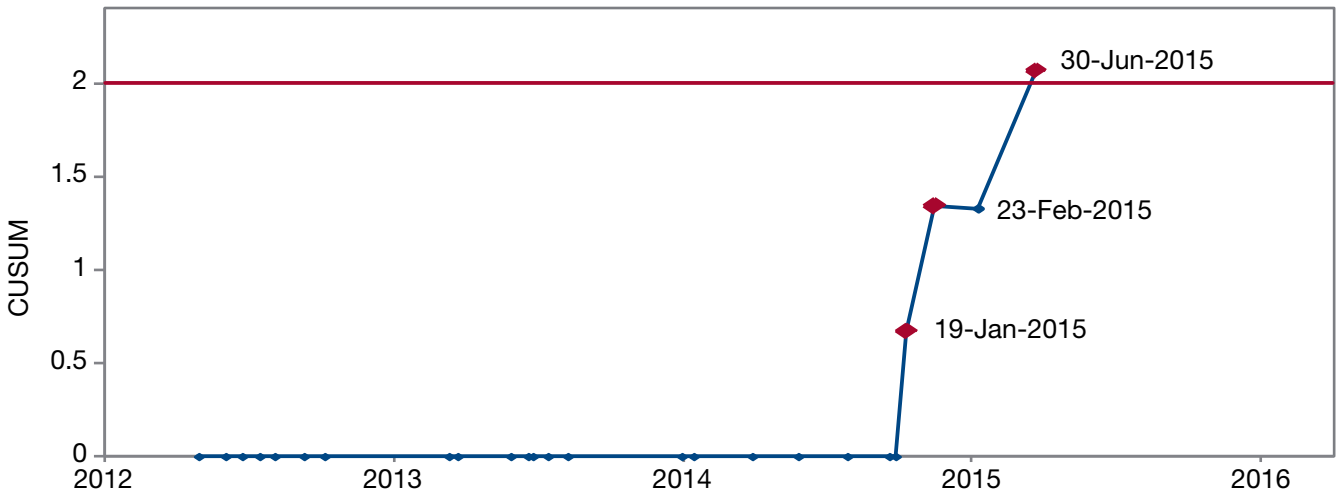
### Arthroplasty coding

Information on codes used to identify arthroplasty operations is available here: Information on codes used to identify arthroplasty operations is available here:
http://www.arthro.scot.nhs/OPCS_codes_summary_150710.pdf.

# Appendix B to Section 6

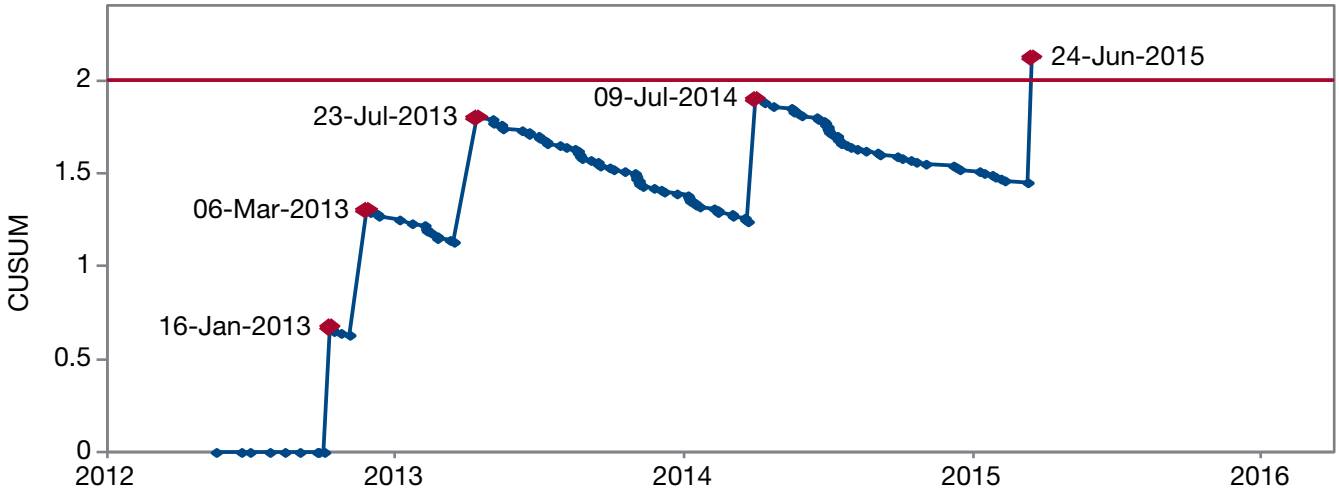
In the case below (Figure 29), CUSUM is low until it rises suddenly to the Control Limit in 2009. Is the rise associated with a change in practise, perhaps a new technique?

**Figure 27** — CUSUM chart showing a surgeon with a higher than expected complication rate following 3 complications in quick succession




In the following case (Figure 30), CUSUM rises steadily to the Control Limit (2.0). The complication rate is always slightly over average - is there an ongoing issue? When the Control Limit is reached the consultant would be notified that their complication rate had been unusually high and asked to complete a review and Action Plan.

**Figure 28** — CUSUM chart showing a surgeon with a higher than expected complication rate following 5 complications over a period of 2.5 years



# Contact

**Martin O'Neill**

Principal Information Analyst

martin.o'neill@nhs.net

0131 275 6244

**Jacqueline Campbell**

Senior Information Analyst

jcampbell25@nhs.net

0141 282 2111

Email: nss.isdarthroplasty@nhs.net

If you have general questions about joint replacement in Scotland please contact Mr Roland Ingram, Chair of the Scottish Arthroplasty Project and Orthopaedic Consultant:

**Mr Roland Ingram FRCS (Tr & Orth)**

Chair of Scottish Arthroplasty Project

Consultant Orthopaedic Surgeon

Glasgow Royal Infirmary

Tel: 0141 211 4420 (secretary)

Email: roland.ingram@nhs.net