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The epidemiology of reoperations for orthopaedic trauma

RC Barksfield[1], R Coomber[1], K Woolf[2], A Prinja[1], D Wordsworth[1], D Lopez[1], S Burtt[1]

[1]Luton and Dunstable Hospital NHS Foundation Trust, UK
[2]University College London, UK

ABSTRACT

INTRODUCTION The Royal College of Surgeons of England (RCS) has issued guidance regarding the use of reoperation rates in the revalidation of UK-based orthopaedic surgeons. Currently, little has been published concerning acceptable rates of reoperation following primary surgical management of orthopaedic trauma, particularly with reference to revalidation.

METHODS A retrospective review was conducted of patients undergoing clearly defined reoperations following primary surgical management of trauma between 1 January 2010 and 31 December 2011. A full case note review was undertaken to establish the demographics, clinical course and context of reoperation. A review of the imaging was performed to establish whether the procedure performed was in line with accepted trauma practice and whether the technical execution was acceptable.

RESULTS A total of 3,688 patients underwent primary procedures within the time period studied while 70 (1.90%, 99% CI: 1.39–2.55) required an unplanned reoperation. Thirty-nine (56%) of these patients were male. The mean age of patients was 56 years (range: 18–98 years) and there was a median time to reoperation of 50 days (IQR: 13–154 days). Potentially avoidable reoperations occurred in 41 patients (58.6%, 99% CI: 43.2–72.6). This was largely due to technical errors (40 patients, 57.1%, 99% CI: 41.8–71.3), representing 1.11% (99% CI: 0.73–1.64) of the total trauma workload. Within RCS guidelines, 28-day reoperation rates for hip, wrist and ankle fractures were 1.4% (99% CI: 0.5–3.3), 3.5% (99% CI: 0.8%–12.1) and 1.86% (99% CI: 0.4–6.6) respectively.

CONCLUSIONS We present novel work that has established baseline reoperation rates for index procedures required for revalidation of orthopaedic surgeons.

KEYWORDS

Reoperation – Orthopaedic trauma – Revalidation – Epidemiology of reoperation

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CORRESPONDENCE TO

Richard Barksfield, E: rcbarksfield@hotmail.com

In 2011 The Royal College of Surgeons of England (RCS) issued guidance on using outcome measures for revalidation that include indicators for general trauma such as reoperation rates following a specific set of index procedures (Figs 1 and 2).[1] A number of agencies collate such hospital episode data although this is highly dependent on coding[2] and the validity for direct comparison between organisations has been called into question.[5] A further important consideration is that, at present, while no universally accepted definition of reoperation exists, the rate of reoperations could vary significantly between units based on data sampling and interpretation rather than a true discrepancy. In order to mitigate the difficulties associated with interpreting nationally collected data, the RCS suggests local audit as a means of monitoring performance but, as yet, established standards of acceptable reoperation rates do not exist.

Our primary aim was to establish the reoperation rate following primary surgical management of general trauma in our unit. Our secondary aim was to determine the reoperation rates following index procedures for the management of hip fractures, tibial plateau fractures, distal radius fractures and ankle fractures in line with RCS guidance. Finally, we sought to clearly define the term 'reoperation' in the context of orthopaedic trauma to allow consistency in the application of the term in the literature.

Methods

A retrospective review was conducted of patients undergoing primary surgical procedures for trauma over a two-year period. All primary procedures were performed between 1 January 2010 and 31 December 2011 with the data capture period extending six months beyond this to allow identification of reoperation cases occurring as a result of primary procedures performed in the latter stages of 2011. All patients were identified from a hospital database using the Office of Population Censuses and Surveys Classification of Interventions and Procedures (OPCS-4.6) codes, and verified manually against electronic patient

Key procedures	OPCS codes	Measurement criteria
Hip fractures	V22 V24 V25 V27 V44 V45	30-day mortality 28-day reoperation/reintervention 28-day unplanned readmission Length of stay (median)

OPCS = Office of Population Censuses and Surveys

Figure 1 Royal College of Surgeons of England revalidation criteria for hip fractures[1]

records and radiographic data. A full case note review was undertaken to establish the demographics, clinical course and context of reoperation.

A patient was considered to have undergone a reoperation where the subsequent procedure either readdressed the presenting diagnosis or addressed a complication arising from the index procedure. Where a secondary procedure was considered to be necessary as part of the expected treatment course, these procedures were not considered to be reoperations and the patients subsequently excluded. Commonly encountered exclusions comprised patients with a primary soft tissue injury requiring secondary debridement or closure, those undergoing washout or revision following primary elective procedures, those undergoing anticipated metalwork removal, those undergoing dynamisation of intramedullary nails and those with incorrectly coded procedures. Where multiple reoperations occurred for the same patient episode, the most significant reoperation was included for analysis. All patients under the age of 18 years were excluded.

A comprehensive review of the imaging was performed by the lead author (RB) and senior author (SB). This was to establish whether the procedure performed was in line with current guidance and accepted trauma practice, and whether the technical execution of the procedure was within acceptable limits. Agreement was reached in all cases. Reoperations relating to the primary procedure were then classified as avoidable or unavoidable based on initial decision making and technical execution.

Calculation of exact central 99% confidence intervals for proportions was performed with the causaScientia online calculator (http://www.causascientia.org/math_stat/ProportionCI.html), which uses a Bayesian approach.

Results

A total of 3,688 primary procedures were performed for trauma during the 2-year period studied. Patient demographics are presented in Table 1. Seventy patients (1.90%, 99% CI: 1.39–2.55) underwent a reoperation during this period. Their mean age was 56 years (range: 18–98 years). Thirty-nine (56%) of the patients were male. Twenty-one patients were ASA (American Society of Anesthesiologists) grade 1, twenty-nine were ASA grade 2, eighteen were ASA grade 3 and two were ASA grade 4.

Classification of reoperation procedures by anatomical site is presented in Figure 3. Overall, the primary procedures performed were consistent with current accepted practice in 56 cases (80.0%, 99% CI: 65.6–89.8) while technical errors were observed in 40 cases (57.1%, 99% CI: 41.8–71.3). When considered in combination, 41 (58.6%, 99% CI: 43.2–72.6) of the 70 patients who had had reoperations were felt to have required additional procedures for complications deemed to be potentially avoidable, representing 1.11% (99% CI: 0.73–1.64) of the total number of trauma procedures performed during this time. Reoperations were further classified by the secondary procedure performed and these data are presented in Table 2.

The median time to reoperation was 50 days (IQR: 13–154 days) and 26 patients underwent reoperations within 28 days, representing an overall rate of 0.71% (99% CI: 0.42–1.14). Over a third (37.1%, 99% CI: 23.7–52.6) of all reoperations occurred within 28 days of the primary procedure while 77.1% (99% CI: 62.4–87.7) of those reoperations captured during the period studied occurred within 6 months of the primary procedure (Fig 4).

Data for performance against RCS revalidation criteria are presented in Table 3. A more detailed breakdown of this analysis is presented below.

Hip and proximal femur fractures

Of the 70 patients who underwent reoperations, 18 (25.7%, 99% CI: 14.5–40.7) did so following operative management of proximal femoral fractures. During this period, 515 primary procedures were conducted for hip/proximal femoral fractures, 402 for intracapsular fractures and 113 for

Key procedures	OPCS codes	Measurement criteria
Intramedullary nailing of the femur / tibia for diaphyseal fracture	W19.2, W24.2	30-day mortality 28-day reoperation/reintervention 28-day unplanned readmission code for infection of operative site Length of stay (day case and median)
ORIF ankle	W20	
ORIF distal radius	W20, W21	
Tibial plateau	W21.1, W21.4	

OPCS = Office of Population Censuses and Surveys

Figure 2 Royal College of Surgeons of England revalidation criteria for index trauma procedures[1]

Table 1 Reoperation cohort demographics (*n*=70)

Characteristic	Measurement
Mean age (years)	56 (range: 18–98)
Male sex	46 (55%)
ASA grade	
1	21 (30%)
2	29 (41%)
3	18 (26%)
4	2 (3%)
5	0 (0%)
Timing of procedure	
Interval to reoperation (days)	50 (IQR: 13–154)
Reoperations within 28 days	26 (37%)
Review of index procedure	
Current accepted practice	56 (80%)
Technical error of primary procedure	40 (57%)
Secondary procedure avoidable	41 (59%)

ASA = American Society of Anesthesiologists; IQR = interquartile range

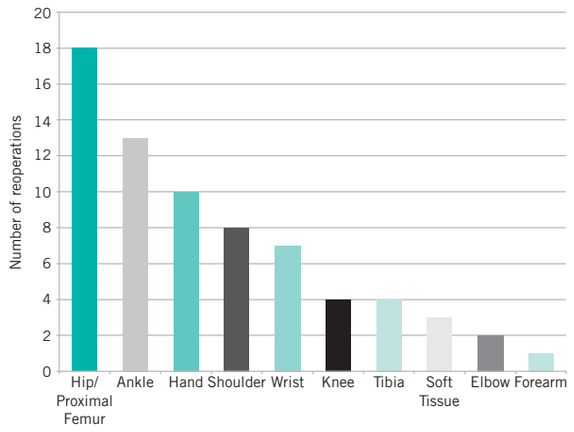

Figure 3 Distribution of reoperation procedures performed in 2010 and 2011 by anatomical site (*n*=70)

Table 2 Percentage of procedures in 2010 and 2011 that required reoperation in 2010 and 2011, and the percentage of reoperation rates for specific procedures

	n	Percentage of total procedures in 2010 and 2011 (*n*=3,688)	99% CI
Reoperations in 2010 and 2011	70	1.90%	1.39–2.55
Primary procedure in 2010	21	1.22%	0.68–2.07
Primary procedure in 2011	49	2.49%	1.71–3.54
	n	**Percentage of total reoperations in 2010 and 2011 (*n*=70)**	**99% CI**
Revision of fixation	25	36%	22.5–51.1
Removal of symptomatic metalwork	10	14%	6.3–27.7
Washout of primary surgical wound	7	10%	3.7–22.4
Revision to total hip arthroplasty	7	10%	3.7–22.4
Revision MUA and K-wire fixation	5	7%	2.2–18.6
Excision arthroplasty	4	6%	1.6–16.7
Removal of infected metalwork	4	6%	1.6–16.7
Primary fixation	3	4%	1.0–14.6
Revision soft tissue repair	3	4%	1.0–14.6
Manipulation of trauma arthroplasty	2	3%	0.5–12.4

CI = confidence interval; MUA = manipulation under anaesthesia

extracapsular fractures, giving an overall reoperation rate of 3.50% (99% CI: 1.88–6.13) for proximal femoral fractures. Six patients required revision of primary fixation, five required revision arthroplasty (three for failure of fixation, one for infection, and one for exploration of sciatic nerve and revision of primary implant), four required excision arthroplasty (two for infections and two for recurrent dislocation), two required manipulations for dislocation and one required wound washout.

Of the 18 hip/proximal femur reoperations, 7 occurred during the first 28 days postoperatively (range: 0–614 days), representing a 28-day reoperation rate of 1.4% (99% CI: 0.5–3.3). Preoperative decision making was found to be consistent with accepted practice in 15 cases (83.3%, 99% CI: 53.2–96.2) but technical execution was unacceptable in 7 (38.9%, 99% CI: 15.5–68.1). In combination, nine reoperations (50.0%, 99% CI: 23.2–76.8) were felt to be avoidable.

Open reduction and internal fixation of the distal radius

Of the 70 patients who underwent reoperations, 5 (7.1%, 99% CI: 2.2–18.7) did so following open reduction and internal fixation (ORIF) of distal radius fractures, with 58 patients undergoing primary fixation during this time. The

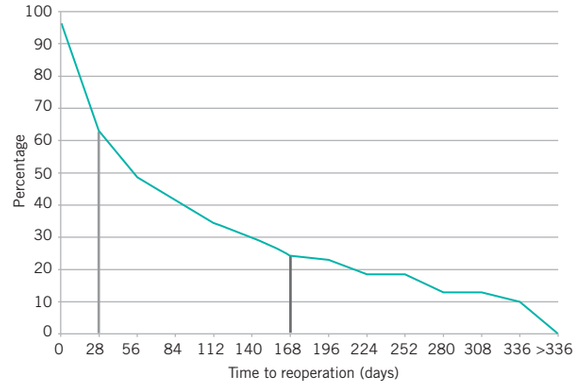

Figure 4 Reoperation free survival from primary procedure at 28 days and at 168 days (*n*=70)

overall reoperation rate was 8.6% (99% CI: 2.7–22.2). Preoperative decision making was consistent with accepted practice in all cases, with technical failures accounting for four patients requiring further procedures and metalwork removal performed in one patient for irritation. Three distal radius reoperations were performed within 28 days, which equates to 3.5% (99% CI: 0.8–12.1) of the total number of reoperations in that period, although the range extended from 6 to 315 days.

Ankle fractures

Of the 70 patients who underwent reoperations, 13 (18.6%, 99% CI: 9.2–32.8) did so following ORIF of ankle fractures. A total of 161 primary ankle fixations were performed during the time period studied. The overall reoperation rate was 8.1% (99% CI: 3.9–15.1). The reoperations performed were revision of fixation in six (46.2%, 99% CI: 17.2–77.7), removal of metalwork in five (38.5%, 99% CI: 12.7–72.0) and wound debridement for infection in two cases (15.4%, 99% CI: 2.6–51.2). Decision making was consistent with accepted practice in 11 cases (84.6%, 99% CI: 48.8–97.4), with technical execution acceptable in only 6 (46.1%, 99% CI: 17.2–77.7) and avoidable complications arising in 8 cases (61.5%, 99% CI: 27.9–87.3). Three patients underwent reoperations after primary ankle fixations within 28 days (range: 12–488 days), equating to a reoperation rate of 1.86% (99% CI: 0.4–6.6).

Discussion

We present a review of trauma practice in our unit over a two-year period focusing on reoperation rates in those patients undergoing primary surgical management of general orthopaedic trauma. There are currently no comparable data in the literature for reoperation rates among all primary trauma procedures but this exercise was an important process that has assisted in local clinical governance of the management of trauma in our unit.

The results showed that while preoperative decision making was in line with accepted best practice in 80% of cases, decision making was deficient in the remaining 20% and this was felt to be a significant contributor to failure in these cases. Acceptable standards of decision making and execution were considered where procedures had been conducted in line with AO (Arbeitsgemeinschaft für Osteosynthesefragen) principles of trauma management and National Institute for Health and Clinical Excellence (NICE) best practice guidelines (Appendix 1 – available online).[4] Not all injuries could be clearly defined and managed in accordance with AO principles or NICE guidance and, in these circumstances, we asked ourselves whether the planned fixation and execution was within satisfactory limits based on the training and experience of the assessors. This introduced an element of subjective bias in those cases not clearly defined within the aforementioned criteria.

Technical errors were observed in 57% of cases and most of these resulted from inadequate implantation of devices or failure to reduce fractures satisfactorily. Although these figures seem alarmingly high on initial review, it is noteworthy that in the context of 3,688 primary procedures, technical errors leading to failure would represent 1.08% of cases overall. In addition, it is difficult to

Table 3 Percentage reoperation rate by Royal College of Surgeons of England revalidation criteria of total trauma workload and in reoperation subgroup

	n	Reoperation rate against trauma workload in 2010 and 2011 (*n*=3,688)	99% CI	Percentage of reoperations in 2010 and 2011 (*n*=70)	99% CI
Hip fractures	18	0.49%	0.26–0.87	25.7%	14.5–40.7
Intramedullary nailing of the femur / tibia for diaphyseal fracture	2	0.05%	<0.01–0.25	2.8%	0.5–12.4
ORIF ankle	13	0.35%	0.16–0.69	18.6%	9.2–32.8
ORIF distal radius	5	0.14%	0.04–0.38	7.1%	2.2–18.7
Tibial plateau	2	0.05%	<0.01–0.25	2.9%	0.5–12.4

CI = confidence interval; ORIF = open reduction and internal fixation

estimate the total contribution that technical errors made to the failure of primary procedures without knowing the rate of technical errors among those primary procedures that did not require reoperations.

Hip and proximal femur

Reoperations for hip and proximal femoral fractures were the most frequently encountered procedures in this study, representing 22% of cases and a reoperation rate of 3.5% in this subgroup. Viberg *et al* reported reoperation rates following the management of intracapsular hip fractures in four patient cohorts undergoing internal fixation, uncemented hemiarthroplasty, cemented hemiarthroplasty or uncemented coated hemiarthroplasty.[5] The overall reoperation rates varied widely in these groups from 5.3% for cemented hemiarthroplasty to 18.3% in those patients undergoing internal fixation. The reasons for reoperation were most commonly failure of fixation in those patients who were fixed internally and periprosthetic fracture or dislocation in those undergoing hemiarthroplasty.

Among the 402 intracapsular fractures in the present study, the most commonly encountered reasons for reoperation were failure of fixation in 3 (1%), infection in 4 (1%) and dislocation in 4 cases (1%). Extrapolation of the figures from the work of Viberg *et al* shows reoperations were performed for 4% owing to failure of fixation, 0.6% owing to infection and 2% for dislocation.[5] An obvious criticism of this comparison is that their study included reoperations up to 19 years following the primary procedure and also that our study populations are not directly comparable. On closer inspection, 58 reoperations (64%) occurred within 1 year of the primary procedure in study by Viberg *et al*, with 68 reoperations (75%) occurring by 2 years. While direct comparisons should not be drawn because of differences in the patient populations, we do believe our findings support those from the previous study.

Extracapsular fractures were managed primarily in 113 patients, with 7 requiring reoperations, giving an overall rate of 6%. The reasons for a second procedure were failed fixation in four cases, periprosthetic fracture in one case, implant failure in one case and non-union in one case. In a study published in 2012 from Greece comparing the use of sliding hip screw and cephalomedullary fixation of these fractures, 13 patients required reoperations from 165 primary procedures, giving a comparable rate of reoperations of 8%.[6] Furthermore, in a meta-analysis comparing gamma nail and dynamic hip screw fixation of peritrochanteric fractures, Liu *et al* observed reoperation rates of 5% for fixation failure.[7] The reoperation rates following operative management of extracapsular fractures in the present study not only support those found in the literature but are also representative of general trauma practice rather than results within a selected study cohort.

The 2013 National Hip Fracture Database report identified that reoperation rates were 'poorly reported' among all hospitals,[8] adding emphasis to the importance of our findings for those seeking a benchmark for the purposes of revalidation. Our hospital was among many that had failed to submit data for 30-day reoperation rates for 2013 but for those that had, there was considerable variation from 0% to 5% and an overall rate of approximately 1%.

Distal radius fractures

In 2011 Sahu *et al* reported reoperations for metalwork complications in 12 cases of 114 distal radius fractures managed with volar locking plating.[9] This would give an overall reoperation rate of 10%, which would support the findings in the present study of a reoperation rate of 8.6% in this subset. In contrast to this, Matschke *et al* reported 10 reoperations in 266 patients (3.8%) undergoing volar locking plate fixation of distal radius fractures in a prospective study.[10] There is also a disparity in the type of reoperation performed between our study and the findings of Matschke *et al* with metalwork irritation and tendon injury occurring frequently in the cited study while fixation failures due to technical execution featured prominently in our study.

Ankle fractures

Our study shows an overall reoperation rate of 8.7% following operative fixation of ankle fractures with the majority (4.3%) of these due to failed fixation and the remainder attributable to prominent metalwork (3.1%) or wound infections (1.2%). Little *et al* reported reoperation rates of 12.5% following ORIF of supination external rotation injuries of the ankle in 112 patients, with 7% undergoing removal of symptomatic metalwork, 1.8% requiring removal for infections and 0.9% requiring plastic surgery for wound complications.[11] This need for reoperations was considered by Little *et al* to be minimal. However, we feel the relatively high number of reoperations observed in the present study highlights the importance of respecting an injury that has a broad spectrum of difficulty and technical requirements.

Study limitations

We recognise that the present study has a number of limitations, not least the reliability of retrospectively assimilated data. We are also aware that the use of coding databases to identify patients has been shown to be unreliable in previous studies.[2] In 2008–2009 the UK Audit Commission reported clinical coding errors in 12.8% of all codes nationally, with our unit falling at the lower end of the normal distribution with a rate of 8.2%.[12] While it is difficult to fully adjust for coding differences between trusts, we do believe that these figures help to interpret the present study in the national context.

A key aspect of our study was the definition of what was considered a reoperation (for example, whether the anticipated removal of syndesmotic screws or dynamisation of intramedullary devices should be included in the analysis). Our exclusion criteria were constructed on what we considered to be anticipated reoperations in the normal course of treatment or unacceptable in the context of each case. This is crucial not only in the comparison of our data with the literature but also in the application of our findings to audit and quality improvement in other general trauma units.

An additional consideration of the present study is that the assessment of preoperative decision making was based on analysis of radiography alone and did not take into account other factors that may influence preoperative procedure choice such as medical co-morbidity, bone quality, availability of equipment and safe anaesthetic time. Furthermore, what is considered acceptable operative management of certain injuries may occasionally be controversial. The process for this evaluation in our study was for the senior author and lead author to review each case and consider the procedure performed against their experience, training and available guidance. It is a strength of the present study that both authors were blinded to the operating surgeon and any preoperative decision making that was documented in the case notes. This method of evaluation does, however, introduce some limitations (not least an element of subjective bias) and would have been stronger had the assessors been independent of the department.

We set out to capture data up to six months of data beyond the two-year study period in an attempt to identify those reoperations arising from primary procedures towards the end of 2011. Despite these considerations, it was identified that 23% of patients captured in the present study underwent reoperations beyond six months from the index procedure. The figures presented here are therefore an underestimation of the total number of reoperations that would be expected. While some may see this as a limitation of the current study, we believe such longer-term data in this context would be of limited value. We have clearly demonstrated 28-day reoperation rates from our dataset and the addition of the 6-month observation period permitted reporting of over three-quarters of predicted reoperations. It would be idealistic to seek a longer follow-up duration but most would recognise that an indefinite follow-up period is impractical for comparison.

Our findings are a representation of the management of trauma in a single organisation and have not undergone any adjustment for variations in the local population that we serve. These adjustments are commonplace and necessary when comparing either organisations or individuals using nationally collected data such as the National Joint Registry or the National Hip Fracture Database. This process of adjustment and careful refinement of the data is intended to prevent the occurrence of outliers that could otherwise be the result of chance. The results quoted in this single unit study must therefore be interpreted carefully and applied with these caveats in mind. While these factors preclude the use of this study as a direct point of reference, we do believe this work provides valuable insight into the epidemiology of reoperations for general orthopaedic trauma.

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