The Knee 29 (2021) 353–364

Contents lists available at ScienceDirect

The Knee

journal homepage:

Revision knee replacement surgery in the NHS: A BASK surgical practice guideline

N.S. Kalson, J.A. Mathews, J.R.A. Phillips, P.N. Baker, A.J. Price, A.D. Toms *on behalf of the BASK Revision Knee Working Group: A. Alvand, B. Bloch, D. Barrett, R. Carrington, D.J. Deehan, K. Eyres, A. Gambhir, P. Hopgood, N. Howells, W. Jackson, P. James, L. Jeys, R. Kerry, J. Miles, B. Mockford, R. Morgan-Jones, J. Murray, G. Pavlou, A. Porteous, M. Sarungi, R. Spencer-Jones, P. Walmsley, H. Waterson, J. Whittaker

British Association for Surgery of the Knee Revision Knee Working Group, 35 – 43 Lincoln's Inn Fields, London WC2A 3PE, United Kingdom

ARTICLE INFO

Article history:
Received 6 June 2020
Revised 20 January 2021
Accepted 30 January 2021

Keywords:
Knee
Arthroplasty
Revision
Infection
Guidelines

ABSTRACT

Background: Revision knee replacement (KR) is both challenging for the surgical team and expensive for the healthcare provider. Limited high quality evidence is available to guide decision-making.
Aim: To provide guidelines for surgeons and units delivering revision KR services.
Methods: A formal consensus process was followed by BASK's Revision Knee Working Group, which included surgeons from England, Wales, Scotland and Northern Ireland. This was supported by analysis of National Joint Registry data.
Results: There are a large number of surgeons operating at NHS sites who undertake a small number of revision KR procedures. To optimise patient outcomes and deliver cost-effective care high-volume revision knee surgeons working at high volume centres should undertake revision KR.

This document outlines practice guidelines for units providing a revision KR service and sets out: The current landscape of revision KR in England, Wales and Northern Ireland. Service organisation within a network model. The necessary infrastructure required to provide a sustainable revision service. Outcome metrics and auditable standards. Financial mechanisms to support this service model.
Conclusions: Revision KR patients being treated in the NHS should be provided with the best care available. This report sets out a framework to both guide and support revision KR surgeons and centres to achieve this aim.

1. Background

Total knee replacement (TKR) is a well-recognised, effective treatment for joint disease that has been demonstrated to reduce pain and improve function [1]. In the UK the annual rate of TKR has been increasing year-on-year [2] and because

* Corresponding author.
E-mail address: Andrewtoms@nhs.net (A.D. Tom).

https://doi.org/10.1016/j.knee.2021.01.032
0968-0160/

of population demographic changes (age, gender and obesity) the rate of primary TKR is projected to increase from 100,000 in 2018 to > 500,000 by 2030 [3]. This increase is also expected in other healthcare systems [4] (see Table 1).

Set alongside the increase in primary TKR the demand for revision knee replacement (KR) will also dramatically increase. Revision KR is complex, often requiring advanced surgical techniques to deal with bone loss, debride infection and restore extensor mechanism function [5]. It is also expensive [6], with high implant and equipment costs and patients regularly require multiple procedures, prolonged hospital stays and higher-level care (e.g. high dependency unit, HDU). Furthermore, outcomes are worse than for primary TKR [7,8] and complications can be devastating.

1.1. Rationale for this guideline

In 2015 the Getting it Right First Time (GIRFT) report recommended rationalisation of orthopaedic service delivery to improve both cost effectiveness and efficiency [9]. In recognition of these challenges BASK developed a Revision Knee Working Group (RKWG), with representatives from units undertaking revision knee surgery in England, Wales, Scotland and Northern Ireland. This guideline has been developed and approved by BASK representatives through this working group, supported by GIRFT and National Health Service (NHS) England and NHS Improvement (NHS E + I) and SCOT (Scottish Committee for Orthopaedics and Trauma) who provided representation at all RKWG meetings (six held thus far), to deliver recommendations on service organisation, infrastructure and audit outcome metrics for units undertaking revision KR in the NHS. A similar process is being undertaken by the British Hip Society to develop equivalent guidelines for revision hip replacement, and is supported by the GIRFT program. Although representation was sought from Wales and Scotland, the initial program of work focused on service re-organisation within England.

The provision and organisation of revision KR services in the UK are variable. Some regions run high quality multidisciplinary team (MDT) discussions coordinated by a tertiary referral Major Revision Centre (MRC) site, at which all revision KR patients are discussed [10,11], whereas some sites have no network and no regular MDT meeting. Additionally a significant proportion of revision KR surgery is performed by low volume surgeons in low volume centres (data presented in this report and [12]. Provision of revision KR surgery on this *ad hoc* basis is more expensive, requiring loan kit, and is delivered by teams who are not regularly caring for these patients.

In the UK significant effort has been made to re-organise specialist care. Success has been achieved in the formation of cancer networks [13] and major trauma networks [14], with evidence now being reported on the positive effects on patient outcomes following these major service re-configurations [15,16]. Parallels may be drawn between revision KR surgery, cancer care and trauma surgery. All have significant long-term health implications; death rates from prosthetic joint infection (PJI, 13% five year mortality), one of the top three indications for revision KR, are comparable to breast cancer, prostate cancer and melanoma (9%, 5% and 11% respectively) [17]. All require a multidisciplinary team, with expertise across multiple domains, such as allied surgical specialties (plastic surgery, vascular surgery), medical expertise in managing frail, elderly patients, infectious disease expertise to manage infection, and therapists experienced in the rehabilitation needs of these patients. At the core of the solution is addressing low volume surgery as well as supporting increased utilisation of MDTs, with transfer of care of complex patients to revision centres with the required infrastructure, expertise and volume to deliver a high-quality and cost-effective service.

1.2. BASK revision knee working group

Members of BASK were approached to form the RKWG using a purposeful sampling strategy. National Joint Registry (NJR) data (revision KR practice over three years, recorded via a K2 form) was used to identify the ten highest volume revision surgeons and the ten highest volume centres in England and Wales. High volume centres were encouraged to put forward one junior consultant. Surgeons from key centres in Scotland and Northern Ireland were also invited. This allowed the recruitment of 25 suitable clinicians from across the UK.

1.3. Evidence checking and research priorities in revision knee surgery

In recognition of the challenges presented by revision knee surgery, BASK supported a James Lind Alliance Priority Setting Partnership (JLA-PSP) on 'Problematic Knee Replacements'. As part of the JLA-PSP systematic evidence check was undertaken to a PRISMA compliant standard (previously reported [18]). Briefly, *Pubmed, Embase* and *CINAHL* databases were searched to

Table 1
Revision workload over three years in the NHS and Private sectors (NJR data).

	NHS	Private	Grand Total
2016	6327	865	7192
2017	6021	823	6844
2018	6007	814	6821
Grand Total	18,355	2502	20,857

identify systematic reviews (SR) and randomised controlled trial (RCT) evidence relating to revision knee surgery. Searches were performed from database inception to January 2019. Following removal of duplicates, 2009 abstracts were reviewed by at least two reviewers and full texts explored as required. Potentially relevant papers were evaluated for quality, uncertainty and relevance. The evidence check confirmed a limited quality of published papers, mostly based on small retrospective case series and cohort studies [19,20]. SRs had self-reported limitations relating to quality of empirical evidence; RCTs did not reveal significant or conclusive results (e.g. [21]).

The PSP elicited ten key research priorities, which included *"What is the best way to diagnose and treat infection in a knee replacement?"* (Priority 2) and *"What are the most effective ways to organise health care and avoid delay to improve the results and patients' experience of revision knee surgery?"* (Priority 3). Overall, none of the research priorities were answered by previously published research. The identification of these priorities and the limited available evidence in revision knee surgery stimulated the development of these guidelines through a consensus process, driven by the RKWG and, for PJI, through the UK-PJI meetings.

1.4. Delphi consensus process

A Delphi process (brainstorming, narrowing down, quantification) was applied based on previously published consensus statements [22,23] and followed guidelines set out by the NHS Research and Development Health Technology Assessment Programme [24] and the British Medical Journal [25]. Draft consensus statements were circulated for rating with a scale of 1 (disagree) to 10 (agree), and comments. An online survey tool (https://www.soscisurvey.de/) was used throughout this process. These inputs were integrated, and amended consensus statements were prepared with a detailed explanation for each statement modification. Anonymised results from the first round were re-circulated for scoring, comments, and proposed modifications for statements that scored <7 in the first round. A predetermined mean score of $\geq$7 (with three or fewer outliers: defined as scores less than 4) was used to define consensus. Fifty-seven statements were drafted. Fifty-five were accepted after one round (mean agreement score of 9.8 ± 0.2/10). Two statements on management of joint infection did not achieve this threshold, were modified and underwent a second round of voting, after which statements scored 9.1 and 9.5/10.

1.5. Recommendations formulated through the Delphi consensus process

Recommendations in this report are also presented in the recently published British Orthopaedic Association Standards (BOASTs) on revision KR [26–28]. These BOASTs are provided as an appendix to this article and comprise >50 care standards encompassing service organisation, MDT working and investigation and management of problematic and infected KR patients. Key standards are highlighted in bold in this manuscript, and the relevant BOAST referenced. Standards pertaining to the organisational and infrastructural components of care of revision KR patients in the NHS are presented here; further publications provide additional detail, particularly around the management of infected KR and the development of revision networks [29,30]. All the BOAST statements were formulated through the Delphi consensus process outlined above. All working group members contributed fully to this process, with a 100% response rate. This report provides context for the BOASTs, with relevant literature. Recommendations in this report that are not in bold did not undergo a consensus process, but all RKWG members read and approved this manuscript, and provided input into and approved all amendments made during the revision and publication process.

2. The current landscape of revision knee replacement in England, Wales, Northern Ireland and the Isle of Man and revision volume recommendations

During 2016–2018 20,857 revision KR procedures (defined as any procedure that generates an NJR K2 form) in England and Wales were undertaken at 237 NHS sites (18,355) and 168 Private sites (2502) [29]. Although there was a reduction in revision surgery 2016–18, the broader picture is of an increasing revision knee volume; there were 6844 revision KR operations recorded in the NJR in 2017, an increase of ~100% over 10 years from 2007 [31]. The most common indication for revision KR recorded on the NJR is loosening (38.7%), followed by instability (17.6%), pain (16.9%), implant wear (14.4%), lysis (10%), malalignment (8%) and infection (6%). Infection is an extremely important indication for revision KR, being both difficult to treat successfully and expensive; the cost for treatment of an infected KR is ~£30,011 compared with ~£9,000 for non-infected cases [6].

2.1. Individual surgeon volume

It is well established in all aspects of surgery that there is a volume to outcome relationship; this has also been well described in knee surgery. In primary knee surgery (total and partial) higher surgeon volume is associated with lower complication rates, lower revision rates and lower mortality rates [32–34]. In unicompartmental knee surgery the evidence supports a level of >13 cases per surgeon per year [34,35]and in total knee replacement the level of improvement of outcomes is seen at a level of 60 cases [33]. Revision KR requires more challenging patient-based decision-making and involves more

technically demanding surgery than primary KR surgery. Evidence is emerging of a volume-outcome relationship in revision arthroplasty [36,37]. The combination of longer surgery times, multiple instrumentation sets and complex team working required, coupled with the higher risk and more devastating outcomes of complications mean that it is highly unlikely that the minimum number per surgeon would be less than a unicompartmental KR and it is reasonable to infer that similar differences in outcomes will be found in studies of revision KR.

Between 2016–18 (three years, NJR data), 227 surgeons undertook only one procedure and 144 undertook two (annual surgeon volume calculated from three year data 2016–2018). NJR data is affected by various factors, including the incorrect attribution of caseload, incorrect procedure coding and data entry error. However, even with these caveats there is a large number and large proportion of low volume surgeons.

2.2. Unit volume

Of the 239 NHS sites in England and Wales that undertook revision knee surgery between 2016–2018, 180 (75%) performed <30 cases per year. Ten sites undertook >80 per year and 23 sites undertook >50 per year; these high volume sites are obvious candidates to become regional specialist centres, with at least one in each NJR region in England. Although smaller volumes were recorded at units in Wales and Northern Ireland, there were centres with significantly greater volumes in these regions which would be candidate MRC/RUs [29]. This is carefully explained in a separate report [29]. Scotland was not included in this analysis as we did not have access to data from the Scottish Arthroplasty Project (SAP) which monitors total knee arthroplasty carried out there. A relationship between higher unit volume and improved outcomes has been recognised in primary knee surgery [33,34]. Evidence is becoming available for revision surgery; analysis of >17,000 revision hip cases showed that low volume centres (<13 cases per year) had significantly worse 90-day mortality and 1-year re-revision rates than high-volume centres[37] and analysis of ~25,000 revision knee cases showed decreased re-revision rates in high volume centres [36]. Analysis of >30,000 hip and knee revision cases showed lower complication rates and lower 90 day readmission rates in high volume centres [38]. Although these reports point towards a volume-outcome relationship in revision KR the precise level remains a research question.

2.3. Consensus surgeon and unit volume recommendations

The current landscape of revision KR in England and Wales is of a number of low-volume surgeons. Although some low-volume surgeons are based in high volume units, the majority practices in low-volume NHS sites. Based on the GIRFT ideals laid out in 2015 and emerging literature that demonstrates a volume-outcome relationship in primary and revision arthroplasty, decreased complication rates and lower cost will be achieved by the introduction of minimum surgeon numbers and minimum unit numbers in revision KR.

The RKWG recommend a minimum revision threshold to be set at 15 cases per individual revision surgeon per year [26]. Surgeon volume is calculated from any procedure that generates a K2 form (including revision of a uni-compartmental KR, debridement, antibiotics and implant retention (DAIR) for infection). This threshold aims to strike a measured balance between what is achievable and realistic set against the evidence for a volume-outcome relationship in primary and revision KR. Surgeon and unit volume should be sufficient for an individual surgeon to develop and maintain expertise. Units undertaking revision KR should achieve a minimum volume of 30 cases per year, with ideally at least two surgeons undertaking revision KR [26]. Passports that allow surgeons to operate across multiple sites and trusts have been established in several regions in England and will allow experienced revision surgeons from smaller units to maintain and develop their practice. Dual surgeon operating is encouraged [26], although it is recognised that currently 'credit' for one procedure can only be attributed to a single surgeon within the NJR. It should be the responsibility of local and regional units to provide robust governance and oversight of all revision activity and outcomes, which will also mitigate against deliberate overtreatment of patients.

3. Organisational structure and infrastructure required to undertake revision knee replacement

3.1. Development of regional major revision centre-revision unit networks

Regional network models have improved outcomes in diverse areas of healthcare in the UK [16]. This recognises both the outcome-volume relationship and the requirement for multiple different specialists to care for complex patients. In revision KR several regions have already established regional MDT meetings for the management of revision knee surgery patients, most notably a pilot in the East Midlands supported by a grant from NHS England [10,11]. In this MRC-RU system all patients being considered for revision KR surgery are discussed at a meeting chaired by the MRC site (Nottingham Trust). The aims of the meeting are to decide on a treatment plan and if surgery is indicated decide where and who undertakes the procedure.

This guideline recommends the widespread implementation of regional 'Revision Knee Networks' into a MRC-RU system [26]. This would:

- Allow both surgeons and centres to achieve and maintain a consistent, high-volume practice.
- Provide a referral pathway and support surgeons' decision making in complex and challenging cases

3.2. Primary arthroplasty units

We recommend that units that currently undertake a low volume of revision knee surgery (<30 cases per year) stop undertaking procedures that generate a K2 form and become Primary Arthroplasty Units (PAUs). These units should link into their regional RU and MRC through a robust referral mechanism and be able to participate in the regional MDT. It is expected that funding mechanisms reflect this change, with the result that these units will not be funded for revision KR surgery within the NHS. Referrals should go to the closest Revision Unit or MRC depending on complexity. Urgent referral is required for infected cases; DAIR procedures should be performed by an experienced arthroplasty surgeon and exchange of all modular components should be performed. To meet this treatment guideline transfer of patients may be required. This is detailed more carefully in a report specifically on PJI treatment [30].

3.3. Revision unit requirements

Revision units should reach minimum surgeon and unit volume requirements and provide the following infrastructure [26]:

- Revision units should not routinely use or require loan implant equipment.
- Revision units should provide ring-fenced, dedicated elective beds in an orthopaedic ward.
- All revision KR patients should have access to advanced post-operative nursing care (level 1.5 or post-operative surgical unit) for their first 24-48hrs.
- All revision KR surgery should be performed in dedicated clean air elective arthroplasty theatres.
- Access to plastic surgeons and allied specialties should be available, either locally or through a regional network.
- A nominated revision KR lead will be appointed in each MRC and RU who will act as contact and liaison within the network. Their job-plan should include dedicated time for revision KR workload such as processing referrals and MDT discussions.

3.4. Major revision unit requirements

In addition to the requirements for RUs, MRCs should have ready access to plastic and vascular surgical support, ideally on site or within the same trust. Post-operative surgical units (POSU) and/or HDU facilities for elective orthopaedic patients are essential. These should be ring-fenced; it is not acceptable for revision KR patients to have their surgical treatment delayed because of insufficient or inadequate post-operative care facilities. The MRC unit should coordinate a regional revision MDT and an infection MDT [26]. This may be a combined meeting or two separate meetings. Complex cases should be referred to the MRC from the RU via a robust referral pathway and once the acute inpatient care episode is completed patients will be repatriated to the referral unit closest to their home.

3.5. Multi-disciplinary team coordination and referral pathways

MRC-RU networks should set up a regular (minimum twice-monthly) regional MDT at which all patients being considered for revision KR will be discussed. Members of both MRC and RU units should attend (either in person or via teleconference). All revision cases should be discussed at an MDT. If urgent surgical treatment resulting in a K2 form is required (e.g. DAIR for sepsis), post-hoc discussion at the MDT should be undertaken and recorded. This should be part of both MRC and RU job plans for the revision KR leads. Robust referral pathways are required to facilitate patient transfer for both elective and acute settings, facilitated by coordinators and online referral platforms. Out of hours referrals should take place via on-call orthopaedic teams and be reviewed the following day. Within each region, surgeons from the RU units and the regional centres should have flexibility to decide on a local individual patient referral processes and post-operative follow-up arrangements.

The revision KR MDT should comprise orthopaedic surgeons, specialist nurses and rehabilitation teams. If cases of suspected or confirmed infection are discussed, infectious disease physicians or microbiologists and pharmacists should be involved in the MDT. The MDT should have dedicated administrative support and an MDT coordinator. Plastic surgeons, vascular surgeons and specialist radiologists should all be easily accessible to the MDT. All MDT discussions should be standardised and recorded. Outcomes should be audited according to published audit standards.

3.6. Specific indications for revision knee replacement

It is recognised that ~20% of patients following knee replacement are not satisfied with their outcome. A small number of these patients will have a surgically correctable cause, and it is the responsibility of the revision network to undertake appropriate investigations in a timely fashion to identify appropriate patients for revision KR [28]. The corollary is that a number of

patients will not have a correctable cause identified. In this case revision KR is not indicated. The regional network should coordinate the care of these patients and remove the pressure to undertake revision KR when the diagnosis is unclear. A MDT approach with second opinions, physiotherapy input and pain specialists are recommended. Further specific guidance from National bodies is expected to follow on the investigation and management of patients with a problematic KR.

3.7. Treatment of infection

Orthopaedic infection is a devastating outcome with a prolonged and challenging treatment course. NJR data shows that 17% of first revisions are for infection. However, 55% of 2nd revisions, 62% of 3rd, 67% of 4th and 74% of 5th revisions include infection as an indication (NJR data, not published). We do not currently have data on the specific procedure performed for infection (e.g. DAIR versus first stage). Complex cases, such as failed revision for infection, should be referred to the MRC. Patients with known or suspected infection should be managed via a regional MDT, coordinated by the MRC unit, according to the recommendations provided in recent publications [28,30].

3.8. Case complexity

A complexity grading tool such as the Revision Knee Complexity Classification [39] should be used to aid communication and allow identification of more complex revision cases that may need to be done in the regional MRC. All complex revisions (R2 + R3) should be discussed at the regional MDT and it is recommended that complex surgery, such as cases with significant bone loss, re-revision and patients with significant confounding factors (e.g. soft tissue compromise) are performed at the MRC units.

3.9. Training and dual surgeon operating

Revision surgeons should engage in continued medical education. MRCs and RUs should facilitate and provide training for surgeons. BASK are producing a list of accredited fellowships in Revision KR surgery, and a BASK instructional course will be run yearly. Dual consultant operating is recommended, particularly for complex cases or for less experienced or lower volume surgeons (15–20 revisions/year). It is recognised that currently only one surgeon can be credited with a revision case on the NJR. This is a challenge that needs addressing in the future to support dual surgeon operating.

3.10. Repatriation and therapy services

Patients with infection, periprosthetic fracture or those who require prolonged postoperative rehabilitation should be immediately accepted back by the referring unit when fit for transfer. This model has been successfully implemented in major trauma networks.

Rehabilitation may be provided centrally or locally depending on local infrastructure. However, it is expected that MRC and RU centres should provide specialist physiotherapy services, where dedicated named staff have experience of treating patients following this type of surgery. The MRC should have a nominated lead therapist, who provides ongoing advice and training to local therapists.

3.11. Issues pertaining to Scotland, Northern Ireland and the private sector

Contribution to arthroplasty and infection registries is subject to differing regulations in Scotland and Northern Ireland. We recommend contribution to the NJR (or the Scottish Arthroplasty Project, in Scotland) and the Bone and Joint Infection Registry (BAJIR) where local conditions allow.

A relatively small proportion of revision surgery is performed outside NHS sites [29]. By design this guideline does not specifically make recommendations for private sector units, although it is notable that most private units are low volume and would fall into the PAU category.

4. Outcome metrics and auditable standards

Units should record and monitor their practice. Further specific guidance from National bodies is expected to follow.

4.1. Outcome measures

Both MRC and RU units should record the following performance indicators:

1. Audit of case load and surgeon volume
2. Grading of case complexity (e.g. the RKCC) [39]
3. MDT attendance and case discussion record

4. Post-surgery morbidity and mortality
5. Revision KR Surgical Site Infection rate
6. Return to theatre rate
7. NJR and Bone and Joint Infection Registry (BAJIR) compliance rate
8. Appointment of support staff
9. Availability and usage of higher level postoperative care
10. Loan kit usage
11. Regional pathways of care

4.2. Auditable standards

1. Entry of all revision knee surgery cases into the NJR

It is currently a minimum standard of care that all surgeons and units undertaking revision surgery enter data into the NJR. A K2 form should be completed for all revisions including DAIRs.

2. All patients within the revision knee pathway should be managed under the direction of a multidisciplinary care team (MDT)

Building on the experience of the provision of orthopaedic related cancer services, it is clear that the complex clinical pathway for revision knee surgery requires an MDT approach. This is a key part of the redesign of revision knee services within the NHS. It is proposed that initially 90% of all cases should be discussed in an MDT with 100% of R2 and R3 cases but as services develop this should approach an overall rate of 95% within 2 years.

3. All PJI cases should be managed under the direction of a specific PJI multidisciplinary care team (MDT) including specialists in infectious diseases or a microbiologist.

Many units offering PJI care have already adopted an MDT approach. The aim would be to extend this approach to all centres undertaking this type of work, with MDTs run at MRCs and RUs having virtual access to the MDT as required. Units should aim for 100% of all PJI cases to have an MDT discussion recorded in the patient notes.

4. All DAIR procedures to be performed by a Consultant surgeon with expertise in arthroplasty surgery

For DAIR to be successful the procedure should be carried out to the highest recognised standards of care. It is widely accepted that this procedure requires an experienced arthroplasty Consultant surgeon as the lead surgeon performing the case.

5. Entry of all infected knee replacement cases into the Bone and Joint Infection Registry

The BAJIR database has been specifically designed to support MDT working and clinical decision making and BASK supports the entry all cases of PJI infection into BAJIR. Engagement in this process should become the standard of care

6. All surgeons undertaking revision knee surgery should undertake specific continued medical education and attend the BASK Revision Surgery Update Course

Continued medical education for all healthcare professional involved in a clinical pathway is a critical component of maintaining standards of care. The BASK Revision Surgery Course will be specifically designed to support healthcare professionals involved in the delivery of revision knee surgery. Revision surgeons should attend this meeting or similar at a minimum of once every two years.

5. Patient information and shared decision making

Patients should be provided with information (both written in the form of a patient information sheet and verbally) from their referring team on why their treatment is being undertaken at a different unit with more experience of revision surgery. It is recognised that some patients may have to travel to receive treatment. This inconvenience should be minimised by repatriation when clinically appropriate and establishment of suitable rehabilitation and therapy services locally, as outlined above.

Complex decision-making is involved in all patients being considered for revision knee surgery. The General Medical Council's 'Good Medical Practice – duties of a doctor' [40] guide states that doctors should

– Listen to patients and respond to their concerns and preferences

- Give patients the information they want or need in a way they can understand
- Respect patients' right to reach decisions with the doctor about their treatment and care
- Support patients in caring for themselves to improve and maintain their health.

It is important that complex decisions are made in a shared process that adheres to these four principles. Direct consultation is absolutely required; decisions made without direct consultation do not adhere to principles of good medical practice. MDT discussions should be explained and communicated to the patient.

6. Finance

Appropriate financial re-imbursement is critical for the development and sustainability of specialist centres. Currently revision KR is financially unsustainable with the maximum tariff set at £12,000, and complex revision KR patients costing >£30,000 to treat [6,41] A centre uplift tariff is currently being developed by NHSE + I with the aim of implementation in 2020. The most common diagnostic and procedural codes for knee revision surgery are provided in the coding appendix.

7. Summary

Revision Knee Surgery is a technically demanding procedure with high complication rates, high cost and complex instrumentation. Optimum patient care requires both an expert surgeon and an expert team including allied surgical specialties (plastic and vascular), infection specialists, physical therapists and anaesthetic and critical care support. Furthermore, there are potentially devastating outcomes for patients when complications occur. This patient group is often in pain and functionally disabled. Assessment involves a difficult pre-operative decision making process, based on multiple investigations and requires a realistic appraisal of both the cause and possible surgical solution for the problem. There is increasing evidence that higher volume surgeons and centres achieve better outcomes with lower complication rates.

Our patients should be provided with the best care available; within the NHS networks have already been very successful in the management of cancer and trauma. Working within networks with a multidisciplinary team approach will require transfer of patients from one unit to another within a region. The aim of this re-organisation, coupled with the introduction of new guidelines, BOASTs and standards is to improve the care for these patients. The Revision Knee Working Group, on behalf of the British Association of Surgery of the Knee, supported by the British Orthopaedic Association and GIRFT (NHS E + I), have developed these guidelines to improve the organisation and delivery of care in this difficult area. The cornerstones of these guidelines are:

1. Establishment of a regional network of Major Revision Centres (MRC), Revision Units (RU) and Primary Arthroplasty Units (PAU), with a structure of care delivery based on surgeon and unit volume and availability of key infrastructure resources.
2. Development of regional MDT networks to facilitate patient discussion and select the most appropriate centre for surgery.
3. Auditable standards to monitor performance.
4. Appropriate financial mechanisms to support this new model of revision KR surgery.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors thank the National Joint Registry for the data used in this study.

Appendix A. Diagnostic and procedure codes

A.1. OPCS

O18.3 – Revision of hybrid prosthetic replacement of knee joint using cement
W40.3 – Revision of total prosthetic replacement of knee joint using cement
W40.4 – Revision of one component of total prosthetic replacement of knee joint using cement
W41.3 – Revision of total prosthetic replacement of knee joint not using cement
W41.4 - Revision of one component of total prosthetic replacement of knee joint not using cement
W42.3 – Revision of total prosthetic replacement of knee joint NEC
W42.5 – Revision of one component of total prosthetic replacement of knee joint NEC
For the first stage of the procedure assign the following codes:
W42.4 – Attention to prosthetic replacement of relevant joint NEC

Y03.7 – Removal of prosthesis from organ NOC
W81.7 – Insertion of therapeutic spacer into joint
Y70.3 – First stage of staged operations NOC
Z site code – Z84.6 knee
Z94 – Laterality of operation

Debridement must not be coded in addition when a joint spacer has been inserted following removal of the prosthesis.
For the second stage of the procedure assign the following codes:
Insertion of like for like prosthesis:
Revision of prosthetic replacement of relevant joint code
Y71.1 – Subsequent stage of staged operations NOC
Insertion of a different type of prosthesis:
Conversion to prosthetic replacement of relevant joint code (new prosthesis inserted during this stage)
Code that classifies conversion from prosthetic replacement of relevant joint (prosthesis removed in stage 1)
Y71.1 – Subsequent stage of staged operations NOC
See also PGCS16: Conversion procedures.
The removal of the joint spacer during the second stage of the procedure must not be coded in addition.

W42.4 + Y03.2 – Change of polyethylene inserts
W42.4 + Y03.6 – Adjustment to knee replacement prosthesis in organ.

Add site code to all

W57.2 – Excision arthroplasty
W57.3 – Revision of excision arthroplasty of joint
W57.4 – Conversion to excision arthroplasty of joint

Add site code to all

W58.1 – primary resurfacing arthroplasty of joint
W58.2 – revision of resurfacing arthroplasty of joint
W58.0 Conversion from previous resurfacing arthroplasty of joint

Add site code to all
The above codes are used for the resurfacing of the patella / patella button with site code Z78.7 as well as unicompartmental knee replacements

Appendix B. ICD 10 codes

B.1. Osteoarthritis of knee

M17.0 – Primary gonarthrosis, bilateral
M17.1 – Other primary gonarthritis
M17.2 – Post-traumatic gonarthrosis, bilateral
M17.3 – Other post traumatic gonarthrosis
M17.4 – Other secondary gonarthrosis, bilateral
M17.5 – Other secondary gonarthrosis
M17.9 – Gonarthrosis, unspecified

B.2. Rheumatoid arthritis of the knee

M05 – Seropositive rheumatoid arthritis
M06.0 – Seronegative rheumatoid arthritis
M06.1 – Adult-onset Still disease
M06.4 – Inflammatory polyarthropathy – can also use M06.8 + M06.9
M08.0 – Juvenile rheumatoid arthritis

ICD codes above need a site code as a fifth character. For the knee the site code is 0.6 – Lower leg; fibula knee joint; tibia/0.0 for multiple sites

There are also numerous duel codes to reflect arthritis when in/due to another condition eg. L40.5D (Dagger) Arthropathic psoriasis M07.3A (Asterisk) Other psoriatic arthropathies

B.3. Periprosthetic fracture (without an identified cause)

M96.6 – Fracture of bone following insertion of orthopaedic
implant, joint prosthesis, or bone plate

B.4. Periprosthetic fracture (with a traumatic cause)

M96.6 – Fracture of bone following insertion of orthopaedic
implant, joint Prosthesis or bone plate

Plus the relevant code for type of trauma from Chapter XX- External causes of morbidity and mortality (The coders will help with this)

Intraoperative fractures (including intraoperative periprosthetic/ peri-implant fractures)

A code from Chapter XlX Injury, poisoning and certain other consequences of external causes (S00-T98) that classifies the fractured bone

Y79.2 – Orthopaedic devices associated with adverse incidents, prosthetic and other implants, materials and accessory devices

Example

S72.30 – Fracture of shaft of femur

Y79.2 – Orthopaedic devices associated with adverse incidents, prosthetic and other implants, materials and accessory devices

B.5. Aseptic loosening

T84.0 – Mechanical complication of internal joint prosthesis

This includes breakdown (mechanical), displacement, malposition, obstruction, perforation, protrusion etc.

B.6. Infection

T84.5 – Infection and inflammatory reaction due to internal joint prosthesis

If the prosthesis is infected assign T84.5 Infection and inflammatory reaction due to internal joint prosthesis.

This code can be immediately followed by codes from categories B95.-, B96.-, B97.- or B98.- if the agent causing the infection is known (additional codes from categories U82, U83, U84 can also be assigned to show any resistances to antimicrobial drugs).

Appendix C. HRG codes

ICD M064 Inflammatory polyarthropathy HD23J
ICD M080 Juvenile rheumatoid arthritis HD23J
ICD M170 Primary gonarthrosis, bilateral HD24H
ICD M171 Other primary gonarthrosis HD24H
ICD M172 Post-traumatic gonarthrosis, bilateral HD24H
ICD M173 Other post-traumatic gonarthrosis HD24H
ICD M174 Other secondary gonarthrosis, bilateral HD24H
ICD M175 Other secondary gonarthrosis HD24H
ICD M179 Gonarthrosis, unspecified HD24H
ICD M966 Fracture of bone following insertion of orthopaedic implant, joint prosthesis, or bone plate HD24H
ICD S7230 Fracture of shaft of femur: closed HE11H
ICD T840 Mechanical complication of internal joint prosthesis HE82D
ICD T845 Infection and inflammatory reaction due to internal joint prosthesis HE81C
ICD Y792 Orthopaedic devices associated with adverse incidents: Prosthetic and other implants, materials and accessory devices UZ01
ICD S7231 Fracture of shaft of femur: open HE11H
OPCS O183 Revision of hybrid prosthetic replacement of knee joint using cement HN81E
OPCS W403 Revision of total prosthetic replacement of knee joint using cement HN81E
OPCS W404 Revision of one component of total prosthetic replacement of knee joint using cement HN81E

OPCS W413 Revision of total prosthetic replacement of knee joint not using cement HN81E
OPCS W414 Revision of one component of total prosthetic replacement of knee joint not using cement HN81E
OPCS W423 Revision of total prosthetic replacement of knee joint NEC HN81E
OPCS W425 Revision of one component of total prosthetic replacement of knee joint NEC HN81E
OPCS Y036 Adjustment to prosthesis in organ NOC UZ01Z
OPCS Y703 First stage of staged operations NOC UZ01Z
OPCS Y711 Subsequent stage of staged operations NOC UZ01Z
OPCS O234 Attention to total prosthetic replacement of knee joint HN81E
W57.2 Primary excision arthroplasty of joint NEC HN64
W57.3 Revision of excision arthroplasty of joint HN63
W57.4 Conversion to excision arthroplasty of joint HN86

Excision arthroplasty is diagnosis driven and requires an ICD code to generate a HRG

Note: 'UZ' codes cannot be mapped to an HRG code in isolation and require input of additional OPCS codes for that episode.

For accurate OPCS HRGs, a diagnosis code is required in addition; some HRGs are diagnosis driven and others change dependent on the ICD-10 code eg. Revision of total prosthetic replacement of knee joint using cement for a mechanical complication = HN81E but the same procedure for an infected joint replacement = HN80D.

HRGs can vary greatly dependent on additional co-morbidities or any other procedures carried out concurrently.

Acknowledgement: Coding information was kindly provided by Robert Morgan, Clinical Coding office, Queen Elizabeth Hospital, Gateshead and Katie Omerod, Exeter Knee Reconstruction Unit, Royal Devon and Exeter Hospital.

Thank you to Ben Lankester and Matthew Hall, Yeovil Hospital, for feedback on these guidelines.

Appendix D. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.knee.2021.01.032.

References

[1] Skou ST, Roos EM, Laursen MB, Rathleff MS, Arendt-Nielsen L, Simonsen O, et al. A randomized, controlled trial of total knee replacement. N Engl J Med 2015;373:1597–606. doi: https://doi.org/10.1056/NEJMoa1505467.
[2] NJR Editorial Board. National Joint Registry Annual Report; 2017.
[3] Culliford D, Maskell J, Judge A, Cooper C, Prieto-Alhambra D, Arden NK, et al. Future projections of total hip and knee arthroplasty in the UK: results from the UK Clinical Practice Research Datalink. Osteoarthr Cartil 2015;23:594–600. doi: https://doi.org/10.1016/j.joca.2014.12.022.
[4] Patel A, Pavlou G, Mújica-Mota RE, Toms AD. The epidemiology of revision total knee and hip arthroplasty in England and Wales: a comparative analysis with projections for the United States. a study using the National Joint Registry dataset. Bone Joint J 2015;97-B:1076–81. doi: https://doi.org/10.1302/0301-620X.97B8.35170.
[5] Phillips JRA, Toms AD, Becker R, Hirschmann MT. Am I the right surgeon, in the right hospital, with the right equipment and staff to do this operation? Knee Surg Sports Traumatol Arthrosc 2019;27:1009–10. doi: https://doi.org/10.1007/s00167-019-05393-7.
[6] Kallala RF, Vanhegan IS, Ibrahim MS, Sarmah S, Haddad FS. Financial analysis of revision knee surgery based on NHS tariffs and hospital costs: does it pay to provide a revision service? Bone Joint J 2015;97-B:197–201. doi: https://doi.org/10.1302/0301-620X.97B2.33707.
[7] Greidanus NV, Peterson RC, Masri BA, Garbuz DS. Quality of life outcomes in revision versus primary total knee arthroplasty. J Arthroplasty 2011;26:615–20. doi: https://doi.org/10.1016/j.arth.2010.04.026.
[8] Wang C-J, Hsieh M-C, Huang T-W, Wang J-W, Chen H-S, Liu C-Y. Clinical outcome and patient satisfaction in aseptic and septic revision total knee arthroplasty. Knee 2004;11:45–9. doi: https://doi.org/10.1016/S0968-0160(02)00094-7.
[9] Briggs TWR. Getting it Right Frist Time. HttpsgettingitrightfirsttimeCoUkwp-contentuploadsGIRFT-National-Report-Mar-WebPdf; 2015.
[10] Bloch B, M R, A M, P J. Experiences using a revision arthroplasty network: a review of the first 250 cases. Orthopaedic Proceedings 2016;98-B:36–6. https://doi.org/10.1302/1358-992X.98BSUPP_11.BHS2016-036.
[11] Bloch B, Raglan M, Manktelow A, James P. The East Midlands Specialist Orthopaedic Network: the future of revision arthroplasty? Bull R College Surgeons England 2017;99:66–70. doi: https://doi.org/10.1308/rcsbull.2017.66.
[12] Baker PN, Critchley R, Jameson SS, Reed MR, Gregg PJ, Deehan DJ. Revision knee replacement in England and Wales: an audit of hospital volume. Ann R Coll Surg Engl 2013;93.
[13] National Institute for Clinical Excellence. Improving Outcomes for People with Sarcoma. HttpswwwNiceorgUkguidancecsgevidencefull-Guideline-Pdf-n.d.
[14] Metcalfe D, Perry DC, Bouamra O, Salim A, Woodford M, Edwards A, et al. Regionalisation of trauma care in England. Bone Joint J 2016;98-B:1253–61. doi: https://doi.org/10.1302/0301-620X.98B9.37525.
[15] Moran CG, Lecky F, Bouamra O, Lawrence T, Edwards A, Woodford M, et al. Changing the system - major trauma patients and their outcomes in the NHS (England) 2008–17. EClinicalMedicine 2018;2–3:13–21. doi: https://doi.org/10.1016/j.eclinm.2018.07.001.
[16] Sewalt CA, Wiegers EJA, Venema E, Lecky FE, Schuit SCE, Hartog Den D, et al. The volume-outcome relationship in severely injured patients: a systematic review and meta-analysis. J Trauma Acute Care Surg 2018;85:810–9. doi: https://doi.org/10.1097/TA.0000000000002043.
[17] Zmistowski B, Karam JA, Durinka JB, Casper DS, Parvizi J. Periprosthetic joint infection increases the risk of one-year mortality. J Bone Joint Surg Am 2013;95:2177–84. doi: https://doi.org/10.2106/JBJS.L.00789.
[18] Mathews JA, Kalson NS, Tarrant PM, Toms AD. Revision Knee Replacement Priority Setting Partnership steering group. Top ten research priorities for problematic knee arthroplasty. Bone Joint J 2020;102-B:1176–82. doi: https://doi.org/10.1302/0301-620X.102B9.BJJ-2020-0203.R1.
[19] Critchley RJ, Baker PN, Deehan DJ. Does surgical volume affect outcome after primary and revision knee arthroplasty? A systematic review of the literature. Knee 2012;19:513–8. doi: https://doi.org/10.1016/j.knee.2011.11.007.
[20] Gu A, Michalak AJ, Cohen JS, Almeida ND, McLawhorn AS, Sculco PK. Efficacy of manipulation under anesthesia for stiffness following total knee arthroplasty: a systematic review. J Arthroplasty 2018;33:1598–605. doi: https://doi.org/10.1016/j.arth.2017.11.054.
[21] Yuan X, Wang J, Wang Q, Zhang X. Synergistic effects of intravenous and intra-articular tranexamic acid on reducing hemoglobin loss in revision total knee arthroplasty: a prospective, randomized, controlled study. Transfusion 2018;58:982–8. doi: https://doi.org/10.1111/trf.14477.

[22] Fearon K, Strasser F, Anker SD, Bosaeus I, Bruera E, Fainsinger RL, et al. Definition and classification of cancer cachexia: an international consensus. Lancet Oncol 2011;12:489–95. doi: https://doi.org/10.1016/S1470-2045(10)70218-7.
[23] Kalson NS, Deehan DJ, Mann DA, Borthwick LA. International Consensus Definition of Post-Surgical Knee Joint Fibrosis. Bone Joint J 2016.
[24] Murphy MK, Black NA, Lamping DL, McKee CM, Sanderson CF, Askham J, et al. Consensus development methods, and their use in clinical guideline development. Health Technol Assess 1998;2. i–iv–1–88.
[25] Jones J, Hunter D. Consensus methods for medical and health services research. BMJ 1995;311:376–80.
[26] British Orthopaedic Association. BOAST: Revision Knee Replacement Surgical Practice Guidelines.
[27] British Orthopaedic Association. BOAST: Investigation and Management of Periprosthetic Knee Joint Infection in Knee Replacement. n.d.
[28] British Orthopaedic Association. BOAST: Investigation and Management of Patients with Problematic Knee Replacements. n.d.
[29] Kalson NS, Mathews JA, Miles J, Bloch BV, Price AJ, Phillips JRA, et al. Provision of revision knee surgery and calculation of the effect of a network service reconfiguration: an analysis from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. Knee 2020;27:1593–600. doi: https://doi.org/10.1016/j.knee.2020.07.094.
[30] Kalson NS, Mathews JA, Alvand A, Morgan-Jones R, Jenkins N, Phillips JRA, Toms AD. BASK Revision Knee Working Group. Investigation and management of prosthetic joint infection in knee replacement: a BASK surgical practice guideline. The Knee 2020;27(6):1857–65. doi: https://doi.org/10.1016/j.knee.2020.09.010. Epub 2020 Nov 14.PMID: 33202289.
[31] NJR Editorial Board. National Joint Registry Annual Report 2018; 2018.
[32] Lau RL, Perruccio AV, Gandhi R, Mahomed NN. The role of surgeon volume on patient outcome in total knee arthroplasty: a systematic review of the literature. BMC Musculoskelet Disord 2012;13:1–10. doi: https://doi.org/10.1186/1471-2474-13-250.
[33] Wilson S, Marx RG, Pan T-J, Lyman S. Meaningful thresholds for the volume-outcome relationship in total knee arthroplasty. Jbjs 2016;98:1683–90. doi: https://doi.org/10.2106/JBJS.15.01365.
[34] Baker P, Jameson S, Critchley R, Reed M, Gregg P, Deehan D. Center and surgeon volume influence the revision rate following unicondylar knee replacement: an analysis of 23,400 medial cemented unicondylar knee replacements. Jbjs 2013;95:702–9. doi: https://doi.org/10.2106/JBJS.L.00520.
[35] Liddle AD, Pandit H, Judge A, Murray DW. Effect of surgical caseload on revision rate following total and unicompartmental knee replacement. Jbjs 2016;98:1–8. doi: https://doi.org/10.2106/JBJS.N.00487.
[36] Halder AM, Gehrke T, Günster C, Heller K-D, Leicht H, Malzahn J, et al. Low hospital volume increases re-revision rate following aseptic revision total knee arthroplasty: an analysis of 23,644 cases. J Arthroplasty 2019. doi: https://doi.org/10.1016/j.arth.2019.11.045.
[37] Jeschke E, Gehrke T, Günster C, Heller K-D, Leicht H, Malzahn J, et al. Low hospital volume increases revision rate and mortality following revision total hip arthroplasty: an analysis of 17,773 cases. J Arthroplasty 2019;34:2045–50. doi: https://doi.org/10.1016/j.arth.2019.05.005.
[38] Ricciardi BF, Liu AY, Qiu B, Myers TG, Thirukumaran CP. What Is the association between hospital volume and complications after revision total joint arthroplasty: a large-database study. Clin Orthop Relat Res 2019;477:1221–31. doi: https://doi.org/10.1097/CORR.0000000000000684.
[39] Phillips JRA, Al-Mouazzen L, Morgan-Jones R, Murray JR, Porteous AJ, Toms AD. Revision knee complexity classification—RKCC: a common-sense guide for surgeons to support regional clinical networking in revision knee surgery. Knee Surg Sports Traumatol Arthrosc 2019;27:1011–7. doi: https://doi.org/10.1007/s00167-019-05462-x.
[40] General Medical Council. Good Medical Practice.
[41] Tokarski AT, Deirmengian CA, Lichstein PM, Austin MS, Deirmengian GK. Medicare fails to compensate additional surgical time and effort associated with revision arthroplasty. J Arthroplasty 2015;30:535–8. doi: https://doi.org/10.1016/j.arth.2014.11.003.