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Clinical prioritisation of revision knee surgical procedures: BASK working group consensus document

N.S. Kalson, J.A. Mathews, A.D. Toms, J.R.D. Murray *, BASK Revision Knee Working Group

BASK, Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, Holborn, London WC2A 3PE, United Kingdom

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Background: Elective orthopaedic surgery during the Covid-19 pandemic requires careful case prioritisation. We aimed to produce consensus-based guidelines on the prioritisation of revision total knee arthroplasty (TKA) procedures.

Method: Twenty-three revision TKA scenarios were assigned priority (NHS England/Royal College of Surgeons scale) by the British Association for Surgery of the Knee (BASK) Revision Knee Working Group (n = 24). Consensus agreement was defined as ≥70% respondents (18/24) giving the same prioritisation. Two voting rounds were undertaken; procedures achieving <70% agreement were given their most commonly assigned priority.

Results: 18/23 procedures achieved ≥70% agreement. Three were P1a (surgery within <24 h); DAIR for sepsis, peri-prosthetic fracture (PPF) fixation and PPF-revision TKA. Three were P1b (<72 h); debridement, antibiotics and implant retention (DAIR) for a stable patient, flap coverage for an open knee, and acute extensor mechanism rupture. Eight were P2 (<4 weeks), including aseptic loosening at risk of collapse, inter-stage patients with poor functioning spacers. Five were P3 (<3 months), including second stage revision for infection, revision for instability with limited mobility. Four were P4 (can wait >3 months) e.g. aseptic loosening.

Conclusion: Sepsis and PPF surgery are the most urgent procedures. Although most procedures should be undertaken within one to three months (P2/3), these cases represent a small revision practice volume; P4 cases (e.g. aseptic loosening without risk of collapse) make up most surgeons’ caseload. These recommendations are a guideline; patient comorbidities, Covid-19 pathways, availability of support services and multi-disciplinary team discussion within the regional revision network will dictate prioritisation.

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1. Background

NHS England, together with the surgical Royal Colleges, recently published a Clinical guide to surgical prioritisation during the Coronavirus (C-19) pandemic [1]. The document recommended prioritisation on clinical grounds for all patients on a waiting list and that each case was discussed in a multi-disciplinary environment. The document encouraged the establish-
ment of local pan-surgical prioritisation committees to balance the needs of different surgical specialties for the rare resource of theatre space during the C-19 recovery. In light of this, the importance of appropriate prioritisation emerged.

To support clinicians the BASK executive responded by establishing sub-specialty groups to recommend appropriate triage levels. This resulted in a guideline [2] on prioritisation of knee procedures from P1a (surgery within 72 h) to P4 (surgery that can safely wait >3 months). These guidelines were based on expert opinion. To develop an evidence-base we applied a consensus methodology to the problem of triage in the revision knee arthroplasty (KA) setting. This was possible in a timely manner due to the existence and continued support of the BASK Revision Knee Working Group (RKWG) which was established to create consensus-based best-practice standards for revision KA, and support the development of regional revision knee networks.

The aim of this report is to produce consensus-based guidelines on prioritisation of revision knee arthroplasty procedures to guide clinicians’ surgical decision-making in a fair and evidence-based manner. This guideline will support surgeons as patient advocates when faced in the setting of competing pressure for theatre time.

2. Methods

2.1. Procedures and clinical scenarios

Twenty-three clinical scenarios were written with the aim of covering the full spectrum of revision knee arthroplasty practice; however it should be pointed out that these scenarios were by no means weighted to the volume of cases in each category.

All scenarios were standardised to an ASA 2 70 years old female patient. Images (radiographs, Computed Tomography (CT) scans) were provided to compliment scenarios. Scenarios and relevant images were circulated to the BASK Revision Knee Working Group via an online survey tool (www.soscisurvey.de).

2.2. Revision Knee Working Group

Members were approached to form the RKWG using a purposeful sampling strategy. National Joint Registry data (revision KA 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. Surgeons from key centres in Scotland and Northern Ireland were also invited. This allowed the recruitment of 25 suitable clinicians from across the UK.

2.3. Consensus process

A threshold for agreement was set at ≥70% of respondents assigning the same prioritisation level. 15/23 (65%) clinical scenarios reached agreement after one round of assessment. The 8/23 (35%) scenarios that did not reach 70% agreement were revised to provide additional clarity of the case history and were re-circulated. After round two five procedures did not reach ≥70% agreement. For these five clinical scenarios we used a simple majority and they were assigned to the most commonly chosen surgical priority.

3. Results

Three clinical scenarios were ranked P1a (surgery within 24 h, Table 1); early debridement, antibiotics and implant retention (DAIR) for a septic patient post-TKA, peri-prosthetic fracture (PPF) fixation and revision TKA for PPF. Three were P1b (<72 h, Table 2); a patient needing an early DAIR and flap coverage for an open knee, and acute extensor mechanism (quadriceps or patella tendon) rupture. Eight were P2 (<4 weeks, Table 3). These included aseptic loosening of a TKA with risk of imminent collapse, inter-stage patients with poor functioning cement spacers during their inter-stage interval and manipulation under anaesthetic (MUA) for stiffness early in the post-operative phase (3 months was the chosen example). Five were P3 (<3 months, Table 4). These include second stage revision for infection (already at 6 months post first stage), and revision for symptomatic instability with limited mobility. Four scenarios were assigned the least urgent priority (P4, can wait beyond 3 months) as listed in Table 5. These included revision for loose components, secondary patella resurfacing and arthrolysis for stiffness.

The five clinical situations for which consensus was not achieved generally had a clear split between two prioritisation categories, but two scenarios straddled three prioritisations. Four of the five cases were for infection management although only one case involved a septic patient. The only non-infected case without consensus was a revision for chronic instability, which had failed to improve with a brace and had limited mobility.
4. Discussion

Most revision knee procedures by case volume are not urgent [3,4], and true emergency scenarios (P1a/b) in revision TKA surgery are limited. These include the management of acute sepsis with prosthetic joint infection and acute trauma with either a fracture or rupture of the extensor mechanism.

The majority of the revision scenarios we provided were classified as P2/3 and should be undertaken within ~12 weeks. This does not reflect the generality of revision knee arthroplasty when the frequency of each diagnosis is factored in as most cases are not-urgent; for example an aseptic loose TKA requiring revision is not time critical. However within this list of clinical scenarios, that were designed to present dilemmas in decision-making, only a small number of cases could be delayed for prolonged periods of time without significant immediate negative effects on the patient or on their eventual outcome.

Almost 80% of the scenarios reached consensus after two rounds of voting. Five scenarios did not reach the threshold for consensus. However, grouping categories (p1b/p1a or p2/3 or p3/4) resulted in >80% agreement for all of the five scenarios.

Table 1
P1a revision TKA procedures to be done within 24 h.

| Procedure | Clinical scenario                                                                 | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (no. (%) of respondents) | Round 2 | Prioritisation |
|-----------|----------------------------------------------------------------------------------|--------------------|------------------|---------------------|---------------------------------|---------|---------------|
| Debridement, antibiotics and implant retention (DAIR) | Septic patient – TKA done 3 weeks ago. Admitted to ward – CRP 300, T 38 °C, HR 110. An aspirate from the knee has been performed and the patient is being optimised on IV antibiotics and fluid. Plan – DAIR procedure. | Yes | No | Yes | P1a 17 (71) | – | 1a |
| Revision for peri-prosthetic fracture | Trauma Patient – Peri-prosthetic fracture – insufficient bone stock. Primary 15 years ago, deterioration in function of TKA over last 12 months. Presents after a mechanical fall yesterday at home, no suspicion of infection. Plan – revision TKA / endoprosthesis | No | Yes | No | P1a 21 (88) | – | 1a |
| ORIF for peri-prosthetic fracture | Trauma patient – Peri-prosthetic fracture – stable implant. TKA done 10 years ago. Well functioning. Mechanical fall yesterday. No history of infection. Plan – ORIF. | No | Yes | No | P1a 21 (88) | – | 1a |

Table 2
P1b procedures to be done within 24–72 h.

| Procedure | Clinical scenario                                                                 | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (no. (%) of respondents) | Round 2 | Prioritisation |
|-----------|----------------------------------------------------------------------------------|--------------------|------------------|---------------------|---------------------------------|---------|---------------|
| DAIR with flap coverage from plastic surgery | Septic Patient – wound dehiscence and soft tissue breakdown post TKA. TKA done 4 weeks ago. Infection presented with wound dehiscence and ‘sucking’ during flexion extension. Presented with two day history of systemic illness, admitted with T°38, CRP > 200, HR > 100. The patient has clinically improved following aspiration and subsequent administration of IVAB such that the observations are now BP 120/70, P70, Sats 98 on 2 l Oxygen. Plan – salvage of prosthesis with plastics input, flap required. | Yes | No | No | P1a 8 (33) | P1b 14 (58) | P1b 22 (92) | – | 1b |
| Extensor mechanism rupture (patella tendon) | Trauma patient – Acute Extensor Rupture / Fracture. 2 years since TKA Good outcome Slipped walking in park Acute traumatic Extensor Rupture Patella Tendon for repair. | No | No | No | P1a 21 (87) | P2 3 (13) | P3 | P4 |
| Extensor mechanism rupture (quadriceps tendon) | Trauma patient – Acute Extensor Rupture / Fracture. Same clinical history as above (patella tendon). Quad Tendon rupture for repair. | No | No | No | P1a 21 (87) | P2 3 (13) | P3 | P4 |
Table 3
P2 procedures to be done within 72 h-four weeks.

| Procedure                                               | Clinical scenario                                                                                                                                                                                                 | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (% of respondents) | Round 2 | Prioritisation |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------|---------------------|----------------------------|---------|---------------|
| Revision TKA for prosthesis at risk of collapse         | Stable patient – Aseptic Loosening TKA with risk of collapse, 12 years old, previously well functioning, infection ruled out with aspiration. The patient is safe at home and able to mobilise 200 yards, the extensor mechanism is intact. Plan – hinge TKA (unsuitable for standard revision implant) | No                  | No               | No                  | P1a
P1b
P2 14 (58) | P2 18 (75) | P3 10 (42) | P3 6 (25) | P4 | 2 |
| Second stage revision (articulating spacer in situ)     | Stable patient – interstage. 1st stage = articulating spacer – good function Previous PJI knee, on oral AB 6 months ago Good function – 0–90, FWB ABs are planned to be stopped from NOW (6 months have been completed). Plan – 2nd stage to revision TKA | Yes                 | No               | No                  | P1a
P1b | P2 20 (83) | P3 4 (17) | P4 | 2 |
| Second stage revision (spacer fracture)                 | Stable patient – interstage. 1st stage = articulating spacer – complications/poor function Previous PJI knee, on oral AB First stage to articulating spacer 4 months ago Problems – fracture / dislocation / very poor function Plan – second stage revision | Yes                 | Yes              | No                  | P1a
P1b 3 (13) | P2 19 (79) | P3 2 (8) | P4 | 2 |
| MUA for stiffness                                       | Stable patient TKA or Rev TKA – stiff – on list for MUA 3 months following primary TKA Pre-operative ROM 10–100. Now stiff – 0–50 Plan – MUA | No                  | No               | No                  | P1a
P1b | P2 20 (83) | P3 2 (8) | P4 | 2 |
| First stage revision with spacer                        | Stable patient – infected native knee, on suppressive antibiotics. Have microbiology samples with known organism. Coping badly at home, poor function, high pain. Observations stable, apyrexial. Plan – debridement and first stage using an articulating spacer. | Yes                 | No               | No                  | P1a
P1b 1 (4) | P2 18 (75) | P3 5 (21) | P4 | 2 |
| First or single stage revision for infection            | Chronic infection patient – old collapsed TKA. TKA done 17 years ago. Deterioration in function over 2 years – loose with chronic infection. Patient was admitted with increasing swelling and pain. The patient is stable following aspiration and antibiotics such that the observations are all normal and the patient is safe to be discharged from acute care. Plan – first (or single) stage revision procedure. | Yes                 | No               | No                  | P1a
P1b 8 (33) | P2 11 (46) | P2 15 (63) | P3 5 (21) | P3 9 (37) | P4 | 2 |
| Implant salvage with plastic surgery reconstruction     | Stable Patient – TKA with chronic infection and sinus. Infected TKA done 6 years ago. Chronic infection with small sinus. Suitable for reconstruction. Not septic – observations are BP 120/70, P70, Sats 98 on 2 l Oxygen. Plan – salvage with plastics soft tissue reconstruction. | Yes                 | No               | No                  | P1a
P1b | P2 14 (58) | P2 10 (42) | P3 9 (38) | P3 11 (46) | P4 1 (4) | 2 |

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### Table 3 (continued)

| Procedure | Clinical scenario                                                                 | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (no. (%) of respondents) | Round 2 | Prioritisation |
|-----------|----------------------------------------------------------------------------------|--------------------|------------------|---------------------|----------------------------------|---------|---------------|
| Above knee amputation for chronic infection | Chronic infection – open knee, significant soft tissue defect, exposed metal and bone. TKA done 10 years ago. Deterioration in function with chronic sinus, failed antibiotic suppression therapy. Presented with two day history of systemic illness – admitted with T 38, CRP > 200, HR > 100. The patient has clinically improved following aspiration and subsequent administration of IVAB such that the observations are now BP 120/70, P70, Sats 98 on 2 l Oxygen. Significant soft tissue loss – not suitable for reconstruction. Plan – Above Knee Amputation. | Yes | No | No | P1a | P1a 3 (13) | 2 |
|          |                                                                                  |                    |                  |                     | P1b 12 (50) | P1b 8 (33) |                |
|          |                                                                                  |                    |                  |                     | P2 12 (50) | P2 13 (54) |                |
|          |                                                                                  |                    |                  |                     | P3      | P3        |                |
|          |                                                                                  |                    |                  |                     | P4      | P4        |                |

### Table 4

P3 procedures to be done within one-three months.

| Procedure | Clinical scenario                                                                 | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (no. (%) of respondents) | Round 2 | Prioritisation |
|-----------|----------------------------------------------------------------------------------|--------------------|------------------|---------------------|----------------------------------|---------|---------------|
| Revision TKA for mal-united fracture | Stable patient – mal-united peri-prosthetic fracture. Primary 8 years ago. Fracture 2 years ago, underwent ORIF. Now has a valgus mal-union. Walking distance 20 yards, using a frame for support. Aspiration negative – no suspicion of infection. Coping badly at home, poor function, high pain. Plan – revision TKA to hinge. | No | No | No | P1a | – | 3 |
|          |                                                                                  |                    |                  |                     | P1b | P2 1 (4) |                |
|          |                                                                                  |                    |                  |                     | P2 3 (13) | P3 19 (79) | P4 2 (8) |
|          |                                                                                  |                    |                  |                     | P3 19 (79) | P4 5 (21) |                |
| Second stage revision for infection (revision TKR) | Stable patient – interstage 1 st stage = static spacer – planning revision to Hinged Knee 4 months post 1st stage to static spacer Good soft tissue, completing 6 month oral AB Plan – revision to Endoprosthetic Replacement rev TKA with hinge. | Yes | No | Yes | P1a | – | 3 |
|          |                                                                                  |                    |                  |                     | P1b | P2 3 (13) | P3 19 (79) |
|          |                                                                                  |                    |                  |                     | P4 2 (8) | P4 5 (21) |                |
| Single stage revision for chronic infection | Stable patient – infected TKA Chronic infection. Aspiration performed and organism known. Not septic. At home. On targeted antibiotics. Plan – revision TKA – single stage or first stage. | Yes | No | Yes | P1a | – | 3 |
|          |                                                                                  |                    |                  |                     | P1b | P2 5 (21) | P3 19 (79) |
|          |                                                                                  |                    |                  |                     | P4 | P4 |                |
| Revision TKA for instability | Stable patient – Tibiofemoral instability Awaiting rev TKA for improved stability 4 years since primary TKA 2 dislocations Unstable in flexion and valgus Exam: Valgus aligned MCL incompetent Good soft tissues, The patient is using a brace which has improved the instability to reasonable daily function, but this is not a long-term solution. Plan – revision TKA | No | No | No | P1a | P1a 3 | 3 |
|          |                                                                                  |                    |                  |                     | P1b | P1b |                |
|          |                                                                                  |                    |                  |                     | P2 | P2 2 (8) |                |
|          |                                                                                  |                    |                  |                     | P3 12 (50) | P3 13 (54) |                |
|          |                                                                                  |                    |                  |                     | P4 12 (50) | P4 9 (36) |                |
| Second stage revision for chronic infection (arthrodesis) | Stable patient – interstage 1st stage = static spacer – planning long term spacer of arthrodesis/interposition nail 5 months post 1st stage to static spacer. Soft tissues in reasonable condition – will compete planned course 6 months oral AB this month. Plan – convert to arthrodesis interposition nail. | Yes | No | No | P1a | P1a 3 | 3 |
|          |                                                                                  |                    |                  |                     | P1b | P1b |                |
|          |                                                                                  |                    |                  |                     | P2 1 (4) | P2 4 (16) |                |
|          |                                                                                  |                    |                  |                     | P3 9 (38) | P3 10 (42) |                |
|          |                                                                                  |                    |                  |                     | P4 14 (58) | P4 10 (42) |                |
One case was for instability and four were for infection (first stage and second stage revision in the setting of a stable patient, arthrodesis and prosthesis salvage requiring plastic surgery input). This suggests that there is some subtlety in individual surgeon interpretations of the scenarios, which would probably be addressed by an MDT discussion as recommended by the surgical prioritisation process. Additionally the chosen time frames have a range, so it may be that all the surgeons would agree on a six week time frame but those nearest time categories straddle >72 hrs to three months with the cut off arbitrarily at four weeks. So the lack of total consensus may be due to artificial time lines and that MDT discussion would have resulted in a unanimous choice.

The challenge in achieving agreement for these scenarios results from (1) the nature of the NHSE prioritisation scale and (2) local variation in support services/infrastructure. The prioritisation scale purposefully and understandably offers binary categorisation, demanding choices between levels with significant time gaps. There was a split P1b versus P2 ranking for the scenario ‘Implant salvage with plastic surgery reconstruction’. In the period between listing and surgery patient optimisation, kit (e.g. polyethylene liners) and an available plastic surgeon needs to be organised. Most surgeons would want to undertake this within ~1 week (P2). However, P1b prioritisation actually provides a closer matching time period.

It is likely local unit infrastructure ancillary issues will force decisions into one category for real-life reasons rather than clinical reasoning. For example if a patient needs transfer from the acute unit to the elective centre for a revision for a PPF, this will add in time. Similarly if plastic surgery is on site their availability may be improved, or if the revision unit is co-located with a Major Trauma Centre there may be pressure on lower limb plastics services to address open lower limb trauma rather than the semi-stable open knee replacement. These differences may have resulted in split decision making within the RKWG group. The difference in opinion is natural and to be expected and is often down to individual surgeons putting varying weighting on different aspects of the scenario as well as interpreting the scenario within their own specific local clinical environment. It is also noteworthy that it is difficult to rank a procedure as, for example P2, when a patient may have already waited >three months during the C-19 pandemic. It is also important to recognise that the timing scale should be interpreted time intervals, i.e. a P2 procedure can wait 72 h to four weeks, and not that it should wait 4 weeks.

We have standardised the scenarios to an ASA 2 70 years old female patient. Responses could be different if the patient has significant co-morbidities that predisposed to covid-related lung disease [5]. Risks of covid post-surgery are still to be quantified and fully understood.

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### Table 5

P4 procedures that can wait >3 months.

| Procedure | Clinical scenario | Infection (yes/no) | Traumatic injury | Unstable physiology | Round 1 (no. (%) of respondents) | Round 2 | Prioritisation |
|-----------|-------------------|--------------------|------------------|--------------------|----------------------------------|---------|---------------|
| Revision TKA for loosening | Stable patient – Aseptic Loosening TKA No imminent risk of collapse – primary done 15 years ago – symptomatic (pain, reduced walking distance to ~100 yards) – no evidence of infection, aspiration – ve – lucency around tibia and femur, patella infera with abutment onto femur, extensor mechanism intact. Plan – revision TKA | No | No | No | P1a – 4 | P1b | P4 17 (71) |
| Extensor allograft for chronic extensor deficiency | Stable patient – Chronic Extensor Mechanism problems Planning Allograft and retain knee prosthesis 2 years since rev TKA Poor outcome – Ext Deficient No trauma Chronic traumatic extensor rupture – symptomatic with occasional falls. Patient is safe at home (lives with partner). Plan – Extensor Allograft | No | No | No | P1a | P1b | P2 | P3 10 (42) | P4 14 (58) | P4 17 (21) |
| Secondary patella resurfacing | Stable patient – Solid TKA – well aligned/sized – un-resurfaced patella with PFJ symptoms – planning PFJ resurfacing for progression of arthritis 6 years from primary PS-TKA (patella not resurfaced at initial operation) Deteriorated at 4 years Anterior knee symptoms Ongoing physio some improvement, still sore Normal alignment and rotational profile Exam – irritable PFJ, 0–110 Planning patella resurfacing | No | No | No | P1a | P1b | P2 | P3 7 | P4 17 (29) |
| Stiff TKA for arthrolysis | Stable patient – TKA – stiff On list for Arthrolysis / TTO 3 years post primary – no progress with range of motion Stiff – 0–30 Plan – arthrolysis ± tibial tubercle elevation ± liner change | No | No | No | P1a | P1b | P2 1(4) | P3 3(13) | P4 28 (63) |
This work has several limitations. We have attempted to cover the broad sub-specialty of revision TKA surgery, but case-specific complexity will demand bespoke decision making on a case-by-case basis. Whilst effort was made to cover the geographical area of England, Wales, Scotland and Northern Ireland, we had a limited number of revision surgeons to poll (24). The threshold of consensus was not reached for every procedure/scenario. We could have undertaken further voting to try and obtain agreement, but (1) felt that the difficult decision-making and potential uncertainty in this complex area is well reflected with a split decision amongst a group of experienced surgeons in a limited number of cases and (2) wanted to produce this guideline in a timely fashion.

Although effort has been made to cover all aspects of revision TKA, there is considerable nuance depending on patient factors (co-morbidities, age) and local facilities (availability of allied specialists e.g. plastic surgeons). These recommendations serve only as a guide and there will necessarily and understandably be local variation in practice.

We have produced a consensus-based guideline on prioritisation of revision knee arthroplasty procedures to guide clinicians’ surgical decision-making in a fair and evidence-based manner. We hope this information supports surgeons as their patients’ advocate and within their surgical divisions when faced with competing pressures for theatre time. Decisions on case prioritisation is complex with multiple clinical, social and psychological patient factors to consider, and reinforces the importance of local clinical MDT discussions.

This publication serves as a guideline and must be interpreted as such. It is impossible to account for absolutely every conceivable patient presentation. Each patient must be treated on his or her own merit with the circumstances unique to that presentation being factored into decision-making. MDT discussion is important but the individual consultant orthopaedic surgeon retains overall accountability and responsibility to prioritise amongst his own clinical practice.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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Ethics Statement

Ethical approval was not required for this manuscript.

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