



# Consensus statement on problematic knee replacement and revision knee replacement: A collaboration between EKS and BASK



Andrew Porteous<sup>a,b,\*</sup>, Frank-Christiaan Wagenaar<sup>a</sup>, Andrew Price<sup>a,b</sup>, Jonathan Phillips<sup>a</sup>, Gijs van Hellemond<sup>a</sup>, the BASK/EKS Consensus Group on Problematic Knees Replacement

<sup>a</sup> European Knee Society (EKS), Europe

<sup>b</sup> British Association for Surgery of the Knee (BASK), Europe

## ARTICLE INFO

### Article history:

Received 19 September 2024

Accepted 18 November 2024

### Keywords:

Consensus

Revision TKA

Problematic knee replacement

BASK and EKS

## ABSTRACT

**Background:** Up to 20% of primary total knee arthroplasty (TKA) patients are not satisfied with their outcome. Both the analysis of these patients and revision surgery can be complex, expensive and outcomes can vary widely.

**Aim:** The aim of this study was to deliver consensus recommendations regarding outpatient analysis, surgical treatment and arrangement of clinical services concerning patients with a problematic TKA or revision knee replacement (RTKA).

**Methods:** Members of BASK and EKS were invited to attend a joint meeting in London, UK (December 2019). A formal consensus process was undertaken at the meeting incorporating a multiple round Delphi exercise, with group discussion of areas of agreement and disagreement between rounds. Eighty delegates attended the meeting and five consensus statements were considered, with a threshold level of 80% agreement required as the definition consensus. A further consensus meeting of EKS members in Kitzbuhl, Austria (January 2023) followed similar methodology and considered a further four statements on this topic.

**Results:** From the first meeting, 5 consensus statements with accompanying supporting evidence and text were agreed. 1) In suspected infection, a recognised diagnostic pathway and definition should be used (e.g. MSIS, ICM, EBJIS) and documented; 2) Revision of an infected TKA should be treated in units with a multidisciplinary team; 3) Initial investigation of a problematic TKA should include a minimum of: clinical investigation, X-Rays and blood tests, with further discussion with the MDT if required; 4) Units providing RTKA should have surgeons with evidence of specific training or experience, and on-going minimum unit numbers; 5) National Orthopaedic/Knee Societies should develop a strategy on Revision TKA provision taking into account: workforce, revision burden, location, hospital infrastructure.

From the second meeting a further 4 consensus statements were agreed. Two statements were agreed text content answering the questions: 1) What should be included in the basic diagnostic workup of a painful TKA? and 2) Which are the key factors for surgeons to consider before offering the patient revision surgery? The two other agreed statements

\* Corresponding author at: Avon Orthopaedic Centre, Southmead Hospital, Bristol BS10 5NB, Europe.

E-mail addresses: [ajporteur@aol.com](mailto:ajporteur@aol.com) (A. Porteous), [f.wagenaar@ocon.nl](mailto:f.wagenaar@ocon.nl) (F.-C. Wagenaar), [andrew.price@ndorms.ox.ac.uk](mailto:andrew.price@ndorms.ox.ac.uk) (A. Price), [jonphillips@nhs.net](mailto:jonphillips@nhs.net) (J. Phillips), [g.vanhellemond@gmail.com](mailto:g.vanhellemond@gmail.com) (G. van Hellemond).

are: 3) Pre-operative diagnosis is related to outcome in RTKA and 4) RTKA for pain, without a surgically treatable diagnosis, is unpredictable.

**Conclusions:** The agreed joint BASK-EKS consensus statements and the EKS consensus statements on the assessment of problematic RTKA are recommended as the contemporary basis of optimal care for these patients and should inform future training and service developments.

© 2024 Published by Elsevier B.V.

## 1. Introduction

The global annual incidence of primary total knee arthroplasty (TKA) surgery continues to increase year on year, and with this there is an increase in the rate of revision knee arthroplasty (RKTA) [1,2]. Up to 20% of patients after primary total knee arthroplasty (TKA) are not satisfied with their outcome [3]. The investigation of problematic TKA can be complex, expensive and the outcomes from RTKA surgery outcomes can vary widely, and many of the questions regarding the assessment and treatment of the problematic TKA are yet to be answered [4]. Current available guidance on this subject is only applicable to certain public healthcare systems and financial models [5]. General guidelines to support decision making around the problematic knee are limited.

The aim of this study was to deliver consensus recommendations regarding the assessment, treatment and arrangement of clinical services concerning problematic TKA and RTKA.

## 2. Methods

### 2.1. Study design

The study employed a Real-time Delphi exercise.

### 2.2. Expert group

Fifty delegates from the European Knee Society (EKS) and thirty delegates from the British Association for Surgery of the Knee (BASK) participated in a consensus exercise at a joint BASK-EKS meeting held in London on 6th December 2019, which was the source of the first five joint-consensus statements. Eligibility for membership of these organisations is the same: orthopaedic surgeons, who have been recommended for membership and seconded by at least two existing members and with practice interest predominantly in knee problems. A further meeting of the EKS members in Kitzbühl on January 25th 2023, was the source of the next four consensus statements.

### 2.3. Initial consensus statement preparation

Prior to the first meeting, five key topics were identified by two opinion leaders in problematic and revision knee arthroplasty, representing BASK and EKS respectively (AJP, GvH). Draft statements were prepared for initial consultation and a presentation of the existing evidence to support each consensus statement was provided at the start of the exercise. For the second meeting, four topics were identified by three EKS members experienced in the field of revision knee assessment and treatment (AJP, GvH, FW). Draft questions, statements and background literature were distributed before the meeting and then presented at the meeting.

### 2.4. Consensus definition

Consensus thresholds were defined a priori with a minimum of 80% agreement required to accept a statement [1,2].

### 2.5. Delphi process

Each draft consensus statement was presented to the audience and discussion invited. Voting was undertaken to determine level of agreement. A three-point Likert scale was utilised (For the EKS/BASK meeting this was: agree, partially agree, disagree while for the EKS meeting this was: agree, disagree, abstain). Voting was undertaken anonymously and recorded using a proprietary electronic polling tool (Slido, <https://www.sli.do/>) to which all delegates had access. Polls were kept open until at least 90% of delegates had voted on each statement. If a statement failed to reach the threshold required for agreement, the group was asked for further comment and feedback around the minimum change in wording that would be required for acceptance. The statements were then revised and the poll re-opened.

### 3. Results

#### 3.1. Results of combined EKS/BASK consensus meeting, London UK

Four statements were accepted, with agreement level > 80%, on the first vote. One statement (statement three: 'Investigation of a problem TKA should include clinical correlation with a standard set of special investigations') was not accepted (51% agree, 41% partially agree, 7% disagree). This statement was re-discussed and the reasons for disagreement established. The statement was revised, and a second vote was performed.

The final, accepted statements are presented below:

##### 3.1.1. Statement 1: In suspected infection, a recognised diagnostic pathway and definition should be used (e.g. MSIS, ICM, EBJIS) and documented

91% agree, 9% partially agree, 0% disagree. Accepted (strong consensus).

Justification: The use of a diagnostic pathway for periprosthetic joint infection (PJI) is known to improve accuracy and reliability of diagnosis. It provides transparency of methodology and allows comparison of patient populations. Documentation of a named diagnostic pathway encourages surgeons to reference evidence-based guidelines when assessing suspected PJI.

Further commentary: The expert panel identified gaps in the evidence for when to initiate a diagnostic algorithm for PJI e.g. how many days of persistent post-operative wound ooze should prompt initiation of a PJI investigative pathway. Determination of the optimum diagnostic algorithm for infection was beyond the scope of this meeting. However, the group highlighted that future research is needed to establish the position of commercial tests in existing diagnostic algorithms.

The expert group also determined that quality assurance schemes for Microbiology laboratories may need to be reviewed in order that there is adequate provision for all necessary tests in revision centres. The inability to obtain synovial white cell counts in some centres was provided as an example where services could be improved.

##### 3.1.2. Statement 2: Revision of infected knee arthroplasty should be treated in units with multidisciplinary teams.

82% agree, 15% partially agree, 3% disagree. Accepted (strong consensus).

Justification: The benefits of multidisciplinary team (MDT) working are well-established in many specialties including cancer and cardiovascular services. The rationale for adoption in revision knee replacement pathways is the association with high complexity, high cost and variable outcomes.

Further commentary: The expert panel recommended research into the required skills mix needed for this MDT. Core members were suggested to be: orthopaedic surgeons, microbiologists, pharmacists, radiologists, anaesthetists and physical therapists with access to other specialities (e.g. plastic and vascular surgery) as required [6].

The utilisation of this MDT was discussed as an area for further research. This should try to establish whether MDT discussion was necessary for every case or for selected patients, e.g. based on case complexity [7,8]. The geography of this MDT should also be evaluated as to whether services should be aggregated into hubs or provisioned locally.

##### 3.1.3. Statement 3: Initial investigation of a problematic TKA should include a minimum of: clinical investigation, X-Rays and blood tests, with further discussion with the MDT if required.

95% agree, 5% partially agree. Result: Accepted (strong consensus).

Justification: Problematic TKA can represent a diagnostic challenge. It was felt that a standardised basic initial investigation set should be undertaken in these patients. Surgeons should then be encouraged to discuss the patient in a local or regional MDT (or refer them to a more specialised unit) in a timely manner before ordering further diagnostic tests that may delay referral, be expensive and may not be helpful in establishing the diagnosis. Many specialist services run MDT services where complex cases can be discussed to aid diagnosis and treatment planning.

##### 3.1.4. Statement 4: Units providing revision knee surgery should have surgeons with evidence of specific training or experience, and on-going minimum unit numbers.

83% agree, 17% partially agree. Accepted (strong consensus).

Justification: This statement is designed to be applicable for major revisions, excluding secondary patella resurfacing and isolated liner exchange, which are reported by some registries as revisions [9]. The expert group determined that the association between lower surgical caseload and poorer outcome (including higher complications) that has been demonstrated for primary TKA and is also likely for RTKA given its high complexity given the results of recent papers [10–21]. The importance of evaluating unit-level and surgeon-level outcomes was based on currently available literature and national guidelines [22–24].

3.1.5. *Statement 5: National Orthopaedic/Knee Societies should develop a strategy on Revision TKA provision taking into account: workforce, revision burden, location, hospital infrastructure.*

92% agree, 8% partially agree. Accepted (strong consensus).

Justification: The expert group determined that national and international strategies for revision knee replacement were important given the high cost and complexity of this problem, the expected increase in the burden of revision knee replacement and the limited information on current organisation of revision knee services [2,25–27].

Further commentary: It was accepted that the feasibility of delivering specialist units with appropriate skill mix and geographical location, would be affected by multiple factors that would differ slightly between nations and healthcare systems. Lessons could be learnt from countries that had already made progress in this area, but local variations would make nation-specific guidelines important [5].

### 3.2. Results of EKS consensus meeting

3.2.1. *Question 1. What should be included in the basic diagnostic work-up of a painful knee arthroplasty?*

Result: Agree 94.1%, Disagree 5.8%, Abstain 0% (Strong consensus).

#### - Primary analysis:

- Detailed history and examination by an experienced arthroplasty surgeon.
- Radiological assessment to include: Anteroposterior X-ray (with/without weight bearing), lateral X-Ray, skyline patella view, and weight bearing long leg alignment film.
- Blood tests to include: CRP (C reactive protein) +/- ESR (erythrocyte sedimentation rate).

#### - Additional investigations may be required if:

- Diagnosis is not apparent after the primary analysis, with differential diagnosis guiding the appropriate investigation or
- if initial assessment suggests further investigation for infection is needed. This warrants infection workup using one of the accepted analysis pathways, e.g. EBJS [28–32].

Justification: This provides further information on the basic diagnostic work-up recommended after Statement 3.

3.2.2. *Question 2. Which are the key factors for surgeons to consider before offering a patient revision TKA?*

Result: Agree 86.2%, Disagree 3.45%, Abstain, 10.34% (Strong consensus).

#### Surgeons should consider:

**1. Patients factors:** medical comorbidity, anaesthetic risk, risk of recurrent infection, quality of skin cover over knee and lower leg & limb vascular status.

**2. Implant factors:** reason for revision identified and assessment of technical complexity of revision procedure.

**3. Surgeon/Unit factors:** depending on the complexity of the case and the infrastructure available, is the individual surgeon or the specific unit appropriate to be delivering the revision procedure. Units should be aware of their Unit and individual surgeon revision numbers and outcome.

**4. Individual units should consider the appropriate level of provision of:** anaesthetic/ITU/Nursing/Microbiology/Plastic surgery/Vascular surgery/Rehabilitation services required to deliver a safe revision service.

**5 Severity of symptoms and realistic expectation of improvement.**

**6. Potential deterioration if revision is not performed** (e.g. lysis/fracture/sepsis).

Justification – this text provides information for surgeons to consider before proceeding to surgery [33].

3.2.3. *Statement 3. Pre-operative diagnosis is related to outcome of revision TKA.*

Result: Agree 97.1%, Disagree 0%, Abstain 2.86% (Strong consensus).

Justification: Even though comparative studies on this matter are limited, literature supports the finding that the reason for RTKA is associated with outcome. Specifically, revision surgery for severe stiffness or infection have less favourable outcomes and revision surgery for aseptic loosening more often achieves superior outcome. Outcomes may be based on a number of factors, including PROMS, complication and re-revision rates.

3.2.4. *Statement 4. Revision TKA for pain, without a surgically treatable diagnosis, is unpredictable.*

Initial Result: Agree 84.4%, Disagree 9.38%, Abstain 6.25%.

After discussion and re-wording: Agree 90%, Disagree 0%, Abstain 10%. (Strong consensus).

Justification: Revision surgery for unexplained pain has shown to result in less favourable or predictable outcomes [34,35]. It is important to realise that “unexplained pain” (or other complaints like instability, stiffness or swelling) after TKA implies that a comprehensive diagnostic work-up has been carried out, including review by a specialist team. Use of “second opinions” and/or MDT discussions can be useful in reaching a conclusion that the problem is truly “unexplained” [36,37]. Attention needs to be given to the assessment of neuropathic and central pain sensitization problems and units should have a pathway for referral and management of these problems [38–40].

#### 4. Discussion

We describe the results of two “expert group” knee societies on several topics relating to problematic TKA and Revision TKA using standardised consensus methodology [41,42]. The same two societies have recently published the outcome of their consensus statements on unicompartamental knee replacement using the same methodology [42].

The goal was to provide consensus statements to assist surgeons in the diagnosis and management of problematic TKA. The statements aimed to cover four broad areas:

- Diagnostics (EKS/BASK combined statements 1 and 3 and EKS statement 1)
- Organisation of services (EKS/BASK combined statement 2, 4 and 5)
- Decision making (EKS statement 2)
- Outcomes (EKS statement 3 and 4).

The value of consensus methodology is that this process brings together both expert opinion and the best available evidence, and can be helpful in particular in areas relating to patient care where higher levels of evidence such as randomised controlled trials have not been performed, may not be appropriate or where the issue is too broad or complex. However, it is also well established that consensus methodology may also be subject to biases.

The statements on diagnostics aim to provide surgeons with a simple methodology to initiate investigation in patients with problematic TKA. Most patients will present to non-specialists in the first instance, and the blood tests and radiographs recommended will diagnose most important pathologies, such as infection or implant loosening.

The consensus statements then recommend that patients are referred on for specialist care for further investigation or treatment. The aim of this is to prevent unnecessary or expensive investigations that may not be indicated. It is recommended that national services are organised such that teams that provide RTKA have appropriate training in revision surgery and are able to provide appropriate care for such patients. There is substantial evidence that complex surgery (such as RTKA) has better outcomes when performed by teams and surgeons that perform the surgery regularly [22–24].

The consensus statements discuss the importance of establishing the diagnosis before performing surgery, and there is an emphasis on ensuring that infection is accurately diagnosed. The statements support that patients with infected TKA are managed in multi-disciplinary teams with assessment using established PJI pathways.

Before proceeding to surgery, the statements encourage a robust evaluation of patient factors and estimation of the complexity of the surgery that may influence the surgery or outcomes. Where appropriate, patients should be referred on for more specialist treatment.

The statements also appreciate that there are many types of healthcare systems worldwide, and as such each region or nation is encouraged to develop an appropriate strategy based upon the revision burden, geography, workforce and hospital infrastructure. While clinical aspects may remain the same, organisational processes may vary between nations.

#### 5. Conclusion

Knee arthroplasty numbers are increasing in most countries and this has been followed by an increase in revision numbers, with further predictions suggesting this trend will continue or increase further in future. RTKA is more complex, has higher complication rates and is more demanding of resources than primary TKA.

It is therefore important to have clear guidance on clinical practice and organisation of revision services. This guidance can be informed by evidence and recommendations from expert groups. This BASK and EKS consensus exercise aims to provide clear and consistent statements on problematic TKA and RTKA that should form the basis of optimal care provision. These statements (Appendix 1 and 2) should now be adopted and support surgeons and care providers in developing and improving practice.

**The BASK/EKS Consensus Group on Problematic Knees Replacement included:** Andrew Porteous, Frank-Christiaan Wagenaar, Jonathan Phillips, Andrew Price, Gijs Van Hellemond, James Murray, Jan Victor, Sigfried Hoffman, Franco Benazzo.

#### CRediT authorship contribution statement

**Andrew Porteous:** Conceptualization, Methodology, Writing – review & editing. **Frank-Christiaan Wagenaar:** Data curation, Project administration, Writing – review & editing. **Andrew Price:** Conceptualization, Methodology, Writing – review & editing. **Jonathan Phillips:** Methodology, Project administration, Writing – review & editing. **Gijs van Hellemond:** Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing.

#### 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.

## Appendix 1. EKS and BASK consensus statements on problematic and revision TKA

1. In suspected infection, a recognised diagnostic pathway and definition should be used (e.g. MSIS, ICM 1, ICM 2018, EBJS) and documented.
2. Revision of infected knee arthroplasty should be treated in units with multidisciplinary teams.
3. Initial investigation of a problematic TKA should include a minimum of: clinical investigation, X-Rays and blood tests, with further discussion with the MDT if required.
4. Units providing revision knee surgery should have surgeons with evidence of specific training or experience, and on-going minimum unit numbers.
5. National Orthopaedic/Knee Societies should develop a strategy on Revision TKA provision taking into account: workforce, revision burden, location, hospital infrastructure.

## Appendix 2. EKS consensus statements on problematic and revision TKA

1. Agreement was reached on what assessments should be included in the basic diagnostic work-up of a painful knee arthroplasty.
2. Agreement was reached on what key factors should be considered before offering a patient a revision TKA.
3. Pre-operative diagnosis is related to outcome of revision TKA.
4. Revision TKA for pain, without a surgically treatable diagnosis, is unpredictable.

## References

- [1] Bozic KJ, Kurtz SM, Lau E, Ong K, Chiu V, Vail TP, et al. The epidemiology of revision total knee arthroplasty in the United States. *Clin Orthop Relat Res* 2010;468(1):45–51.
- [2] 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(8):1076–81.
- [3] Baker PN, van der Meulen JH, Lewsey J, Gregg PJ, Wales NJRfEa. The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry for England and Wales. *J Bone Joint Surg Br*. 2007;89(7):893–900.
- [4] Mathews JA, Kalson NS, Tarrant PM, Toms AD, group RKRPSs. Top ten research priorities for problematic knee arthroplasty. *Bone Joint J*. 2020;102-B(9):1176–82.
- [5] Toms AD. BASK Revision Knee Replacement Guidelines. *Knee* 2020;27(5):1662–3.
- [6] BOAST – Revision Total Knee Replacement Surgical Practice Guidelines. [www.boa.ac.uk/resource/revision-total-knee-replacement-surgical-practice-guidelines.html](http://www.boa.ac.uk/resource/revision-total-knee-replacement-surgical-practice-guidelines.html).
- [7] 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(4):1011–7.
- [8] Phillips JRA, Murray J, Porteous AJ, Morgan-Jones R, Toms AD. Revision knee complexity classification (RKCC). *Knee* 2020;27(5):1684–7.
- [9] National Joint Registry 20th Annual Report. 2023.
- [10] 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;13:250.
- [11] Kazarian GS, Lawrie CM, Barrack TN, Donaldson MJ, Miller GM, Haddad FS, et al. The Impact of Surgeon Volume and Training Status on Implant Alignment in Total Knee Arthroplasty. *J Bone Joint Surg Am* 2019;101(19):1713–23.
- [12] Pappas MA, Spindler KP, Hu B, Higuera-Rueda CA, Rothberg MB. Volume and Outcomes of Joint Arthroplasty. *J Arthroplasty* 2022;37(11):2128–33.
- [13] Yu TH, Chou YY, Tung YC. Should we pay attention to surgeon or hospital volume in total knee arthroplasty? Evidence from a nationwide population-based study. *PLoS One* 2019;14(5):e0216667.
- [14] Snoeker B, Turkiewicz A, Magnusson K, Frobell R, Yu D, Peat G, et al. Risk of knee osteoarthritis after different types of knee injuries in young adults: a population-based cohort study. *Br J Sports Med* 2020;54(12):725–30.
- [15] Wek C, Okoro T, Tomescu S, Paterson JM, Ravi B. How much is enough for total knee arthroplasty? *BMJSurg Interv Health Technol* 2021;3(1):e000102.
- [16] Okoro T, Tomescu S, Paterson JM, Ravi B. Analysis of the relationship between surgeon procedure volume and complications after total knee arthroplasty using a propensity-matched cohort study. *BMJSurg Interv Health Technol* 2021;3(1):e000072.
- [17] Randsborg PH, Chen AC. How much is enough? Finding the minimum annual surgical volume threshold for total knee replacement. *BMJSurg Interv Health Technol* 2021;3(1):e000092.
- [18] Wilson S, Marx RG, Pan TJ, Lyman S. Meaningful Thresholds for the Volume-Outcome Relationship in Total Knee Arthroplasty. *J Bone Joint Surg Am* 2016;98(20):1683–90.
- [19] Vaotuaa D, O'Connor P, Belford M, Lewis P, Hatton A, Holder C, et al. The effect of surgeon volume on revision for periprosthetic joint infection: an analysis of 602,919 primary total knee arthroplasties. *J Bone Joint Surg Am* 2023;105(21):1663–75.
- [20] Memtsoudis SG, Wilson LA, Liu J, Poeran J. Surgeon-anaesthesiologist team case volume and perioperative outcomes in total joint arthroplasty. *Br J Anaesth* 2020;125(5):e395–6.
- [21] Schraknepper J, Dimitriou D, Helmy N, Hasler J, Radzanowski S, Flury A. Influence of patient selection, component positioning and surgeon's caseload on the outcome of unicompartmental knee arthroplasty. *Arch Orthop Trauma Surg* 2020;140(6):807–13.
- [22] Roof MA, Sharan M, Merkow D, Feng JE, Long WJ, Schwarzkopf RS. High-volume revision surgeons have better outcomes following revision total knee arthroplasty. *Bone Joint J*. 2021;103-B(6 Supple A):131–6.
- [23] Halder AM, Gehrke T, Günster C, Heller KD, 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.
- [24] Yapp LZ, Walmsley PJ, Moran M, Clarke JV, Simpson AHRW, Scott CEH. The effect of hospital case volume on re-revision following revision total knee arthroplasty. *Bone Joint J*. 2021;103-B(4):602–9.
- [25] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am* 2007;89(4):780–5.
- [26] Lewis PL, Robertsson O, Graves SE, Paxton EW, Prentice HA, W-Dahl A. Variation and trends in reasons for knee replacement revision: a multi-registry study of revision burden. *Acta Orthop* 2021;92(2):182–8.
- [27] Upfill-Brown A, Hsiue PP, Sekimura T, Shi B, Ahlquist SA, Patel JN, et al. Epidemiology of revision total knee arthroplasty in the United States, 2012 to 2019. *Arthroplast Today*. 2022;15:188–195.e6.
- [28] Zmistowski B, Della Valle C, Bauer TW, Malizos KN, Alavi A, Bedair H, et al. Diagnosis of periprosthetic joint infection. *J Arthroplasty* 2014;29(2 Suppl):77–83.

- [29] Parvizi J, Gehrke T, Chen AF. Proceedings of the International Consensus on Periprosthetic Joint Infection. *Bone Joint J* 2013;95-B(11):1450–2.
- [30] Shohat N, Tan TL, Della Valle CJ, Calkins TE, George J, Higuera C, et al. Development and validation of an evidence-based algorithm for diagnosing periprosthetic joint infection. *J Arthroplasty*. 2019;34(11). 2730–6.e1.
- [31] Parvizi J, Tan TL, Goswami K, Higuera C, Della Valle C, Chen AF, et al. The 2018 definition of periprosthetic hip and knee infection: an evidence-based and validated criteria. *J Arthroplasty*. 2018;33(5). 1309–14.e2.
- [32] McNally M, Sousa R, Wouthuyzen-Bakker M, Chen AF, Soriano A, Vogely HC, et al. The EBJS definition of periprosthetic joint infection. *Bone Joint J*. 2021;103-B(1):18–25.
- [33] van Kempen RW, Schimmel JJ, van Hellemond GG, Vandenneucker H, Wymenga AB. Reason for revision TKA predicts clinical outcome: prospective evaluation of 150 consecutive patients with 2-years followup. *Clin Orthop Relat Res* 2013;471(7):2296–302.
- [34] Mont MA, Serna FK, Krackow KA, Hungerford DS. Exploration of radiographically normal total knee replacements for unexplained pain. *Clin Orthop Relat Res* 1996;331:216–20.
- [35] Arndt KB, Schröder HM, Troelsen A, Lindberg-Larsen M. Patient-reported outcomes and satisfaction 1 to 3 years after revisions of total knee arthroplasties for unexplained pain versus aseptic loosening. *J Arthroplasty*. 2023;38(3):535–540.e3.
- [36] Erivan R, Jacquet C, Villatte G, Ollivier M, Paprosky W. Epidemiology of painful knee after total knee arthroplasty in a tertiary care center: Assessment by decision tree. *Knee* 2020;27(3):1049–56.
- [37] Awad F, Fine N, Phillips J, Toms A. A regional MDT service for the management of infected native and total knee replacements: development and results of an established service. Leicester: BASK; 2018.
- [38] Wylde V, Hewlett S, Learmonth ID, Dieppe P. Persistent pain after joint replacement: prevalence, sensory qualities, and postoperative determinants. *Pain* 2011;152(3):566–72.
- [39] Wylde V, Beswick A, Bruce J, Blom A, Howells N, Goberman-Hill R. Chronic pain after total knee arthroplasty. *EFORT Open Rev* 2018;3(8):461–70.
- [40] Phillips JR, Hopwood B, Arthur C, Stroud R, Toms AD. The natural history of pain and neuropathic pain after knee replacement: a prospective cohort study of the point prevalence of pain and neuropathic pain to a minimum three-year follow-up. *Bone Joint J*. 2014;96-B(9):1227–33.
- [41] Abram SGF, Beard DJ, Price AJ, Group BMW. Arthroscopic meniscal surgery: a national society treatment guideline and consensus statement. *Bone Joint J*. 2019;101-B(6):652–9.
- [42] Price A, Thienpont E, Catani F, Abram S, Troelsen A. BASK and EKS Consensus Group. Consensus statement on unicompartmental knee replacement: A collaboration between BASK and EKS. *Knee* 2023;41:391–6.