

Joint replacement (primary): hip, knee and shoulder

[T] Evidence review for long-term follow-up and monitoring

NICE guideline

Intervention evidence review

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This evidence review was developed by the National Guideline Centre, hosted by the Royal College of Physicians

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1 ¹ Long-term monitoring

1.1 ² Review questions:

- ³ • In adults having primary elective joint replacement, what
⁴ would be the optimal timing of follow-up or surveillance
⁵ appointments?
- ⁶ • In adults having primary elective joint replacement, who
⁷ should carry out follow-up or surveillance appointments?
- ⁸ • In adults having primary elective joint replacement, should
⁹ x-rays be undertaken for all follow-up or surveillance
¹⁰ appointments?

1.2¹¹ Introduction

¹² Primary elective hip, knee and shoulder replacement surgery aims to reduce joint pain and
¹³ increase function in people with joint degeneration, but short-term complications from the
¹⁴ operation or longer term from the failure of the joint replacement, can cause significantly poor
¹⁵ outcomes.

¹⁶ There is uncertainty whether healthcare professionals should routinely monitor people for
¹⁷ complications after their operation and at what intervals. One approach currently used is, if a
¹⁸ problem arises, most commonly worsening pain, to advise people who have had a hip, knee
¹⁹ or shoulder replacement to contact their General Practitioner (GP) or hospital orthopaedic
²⁰ team. This leads to a series of investigations to determine if, for example, physiotherapy or
²¹ further surgery is required. Another approach is to monitor patients with x-rays and
²² questionnaires at regular intervals, such as one, three, five and 10 years after joint
²³ replacement. There are potential clinical benefits in regular monitoring to detect adverse
²⁴ changes including asymptomatic complications, but the total cost to the NHS, given the
²⁵ number of joint replacements performed in the UK, is significant. The cost-benefits of regular
²⁶ monitoring are therefore uncertain.

²⁷ There is variability in UK provision in terms of long-term follow-up and monitoring for people
²⁸ after hip, knee and shoulder replacement. Some are discharged six weeks after the
²⁹ operation and advised to contact their GP if they experience problems; the GP can re-refer to
³⁰ an orthopaedic team. Others have routine follow-up appointments at six to 12 months with a
³¹ member of the orthopaedic team and are then discharged. Yet others have annual or
³² biannual questionnaire assessments to monitor pain and function and are only contacted by
³³ the orthopaedic team if their scores suggest they have significantly deteriorated.

³⁴ There have been developments in digital technology where individuals can be remotely
³⁵ monitored using tele- or video-conferencing facilities. This has allowed follow-up
³⁶ appointments without the need for person to attend the hospital or clinic environment.

³⁷ Given this variability in current practice and the changing technology, this review seeks to
³⁸ explore a number of questions around long-term follow-up and monitoring of people after hip,
³⁹ knee and shoulder replacement. It seeks to determine when people should be followed-up
⁴⁰ after their joint replacement surgery, who should carry out this follow-up and whether x-rays
⁴¹ should be undertaken at all follow-up appointments.

1.3 1 PICO table

2 For full details, see the review protocol in appendix A.

3 Table 1: PICO characteristics of review question

Population	Adults who have undergone primary hip, knee or shoulder joint replacement.
Interventions	<p>Follow up/surveillance strategy</p> <p>Interventions separated by:</p> <ul style="list-style-type: none"> • Timing of appointments points starting from initial follow-up /surveillance appointment • The healthcare professionals carrying out the follow-up /surveillance appointments, for example, a member of the orthopaedic team, GP or physiotherapist. • Whether routine x-rays are utilised for each follow-up /surveillance monitoring appointment.
Comparison	Comparison of interventions
Outcomes	<p>Critical</p> <ul style="list-style-type: none"> • Emergency reoperation (dichotomous) • Mortality: life expectancy (time to event) • Quality of life at 2 years after surgery, at the longest time point (at least 4 years after surgery) (continuous): for example EQ-5D, EQ-VAS. • Patient Reported Outcome Measures (PROMs) at 2 years after surgery, at the longest time point (at least 4 years after surgery; continuous) • Reoperation (including revision) at 2 years after surgery, at the longest time point (at least 4 years after surgery; dichotomous) <p>To be extracted when not included within a PROM:</p> <ul style="list-style-type: none"> • Function at 2 years after surgery, at the longest time point (at least 4 years after surgery; continuous) • Pain at 2 years after surgery, at the longest time point (at least 4 years after surgery; continuous)
Study design	<p>Randomised controlled trials</p> <p>If no well-conducted RCTs are available, then observational studies with multivariate analysis will be investigated.</p>

1.4 4 Clinical evidence

1.4.1 5 Included studies

6 A search was conducted for studies comparing long-term follow-up strategies for people who
 7 have undergone primary hip, knee or shoulder joint replacement surgery.

8 No relevant clinical studies investigating follow-up programs were identified. See also the
 9 study selection flow chart in appendix C.

1.4.20 Excluded studies

11 See the excluded studies list in appendix I.

1.4.32 Summary of clinical studies included in the evidence review

13 No clinical evidence was identified.

1.4.4 1 Quality assessment of clinical studies included in the evidence review

2 No clinical evidence was identified.

3

1.5 4 Economic evidence

1.5.1 5 Included studies

6 One health economic study was identified with the relevant comparison and has been
7 included in this review⁵⁰. The study is summarised in the health economic evidence profile
8 below (Table 2) and the health economic evidence table in appendix H.

1.5.2 9 Excluded studies

10 Two health economic studies that were relevant to this question were excluded due to
11 assessment of methodological limitations.

12 See also the health economic study selection flow chart in appendix G and excluded studies
13 in appendix I

14

1.5.3 1 Summary of studies included in the economic evidence review

2 Table 2: Health economic evidence profile: New BOA follow up guidelines versus the old BOA follow up guidelines

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Roberts 2016 ⁵⁰ [UK]	Partially applicable ^(a)	Potentially serious limitations ^(b)	Population: people with total hip replacement on the NJR in 2012 Design: cohort model comparing follow up strategies Strategies: (1) Old BOA follow up guidelines ^(c) (2) New BOA follow up guidelines ^(d)	(2-1): Follow up under the new BOA guidelines is more expensive by £350 per patient.	Not applicable	Not applicable	95% confidence intervals are reported for the total number of appointments required and the estimated total costs.

3 Abbreviations: BOA: British Orthopaedic Association

4 (a) A cost comparison with a UK NHS perspective which looks at the costs of 2 strategies with different quantities of follow-ups required. No QALYs.

5 (b) No inclusion of quality of life or other health outcomes; not all relevant costs are included as the costs of revision and other subsequent care were excluded Uses
6 observational data that is not included in the clinical review.

7 (c) Follow up at 1, 5 and each subsequent 5 years after operation (previous BOA guideline)

8 (d) For ODEP 10a- rated combinations: follow up in the first year, at 7 years and 3 yearly thereafter in asymptomatic patients; For non ODEP 10a- rated combinations: follow
9 up usually for the first 5 years, 2-yearly to 10 years and 3-yearly thereafter; patients over 75 years with ODEP 10a implants need not be routinely reviewed after the post-
10 operative period (new BOA guidelines)
11

12

1.5.4 1 Unit costs

2 Relevant unit costs are provided below to aid consideration of cost effectiveness.

3 **Table 3: Unit costs for hospital based professionals who may conduct follow up** 4 **appointments**

Hospital based profession	Pay Band	Cost per working hour
Occupational therapist/Physiotherapist	4-8b	£30-77
Nurse	4-8a	£28-62
Consultant surgeon	n/a	£107

5 *Source: PSSRU 2017¹³*

6 **Table 4: Unit costs for an X-ray**

Description	Unit cost
Direct access plain film X-ray	£25

7 *Source: National Tariff Workbook 2016/17⁴⁵*

1.6 8 Evidence statements

1.6.1 9 Clinical evidence statements

10 No clinical evidence was identified.

1.6.2 1 Health economic evidence statements

12 One comparative cost analysis showed that follow up after total hip replacement based on
13 the ODEP implant rating to be more expensive per person (£350 more per person) than
14 follow up of all implant types in the 1st and 7th year and then 3-yearly thereafter. This analysis
15 was assessed as partially applicable with potentially serious limitations.

1.7 16 The committee's discussion of the evidence

1.7.1 17 Interpreting the evidence

1.7.1.1 18 The outcomes that matter most

19 The critical outcomes include emergency reoperation and life expectancy. With 3 other
20 critical outcomes divided into short- and long-term time points: quality of life, patient reported
21 outcome measures (PROMs) and reoperation. Function and pain would be extracted if not
22 included in a PROM. The most critical outcome was emergency reoperation, and this was
23 designed to pick up follow-up regimens that do not notice people's increased pain,
24 decreased function or asymptomatic complications to the point that an emergency
25 reoperation is required. An ideal follow-up programme would facilitate well-timed revisions
26 based on implant failure that cause people as little pain, reduced function and reduced
27 quality of life as possible. Subjective outcomes that assess how people find the whole joint
28 replacement surgery experience including the effects of follow-up were quality of life and
29 PROMs. The 2 time points were to highlight 2 distinctive periods in the existence of a joint
30 replacement. Within the first 2 years, the appointments exist to assess whether function is
31 improving to the level expected after surgery, to assess if pain has reduced from the raised
32 level in the post-surgical period, and to monitor the occurrence of adverse events. Recovery

1 after hip, knee and shoulder joint replacement has been demonstrated to stabilise and
2 plateau within 2 years. The longer follow-up period still assesses pain and function as an
3 indicator to how the joint replacement is working on an ongoing basis and a plain
4 radiographic assessment of the joint may also be needed to evaluate the position and
5 stability in the joint.

1.7.1.2 6 The quality of the evidence

7 No relevant clinical studies were found for this question.

1.7.1.3 8 Benefits and harms

9 Follow-up varies greatly across the NHS. A committee member indicated that his centre
10 gives people 2 standard post-hospital discharge appointments with the orthopaedic team.
11 The first at 2 weeks and the second at 8 weeks; people are then discharged from
12 orthopaedic care if there are no complications at that point. These appointments are largely
13 intended to evaluate the person's has recovered from the operation and how the wound is
14 healing. It also provides an indication as to whether further rehabilitation is needed to
15 promote recovery. No regular monitoring appointments with the orthopaedic team happen
16 after discharge from orthopaedic care. However, other centres offer regular follow-up
17 appointments based various factors such as the joint being replaced and the Orthopaedic
18 Data Evaluation Panel (ODEP) rating of the implant. These appointments could be ongoing
19 for many years.

20 The committee discussed arguments for and against regular follow-up appointments. The
21 arguments against are that they may well be unnecessary as people tend to do well after
22 joint replacement surgery and they might seem like an imposition on their time. In addition, if
23 they are not necessary and people gain no benefit from them then it could be a cost-saving
24 not to schedule them in. However there are arguments they do have a role to play, one
25 strong benefit of these appointments is the discovery of asymptomatic complications such as
26 bone lysis (osteolysis) that may only be discovered prior to the necessity of revision surgery
27 by scheduled follow-up appointments. It is possible these complications, if not spotted, could
28 lead to very negative outcomes including fracture if left unchecked. However, asymptomatic
29 complications are rare and it is unclear if follow-up appointments on their basis are cost-
30 effective. A committee member spoke about their for those people who would not feel
31 comfortable highlighting their difficulties to the GP. These appointments are then a safety net
32 that would notice people who are in pain or have poor function and are not able or willing to
33 get access to orthopaedic help outside of the scheduled appointments. People might feel
34 abandoned if, after a number of years post-surgery, they have not interacted with the
35 orthopaedic team for some time. In addition, follow-up appointments may encourage people
36 to keep up with the important functional targets and doing regular activities, such as exercise,
37 to keep the joint working well. It was suggested that having scheduled follow up
38 appointments period might encourage long term engagement with rehabilitation and other
39 beneficial ways of living, but this is speculative.

40 There was some committee discussion on who would carry out the follow-up appointments.
41 The committee were disappointed there was no evidence for primary care services including
42 community physiotherapy and general practice to offer routine monitoring of people after joint
43 replacement surgery. This may take the burden off acute services while also providing
44 reassurance to people. It was acknowledged that training and support may be required for
45 such a service to be provided, but the current evidence base does not provide information on
46 such care providers.

47 The committee spoke about methods of surveillance appointments that could be used. Tele-
48 monitoring is an option which might use video calls or telephone consultations. This may be

1 a particularly valuable approach for people who live in more rural settings or those who face
2 difficulties in getting to health services. The committee acknowledged that some operations
3 are performed in specialist centres that may be many miles from the person's home. Such
4 remote monitoring may be valuable in that instance to reduce the inconvenience people face,
5 while also providing the specialist consultation and surgical continuity from their health care
6 providers.

7 One option that does not replace the importance of regular follow-up appointments but could
8 complement them, is patient-directed follow-up. This approach is for people to be able to go
9 to a GP, physiotherapist, or occupational therapist and be referred back to the orthopaedic
10 team.

11 The committee decided to recommend this as it means that the people the orthopaedic team
12 are seeing those who are developing new or worsening pain, limp or loss of function related
13 to their joint prosthesis rather than the majority of people who are living well with the joint
14 replacement. The committee agreed there are advantages and disadvantages to patient-
15 directed follow-up. Joint replacements can fail early, midterm, or indeed last for many years
16 and patient-directed follow-up would be active in all these periods to pick up people in
17 difficulty. Thus, people would be able to gain a referral if required and would not wait long
18 periods for the next monitoring appointment. Disadvantages are that asymptomatic
19 complications would only be picked up if discovered via a referral for a different symptomatic
20 problem and the requirement to self-refer may give a feeling of being abandonment by the
21 health care system.

22 As no evidence was found, the committee decided not to alter current practice. There are
23 British Orthopaedic Association (BOA) guidelines on long-term follow-up after total hip
24 replacement. These were drafted from expert consensus and lower-level evidence. The
25 committee did not feel that it would override this consensus with its own consensus given the
26 lack of evidence.

27 The committee considered people who may find accessing healthcare more challenging
28 through cognitive impairment, comorbidities, or difficulties with activities of daily living. The
29 committee felt that currently, a person's carer, family member or friend is often a good judge
30 to indicate whether, in everyday life, the individual's joint pain or function has changed. Thus
31 the person's carer, family member or friend could accompany them to the GP,
32 physiotherapist, or occupational therapist appointment and highlight the situation if it is
33 unclear. It was therefore felt that no adaptation was required for the guidelines for this
34 population.

35 The recommendation that monitoring is patient-led provides flexibility but also a pathway for
36 people to seek assessment when required. This is not be limited by patient characteristics
37 and is available to all people who have had joint replacement surgery. Clinical decision-
38 making may determine that people may follow differing follow-up pathways depending on
39 complications and technicalities in the surgery or person's presentation. However, the
40 recommendation is based on a minimal expectation. No evidence was found suggesting at-
41 risk subgroups of people who need greater or lesser levels of surveillance.

1.7.242 Cost effectiveness and resource use

43 One health economic study was included in this review that was a cost comparison of the old
44 and new British Orthopaedic Association (BOA) hip replacement follow-up guidelines. The
45 study was limited, as it did not include health outcomes or costs outside of the actual follow-
46 up sessions. After discussing the evidence, the committee agreed that one of the papers
47 originally presented to the committee should be excluded given that the intervention effects
48 were taken from a single Swedish observational study, and there were unreasonably large
49 assumptions about using the same utility values over the time horizon. The UK SAFE study,

1 due to be completed in the near future, will contain a Markov model which should provide an
2 insight into the cost-effectiveness of follow-up strategy for hip and knee replacements but not
3 shoulder replacements.

4 Current practice is difficult to define for the different sites of surgery. The BOA only has
5 follow-up guidelines published for total hip replacement procedures although the committee
6 acknowledged that these are not always adhered to. It seems that current practice is variable
7 in accordance with local decision-making. A few committee members discussed that
8 screening on a regular basis for all joint replacements to pick up problems in a low
9 percentage of people would be unlikely to be cost effective. No recommendation could made
10 for regular follow-ups for the entire joint replacement population as this would be costly and
11 resource intensive, furthermore there is no evidence to say that this would be clinically
12 effective.

13 However, the committee also agreed that it would be bad practice not to provide follow-up
14 sessions to people who experience new or worsening pain, limp or loss of function after their
15 joint replacement. Approximately 20% of people experience ongoing pain after their knee
16 replacement surgery. This would be the maximum proportion referred for follow-up. In areas
17 where referral for those who experience new or worsening pain is current practice, the
18 recommendation will not have any resource impact. However for other areas where it is not
19 current practice, there may be a resource impact from an increase in referrals.

1.7.30 Other factors the committee took into account

21 The National Institute for Health Research (NIHR) Leeds Musculoskeletal Biomedical
22 Research Unit is currently undertaking the UK SAFE: UK post Arthroplasty Follow-up
23 recommendations project. It is a multi-layered study aimed to investigate the curtailing
24 primary hip and knee arthroplasty follow-up services to deal with growing financial pressure.
25 The aim of this is to examine the requirements for joint replacement follow-up and produce
26 evidence and consensus-based recommendations as to how, when and on whom follow-up
27 should be conducted. It does this through a systematic literature review, a retrospective
28 cohort study that uses large national data sets including the Hospital Episode Statistics
29 (HES) and the National Joint Registry (NJR), a prospective study investigating follow-up
30 routines, a health economic analysis and Markov model utilising the data they find and create
31 in the other investigative strands, and a Delphi consensus study involving 25-30 participants
32 including patients, surgeons, GPs, and commissioners.

33 This project should lead to more nuanced recommendations on follow-up in people after hip
34 and knee arthroplasty. This leaves a hole in the research around shoulder joint replacement;
35 therefore, the committee decided to make a research recommendation for people having
36 shoulder replacement surgery.

37

38

39

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1 Appendices

2 Appendix A: Review protocols

3 Table 5: Review protocol: long-term monitoring

ID	Field	Content
0.	PROSPERO registration number	Not registered
1.	Review title	Long-term monitoring after joint replacement surgery
2.	Review question	<p>In adults having primary elective joint replacement, what would be the optimal timing of follow-up or surveillance appointments?</p> <p>In adults having primary elective joint replacement, who should carry out follow-up or surveillance appointments?</p> <p>In adults having primary elective joint replacement, should x-rays be undertaken for all follow-up or surveillance appointments?</p>
3.	Objective	<p>It is currently unclear what the most effective monitoring strategy is for people who have had joint replacement surgery. There are a number of variables in this practice: how often and for what length of time should someone should be monitored, who should undertake the monitoring appointments and whether this should change over time after surgery, and whether x-rays should be undertaken for each appointment.</p> <p>The role of these appointments change. In the first 2 years after surgery, the appointments exist to assess whether function is improving to the level expected after joint replacement, to assess if pain has reduced from the raised level in the post-surgical period, and to monitor the occurrence of adverse events. After 2 years, the benefits of joint replacement are likely to have plateaued. Pain and function would still be monitored and addressed with an assessment of whether the joint replacement should be revised.</p> <p>In addition, these appointments could assess the presence of asymptomatic complications, for example bone lysis; x-rays are required for this assessment.</p> <p>This review seeks to find the most effective follow-up or surveillance strategy. It also seeks to establish when someone should be discharged from orthopaedic care. This would be indicated through the strategy in terms of who should carry out follow-up or surveillance appointments. If the strategy indicates someone outside the orthopaedic team would carry out the follow-up or surveillance appointments, then this would also indicate that it is possible to discharge the person from orthopaedic care at that time.</p>
4.	Searches	<p>The following databases will be searched:</p> <p>Cochrane Central Register of Controlled Trials (CENTRAL)</p>

ID	Field	Content
		<p>Cochrane Database of Systematic Reviews (CDSR) Embase MEDLINE</p> <p>Searches will be restricted by: English language Human studies Letters and comments are excluded.</p> <p>Other searches: Inclusion lists of relevant systematic reviews will be checked by the reviewer.</p> <p>The searches may be re-run 6 weeks before final committee meeting and further studies retrieved for inclusion if relevant.</p> <p>The full search strategies will be published in the final review.</p>
5.	Condition or domain being studied	Primary elective shoulder joint replacement surgery
6.	Population	<p>Inclusion: Adults who have undergone primary hip, knee or shoulder joint replacement.</p> <p>Exclude studies including people meeting any of the following criteria: Adults having joint replacement as immediate treatment following fracture Adults having revision joint replacement. Adults having joint replacement as treatment for primary or secondary cancer affecting the bones.</p>
7.	Intervention/Exposure/Test	<p>Follow up/surveillance strategy</p> <p>Interventions to be separated by: Different time points starting from initial follow-up /surveillance appointment</p>

ID	Field	Content
		The healthcare professionals carrying out the follow-up /surveillance appointments, for example, member of the orthopaedic team, GP or physiotherapist. Whether routine x-rays are utilised for each follow-up /surveillance monitoring appointment.
8.	Comparator/Reference standard/Confounding factors	Comparison of interventions
9.	Types of study to be included	Systematic reviews RCTs If no well-conducted RCTs are available, then observational studies with multivariate analysis will be investigated.
10.	Other exclusion criteria	Non-English language studies. Abstracts will be excluded as it is expected there will be sufficient full text published studies available.
11.	Context	N/A
12.	Primary outcomes (critical outcomes)	Emergency reoperation (dichotomous) Mortality: life expectancy (time to event) Quality of life at 2 years after surgery, at the longest time point (at least 4 years after surgery) (continuous) Patient Reported Outcome Measures (PROMs) at 2 years after surgery, at the longest time point (at least 4 years after surgery; continuous) Reoperation (including revision) at 2 years after surgery, at the longest time point (at least 4 years after surgery; dichotomous)
13.	Secondary outcomes (important outcomes)	To be extracted when not included within an extracted PROM: Function at 6 weeks or earlier, later than 6 weeks up to 1 year, at least 2 years (continuous) Pain at 6 weeks or earlier, later than 6 weeks up to 1 year, at least 2 years (continuous)
14.	Data extraction (selection and coding)	EndNote will be used for reference management, sifting, citations and bibliographies. Titles and/or abstracts of studies retrieved using the search strategy and those from additional sources will be screened for inclusion. The full text of potentially eligible studies will be retrieved and will be assessed for eligibility in line with the criteria outlined above. 10% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer.

ID	Field	Content
		<p>An in-house developed database; EviBase, will be used for data extraction. A standardised form is followed to extract data from studies (see Developing NICE guidelines: the manual section 6.4) and for undertaking assessment of study quality. Summary evidence tables will be produced including information on: study setting; study population and participant demographics and baseline characteristics; details of the intervention and control interventions; study methodology' recruitment and missing data rates; outcomes and times of measurement; critical appraisal ratings.</p> <p>A second reviewer will quality assure the extracted data. Discrepancies will be identified and resolved through discussion (with a third reviewer where necessary).</p>
15.	Risk of bias (quality) assessment	<p>Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual. For Intervention reviews the following checklist will be used according to study design being assessed: Systematic reviews: Risk of Bias in Systematic Reviews (ROBIS) Randomised Controlled Trial: Cochrane RoB (2.0)</p> <p>Disagreements between the review authors over the risk of bias in particular studies will be resolved by discussion, with involvement of a third review author where necessary.</p>
16.	Strategy for data synthesis	<p>Where possible, data will be meta-analysed. Pairwise meta-analyses will be performed using Cochrane Review Manager (RevMan5) to combine the data given in all studies for each of the outcomes stated above. A fixed effect meta-analysis, with weighted mean differences for continuous outcomes and risk ratios for binary outcomes will be used, and 95% confidence intervals will be calculated for each outcome.</p> <p>Heterogeneity between the studies in effect measures will be assessed using the I² statistic and visually inspected. We will consider an I² value greater than 50% indicative of substantial heterogeneity. Sensitivity analyses will be conducted based on pre-specified subgroups using stratified meta-analysis to explore the heterogeneity in effect estimates. If this does not explain the heterogeneity, the results will be presented using random-effects.</p> <p>GRADE pro will be used to assess the quality of each outcome, taking into account individual study quality and the meta-analysis results. The 4 main quality elements (risk of bias, indirectness, inconsistency and imprecision) will be appraised for each outcome.</p> <p>If the population included in an individual study includes children aged under 12, it will be included if the majority of the population is aged over 12, and downgraded for indirectness if the overlap into those aged less than 12 is greater than 20%.</p> <p>Publication bias is tested for when there are more than 5 studies for an outcome.</p>

ID	Field	Content		
		Other bias will only be taken into consideration in the quality assessment if it is apparent. Where meta-analysis is not possible, data will be presented and quality assessed individually per outcome. If sufficient data is available to make a network of treatments, WinBUGS will be used for network meta-analysis.		
17.	Analysis of sub-groups	Site of joint replacement: knee, shoulder, hip Age: working age, above working age Appointments type: virtual, in person Grade /experience of team member undertaking review Implant rating: ODEP <10a, ODEP ≥10aAge		
18.	Type and method of review	<input checked="" type="checkbox"/> Intervention		
		<input type="checkbox"/> Diagnostic		
		<input type="checkbox"/> Prognostic		
		<input type="checkbox"/> Qualitative		
		<input type="checkbox"/> Epidemiologic		
		<input type="checkbox"/> Service Delivery		
		<input type="checkbox"/> Other (please specify)		
19.	Language	English		
20.	Country	England		
21.	Anticipated or actual start date	16/03/19		
22.	Anticipated completion date	20/03/20		
23.	Stage of review at time of this submission	Review stage	Started	Completed
		Preliminary searches	<input checked="" type="checkbox"/>	<input type="checkbox"/>
		Piloting of the study selection process	<input checked="" type="checkbox"/>	<input type="checkbox"/>
		Formal screening of search results against eligibility criteria	<input type="checkbox"/>	<input type="checkbox"/>

ID	Field	Content
		Data extraction <input type="checkbox"/>
		Risk of bias (quality) assessment <input type="checkbox"/>
		Data analysis <input type="checkbox"/>
24.	Named contact	<p>5a. Named contact National Guideline Centre</p> <p>5b Named contact e-mail Headches@nice.org.uk</p> <p>5e Organisational affiliation of the review National Institute for Health and Care Excellence (NICE) and the National Guideline Centre</p>
25.	Review team members	<p>From the National Guideline Centre:</p> <p>Carlos Sharpin [Guideline lead] Alex Allen [Senior Systematic Reviewer] Rafina Yarde [Systematic reviewer] Robert King [Health economist] Agnès Cuyàs [Information specialist] Eleanor Priestnall [Project Manager]</p>
26.	Funding sources/sponsor	This systematic review is being completed by the National Guideline Centre which receives funding from NICE.
27.	Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.
28.	Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the

ID	Field	Content
		development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: [NICE guideline webpage].
29.	Other registration details	
30.	Reference/URL for published protocol	
31.	Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: notifying registered stakeholders of publication publicising the guideline through NICE's newsletter and alerts issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.
32.	Keywords	Joint replacement surgery, arthroplasty, surveillance, monitoring,
33.	Details of existing review of same topic by same authors	N/A
34.	Current review status	<input checked="" type="checkbox"/> Ongoing
		<input type="checkbox"/> Completed but not published
		<input type="checkbox"/> Completed and published
		<input type="checkbox"/> Completed, published and being updated
		<input type="checkbox"/> Discontinued
35..	Additional information	N/A
36.	Details of final publication	www.nice.org.uk

1 **Table 6: Health economic review protocol**

Review question	All questions – health economic evidence
Objectives	To identify health economic studies relevant to any of the review questions.
Search criteria	<ul style="list-style-type: none"> • Populations, interventions and comparators must be as specified in the clinical review protocol above. • Studies must be of a relevant health economic study design (cost–utility analysis, cost-effectiveness analysis, cost–benefit analysis, cost–consequences analysis, comparative cost analysis). • Studies must not be a letter, editorial or commentary, or a review of health economic evaluations. (Recent reviews will be ordered although not reviewed. The bibliographies will be checked for relevant studies, which will then be ordered.) • Unpublished reports will not be considered unless submitted as part of a call for evidence. • Studies must be in English.
Search strategy	A health economic study search will be undertaken using population-specific terms and a health economic study filter – see appendix B below.
Review strategy	<p>Studies not meeting any of the search criteria above will be excluded. Studies published before 2003, abstract-only studies and studies from low or middle-income countries (for example, most non-OECD countries) or the USA will also be excluded.</p> <p>Each remaining study will be assessed for applicability and methodological limitations using the NICE economic evaluation checklist which can be found in appendix H of Developing NICE guidelines: the manual (2014).⁴⁴</p> <p>Inclusion and exclusion criteria</p> <ul style="list-style-type: none"> • If a study is rated as both ‘Directly applicable’ and with ‘Minor limitations’, then it will be included in the guideline. A health economic evidence table will be completed and it will be included in the health economic evidence profile. • If a study is rated as either ‘Not applicable’ or with ‘Very serious limitations’, then it will usually be excluded from the guideline. If it is excluded then a health economic evidence table will not be completed and it will not be included in the health economic evidence profile. • If a study is rated as ‘Partially applicable’ with ‘Potentially serious limitations’ or both, then there is discretion over whether it should be included. <p>Where there is discretion</p> <p>The health economist will make a decision based on the relative applicability and quality of the available evidence for that question, in discussion with the guideline committee if required. The ultimate aim is to include health economic studies that are helpful for decision-making in the context of the guideline and the current NHS setting. If several studies are considered of sufficiently high applicability and methodological quality that they could all be included, then the health economist, in discussion with the committee if required, may decide to include only the most applicable studies and to exclude selectively the remaining studies. All studies excluded based on applicability or methodological limitations will be listed with explanation in the excluded health economic studies appendix below.</p> <p>The health economist will be guided by the following hierarchies.</p> <p><i>Setting:</i></p> <ul style="list-style-type: none"> • UK NHS (most applicable). • OECD countries with predominantly public health insurance systems (for example, France, Germany, Sweden). • OECD countries with predominantly private health insurance systems (for example,

	<p>Switzerland).</p> <ul style="list-style-type: none">• Studies set in non-OECD countries or in the USA will be excluded before being assessed for applicability and methodological limitations. <p><i>Health economic study type:</i></p> <ul style="list-style-type: none">• Cost–utility analysis (most applicable).• Other type of full economic evaluation (cost–benefit analysis, cost-effectiveness analysis, cost–consequences analysis).• Comparative cost analysis.• Non-comparative cost analyses including cost-of-illness studies will be excluded before being assessed for applicability and methodological limitations. <p><i>Year of analysis:</i></p> <ul style="list-style-type: none">• The more recent the study, the more applicable it will be.• Studies published in 2003 or later but that depend on unit costs and resource data entirely or predominantly before 2003 will be rated as 'Not applicable'.• Studies published before 2003 will be excluded before being assessed for applicability and methodological limitations. <p><i>Quality and relevance of effectiveness data used in the health economic analysis:</i></p> <ul style="list-style-type: none">• The more closely the clinical effectiveness data used in the health economic analysis match with the outcomes of the studies included in the clinical review the more useful the analysis will be for decision-making in the guideline.
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1 Appendix B: Literature search strategies

2 The literature searches for this review are detailed below and complied with the methodology
3 outlined in Developing NICE guidelines: the manual.⁴⁴

4 *For more detailed information, please see the Methodology Review.*

B.1.5 Clinical search literature search strategy

6 Searches were constructed using a PICO framework where population (P) terms were
7 combined with Intervention (I) and in some cases Comparison (C) terms. Outcomes (O) are
8 rarely used in search strategies for interventions as these concepts may not be well
9 described in title, abstract or indexes and therefore difficult to retrieve. Search filters were
10 applied to the searches where appropriate.

11 **Table 7: Database date parameters and filters used**

Database	Dates searched	Search filter used
Medline (OVID)	1946 – 01 May 2019	Exclusions Randomised controlled trials Systematic review studies Observational studies
Embase (OVID)	1974 – 01 May 2019	Exclusions Randomised controlled trials Systematic review studies Observational studies
The Cochrane Library (Wiley)	Cochrane Reviews to 2019 Issue 5 of 12 CENTRAL to 2019 Issue 5 of 12	None

12 Medline (Ovid) search terms

1.	arthroplasty/ or arthroplasty, replacement/ or arthroplasty, replacement, hip/ or arthroplasty, replacement, knee/ or arthroplasty, replacement, shoulder/ or hemiarthroplasty/
2.	joint prosthesis/ or hip prosthesis/ or knee prosthesis/ or shoulder prosthesis/
3.	((joint* or knee* or shoulder* or hip*) adj5 (surger* or replace* or prosth* or endoprosth* or implant* or artificial or arthroplast* or hemiarthroplast*)).ti,ab.
4.	or/1-3
5.	letter/
6.	editorial/
7.	news/
8.	exp historical article/
9.	Anecdotes as Topic/
10.	comment/
11.	case report/
12.	(letter or comment*).ti.
13.	or/5-12
14.	randomized controlled trial/ or random*.ti,ab.
15.	13 not 14
16.	animals/ not humans/

17.	exp Animals, Laboratory/
18.	exp Animal Experimentation/
19.	exp Models, Animal/
20.	exp Rodentia/
21.	(rat or rats or mouse or mice).ti.
22.	or/15-21
23.	4 not 22
24.	limit 23 to English language
25.	Monitoring, physiologic/
26.	(monitoring or followup or follow up or surveillance).ti.
27.	((followup or follow* up or surveillance or monitor*) adj2 (strateg* or program* or regular* or routine* or periodic* or schedul* or frequen* or timing or long term or longterm or services)).ti,ab.
28.	((followup or follow* up or surveillance or monitoring) adj2 (specialist* or physician* or nurse* or surgeon* or general practi* or GP or family practi* or doctor or orthopaedic or physiotherapist*)).ti,ab.
29.	((followup or follow* up or surveillance or monitoring) adj2 (x-ray* or xray* or x-radiation* or xradiation* or roentgen ray* or radiograph*)).ti,ab.
30.	or/25-29
31.	24 and 30
32.	randomized controlled trial.pt.
33.	controlled clinical trial.pt.
34.	randomi#ed.ti,ab.
35.	placebo.ab.
36.	randomly.ti,ab.
37.	Clinical Trials as topic.sh.
38.	trial.ti.
39.	or/32-38
40.	Meta-Analysis/
41.	exp Meta-Analysis as Topic/
42.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
43.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
44.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
45.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
46.	(search* adj4 literature).ab.
47.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
48.	cochrane.jw.
49.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
50.	or/40-49
51.	Epidemiologic studies/
52.	Observational study/
53.	exp Cohort studies/
54.	(cohort adj (study or studies or analys* or data)).ti,ab.
55.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.

56.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
57.	Controlled Before-After Studies/
58.	Historically Controlled Study/
59.	Interrupted Time Series Analysis/
60.	(before adj2 after adj2 (study or studies or data)).ti,ab.
61.	or/51-60
62.	exp case control study/
63.	case control*.ti,ab.
64.	or/62-63
65.	61 or 64
66.	Cross-sectional studies/
67.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
68.	or/66-67
69.	61 or 68
70.	61 or 64 or 68
71.	31 and (39 or 50 or 70)

1 Embase (Ovid) search terms

1.	*arthroplasty/ or *replacement arthroplasty/ or *hip replacement/ or *knee replacement/ or *shoulder replacement/ or *hemiarthroplasty/
2.	*joint prosthesis/ or *hip prosthesis/ or *knee prosthesis/ or *shoulder prosthesis/
3.	((joint* or knee* or shoulder* or hip*) adj5 (surger* or replace* or prosthe* or endopros* or implant* or artificial or arthroplast* or hemiarthroplast*)).ti,ab.
4.	or/1-3
5.	letter.pt. or letter/
6.	note.pt.
7.	editorial.pt.
8.	case report/ or case study/
9.	(letter or comment*).ti.
10.	or/5-9
11.	randomized controlled trial/ or random*.ti,ab.
12.	10 not 11
13.	animal/ not human/
14.	nonhuman/
15.	exp Animal Experiment/
16.	exp Experimental Animal/
17.	animal model/
18.	exp Rodent/
19.	(rat or rats or mouse or mice).ti.
20.	or/12-19
21.	4 not 20
22.	limit 21 to English language
23.	patient monitoring/
24.	(monitoring or followup or follow up or surveillance).ti.
25.	((followup or follow* up or surveillance or monitor*) adj2 (strateg* or program* or regular* or routine* or periodic* or schedul* or frequen* or timing or long term or

	longterm or services)).ti,ab.
26.	((followup or follow* up or surveillance or monitoring) adj2 (specialist* or physician* or nurse* or surgeon* or general practi* or GP or family practi* or doctor or orthopaedic or physiotherapist*)).ti,ab.
27.	((followup or follow* up or surveillance or monitoring) adj2 (x-ray* or xray* or x-radiation* or xradiation* or roentgen ray* or radiograph*)).ti,ab.
28.	or/23-27
29.	22 and 28
30.	random*.ti,ab.
31.	factorial*.ti,ab.
32.	(crossover* or cross over*).ti,ab.
33.	((doubl* or singl*) adj blind*).ti,ab.
34.	(assign* or allocat* or volunteer* or placebo*).ti,ab.
35.	crossover procedure/
36.	single blind procedure/
37.	randomized controlled trial/
38.	double blind procedure/
39.	or/30-38
40.	systematic review/
41.	meta-analysis/
42.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
43.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
44.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
45.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
46.	(search* adj4 literature).ab.
47.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
48.	cochrane.jw.
49.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
50.	or/40-49
51.	Clinical study/
52.	Observational study/
53.	family study/
54.	longitudinal study/
55.	retrospective study/
56.	prospective study/
57.	cohort analysis/
58.	follow-up/
59.	cohort*.ti,ab.
60.	58 and 59
61.	(cohort adj (study or studies or analys* or data)).ti,ab.
62.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
63.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
64.	(before adj2 after adj2 (study or studies or data)).ti,ab.

65.	or/51-57,60-64
66.	exp case control study/
67.	case control*.ti,ab.
68.	or/66-67
69.	65 or 68
70.	cross-sectional study/
71.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
72.	or/70-71
73.	65 or 72
74.	65 or 68 or 72
75.	29 and (39 or 50 or 74)

1 Cochrane Library (Wiley) search terms

#1.	MeSH descriptor: [Arthroplasty] this term only
#2.	MeSH descriptor: [Arthroplasty, Replacement] this term only
#3.	MeSH descriptor: [Arthroplasty, Replacement, Hip] this term only
#4.	MeSH descriptor: [Arthroplasty, Replacement, Knee] this term only
#5.	MeSH descriptor: [Arthroplasty, Replacement, Shoulder] this term only
#6.	MeSH descriptor: [Hemiarthroplasty] this term only
#7.	(or #1-#6)
#8.	MeSH descriptor: [Joint Prosthesis] this term only
#9.	MeSH descriptor: [Hip Prosthesis] this term only
#10.	MeSH descriptor: [Knee Prosthesis] this term only
#11.	MeSH descriptor: [Shoulder Prosthesis] this term only
#12.	(or #8-#11)
#13.	((joint* or knee* or shoulder* or hip*) near/5 (surger* or replace* or prosth* or endoprosth* or implant* or artificial or arthroplast* or hemiarthroplast*)):ti,ab
#14.	(or #7, #12-#13)
#15.	MeSH descriptor: [Monitoring, Physiologic] this term only
#16.	(monitoring or followup or follow up or surveillance):ti
#17.	((followup or follow* up or surveillance or monitor*) near/2 (strateg* or program* or regular* or routine* or periodic* or schedul* or frequen* or timing or long term or longterm or services)):ti,ab
#18.	((followup or follow* up or surveillance or monitoring) near/2 (specialist* or physician* or nurse* or surgeon* or general practi* or GP or family practi* or doctor or orthopaedic or physiotherapist*)):ti,ab
#19.	((followup or follow* up or surveillance or monitoring) near/2 (x-ray* or xray* or x-radiation* or xradiation* or roentgen ray* or radiograph*)):ti,ab
#20.	(OR #15-#19)
#21.	#14 AND #20

B.2.2 Health Economics literature search strategy

3 Health economic evidence was identified by conducting a broad search relating to joint
4 replacement population in NHS Economic Evaluation Database (NHS EED – this ceased to
5 be updated after March 2015) and the Health Technology Assessment database (HTA) with
6 no date restrictions. NHS EED and HTA databases are hosted by the Centre for Research
7 and Dissemination (CRD). Additional health economics searches were run in Medline and
8 Embase.

1 **Table 8: Database date parameters and filters used**

Database	Dates searched	Search filter used
Medline	2014 – 01 May 2019	Exclusions Health economics studies
Embase	2014 – 01 May 2019	Exclusions Health economics studies
Centre for Research and Dissemination (CRD)	HTA - Inception – 01 May 2019 NHSEED - Inception to March 2015	None

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3 **Medline (Ovid) search terms**

1.	arthroplasty/ or arthroplasty, replacement/ or arthroplasty, replacement, hip/ or arthroplasty, replacement, knee/ or arthroplasty, replacement, shoulder/ or hemiarthroplasty/
2.	joint prosthesis/ or hip prosthesis/ or knee prosthesis/ or shoulder prosthesis/
3.	((joint* or knee* or shoulder* or hip*) adj5 (surger* or replace* or prosthe* or endopros* or implant* or artificial or arthroplast* or hemiarthroplast*)).ti,ab.
4.	or/1-3
5.	letter/
6.	editorial/
7.	news/
8.	exp historical article/
9.	Anecdotes as Topic/
10.	comment/
11.	case report/
12.	(letter or comment*).ti.
13.	or/5-12
14.	randomized controlled trial/ or random*.ti,ab.
15.	13 not 14
16.	animals/ not humans/
17.	exp Animals, Laboratory/
18.	exp Animal Experimentation/
19.	exp Models, Animal/
20.	exp Rodentia/
21.	(rat or rats or mouse or mice).ti.
22.	or/15-21
23.	4 not 22
24.	limit 23 to English language
25.	Economics/
26.	Value of life/
27.	exp "Costs and Cost Analysis"/
28.	exp Economics, Hospital/
29.	exp Economics, Medical/
30.	Economics, Nursing/
31.	Economics, Pharmaceutical/

32.	exp "Fees and Charges"/
33.	exp Budgets/
34.	budget*.ti,ab.
35.	cost*.ti.
36.	(economic* or pharmaco?economic*).ti.
37.	(price* or pricing*).ti,ab.
38.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
39.	(financ* or fee or fees).ti,ab.
40.	(value adj2 (money or monetary)).ti,ab.
41.	or/25-40
42.	24 and 41

1 Embase (Ovid) search terms

1.	*arthroplasty/ or *replacement arthroplasty/ or *hip replacement/ or *knee replacement/ or *shoulder replacement/ or *hemiarthroplasty/
2.	*joint prosthesis/ or *hip prosthesis/ or *knee prosthesis/ or *shoulder prosthesis/
3.	((joint* or knee* or shoulder* or hip*) adj5 (surger* or replace* or prosthe* or endoprosthe* or implant* or artificial or arthroplast* or hemiarthroplast*)).ti,ab.
4.	or/1-3
5.	letter.pt. or letter/
6.	note.pt.
7.	editorial.pt.
8.	case report/ or case study/
9.	(letter or comment*).ti.
10.	or/5-9
11.	randomized controlled trial/ or random*.ti,ab.
12.	10 not 11
13.	animal/ not human/
14.	nonhuman/
15.	exp Animal Experiment/
16.	exp Experimental Animal/
17.	animal model/
18.	exp Rodent/
19.	(rat or rats or mouse or mice).ti.
20.	or/12-19
21.	4 not 20
22.	limit 21 to English language
23.	health economics/
24.	exp economic evaluation/
25.	exp health care cost/
26.	exp fee/
27.	budget/

28.	funding/
29.	budget*.ti,ab.
30.	cost*.ti.
31.	(economic* or pharmaco?economic*).ti.
32.	(price* or pricing*).ti,ab.
33.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
34.	(financ* or fee or fees).ti,ab.
35.	(value adj2 (money or monetary)).ti,ab.
36.	or/23-35
37.	22 and 36

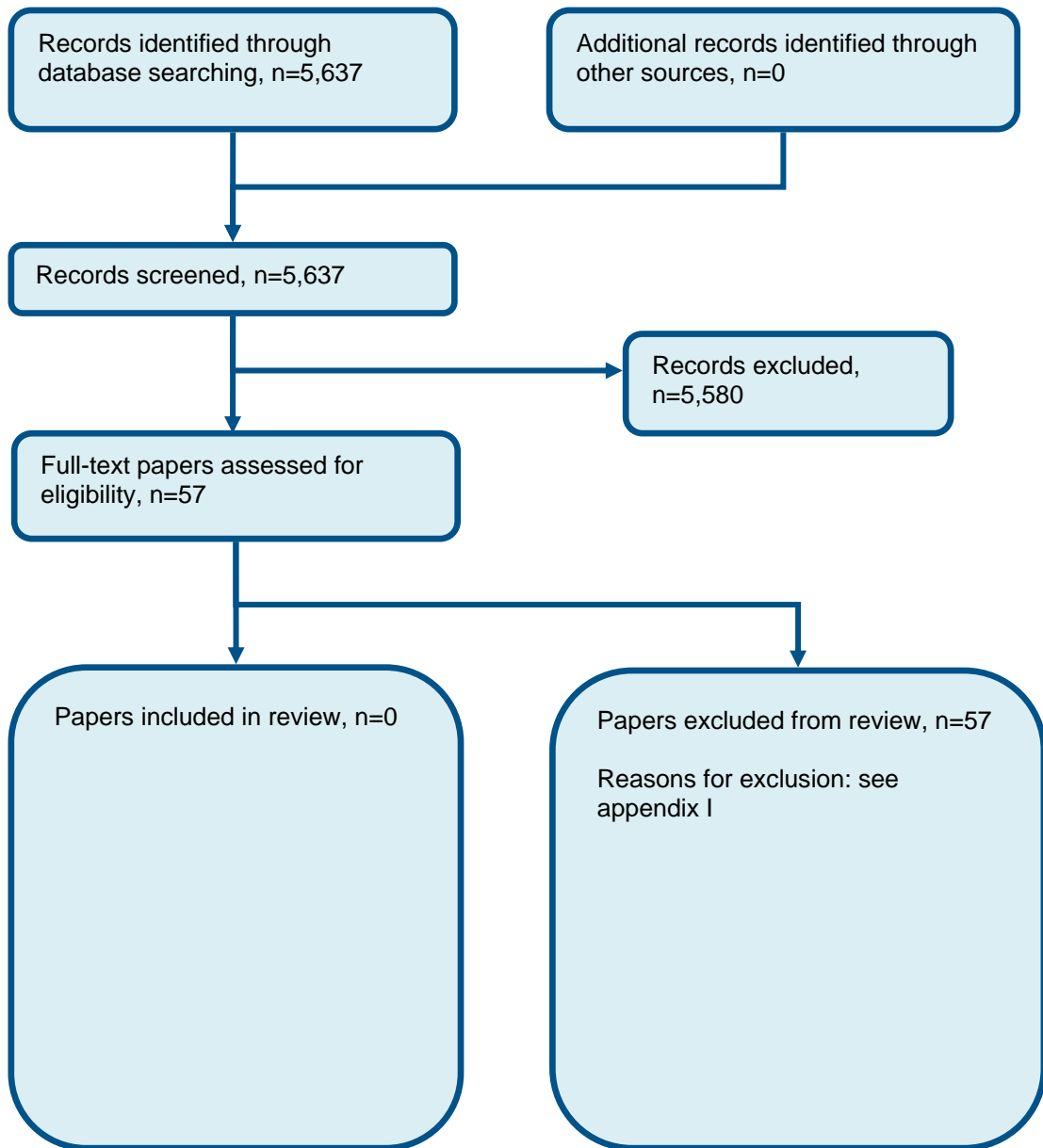
1 NHS EED and HTA (CRD) search terms

#1.	MeSH DESCRIPTOR arthroplasty
#2.	MeSH DESCRIPTOR arthroplasty, replacement
#3.	MeSH DESCRIPTOR arthroplasty, replacement, hip
#4.	MeSH DESCRIPTOR arthroplasty, replacement, knee
#5.	MeSH DESCRIPTOR arthroplasty, replacement, shoulder
#6.	MeSH DESCRIPTOR hemiarthroplasty
#7.	MeSH DESCRIPTOR joint prosthesis
#8.	MeSH DESCRIPTOR hip prosthesis
#9.	MeSH DESCRIPTOR knee prosthesis
#10.	MeSH DESCRIPTOR shoulder prosthesis
#11.	(((joint* or knee* or shoulder* or hip*) adj5 (surger* or replace* or prosthe* or endoproshe* or implant* or artificial or arthroplast* or hemiarthroplast*)))
#12.	(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11) IN NHSEED
#13.	(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11) IN HTA

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1 Appendix C: Clinical evidence selection

Figure 1: Flow chart of clinical study selection for the review of long-term monitoring



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1 **Appendix D: Clinical evidence tables**

2 No clinical evidence was identified.

3 **Appendix E: Forest plots**

4 No clinical evidence was identified.

5 **Appendix F: GRADE tables**

6 No clinical evidence was identified

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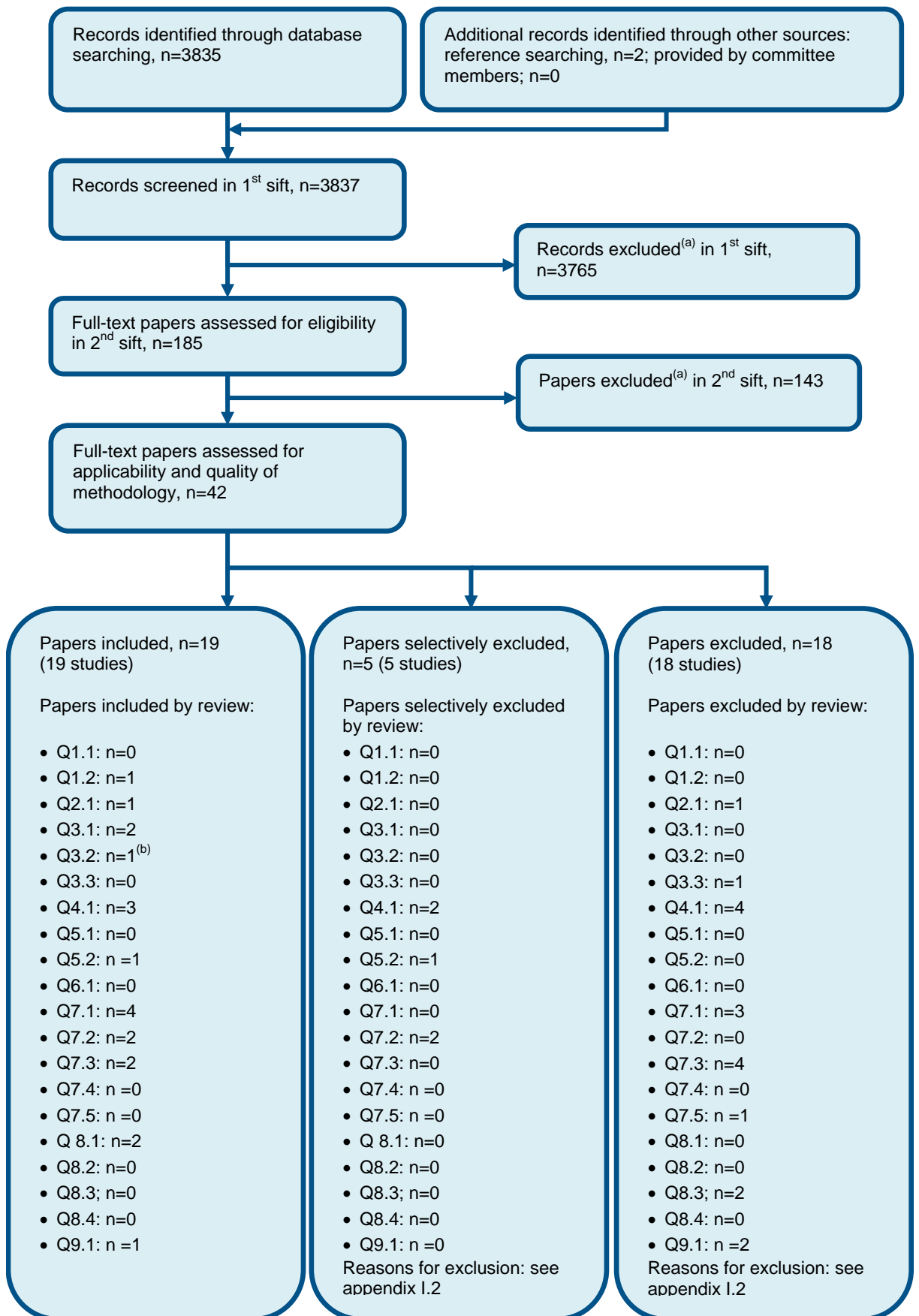
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1 **Appendix G: Health economic evidence** 2 **selection**

Figure 2: Flow chart of health economic study selection for the guideline



a) Non-relevant population, intervention, comparison, design or setting; non-English language
b) One study was applicable to both Q3.1 and Q3.2

Appendix H: Health economic evidence tables

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Study	Roberts 2016 ⁵⁰		
Study details	Population & interventions	Costs	Cost effectiveness
<p>Economic analysis: Comparative costing</p> <p>Study design: Cohort model</p> <p>Approach to analysis: Simple cohort model simulating the costs of the old and new BOA follow up guidelines</p> <p>Perspective: UK NHS perspective</p> <p>Time horizon: Lifetime assuming 16.8 years life expectancy for the mean cohort age</p>	<p>Population: People on the NJR who underwent primary THR in England and Wales in 2012</p> <p>Cohort settings: 74,419 people Mean age: 69.7 for females and 67.2 for males Male: 40%</p> <p>Intervention 1: Follow up at 1, 5 and each subsequent 5 years after operation (previous BOA guideline)</p> <p>Intervention 2: ODEP 10a- rated combination: follow up in the first year, at 7 years and 3 yearly thereafter in asymptomatic patients Non ODEP 10a- rated combination: follow up usually for the first 5 years, 2-yearly to 10 years and 3-yearly thereafter Patients over 75 years with ODEP 10a implants need not be routinely reviewed after the post-operative period (new BOA guidelines)</p>	<p>Total costs (mean per patient): 1: £318 2: £668 (£295 for a 10a implant and £720 for non-10a implant) Incremental (2-1): Intervention 2 costs £350 more per person</p> <p>Currency & cost year: 2014 UK pounds</p> <p>Cost components incorporated: The cost of a follow up appointment in 2012 which was estimated at £83</p>	<p>The overall cost of following up a patient is more expensive under the new BOA guidelines. However, for non-10a implants the new guideline is cheaper.</p> <p>Analysis of uncertainty: 95% confidence intervals were presented for the total number of appointments required and the total cost per arm but not for incremental costs</p>
Data sources	<p>Health outcomes: Only used as part of the baseline cost calculations; cumulative revision rate reported up to 9 years after operation from the NJR 2012 and extrapolated until 16 years by assuming a 0.539% mean annual increase Population: All patients on the NJR who underwent THR in 2012 Cost sources: The 2014/15 National Tariff Payment System. The cost of a single follow up appointment was assumed to be the same as a standard NHS follow up tariff.</p>		
Comments	<p>Source of funding: NR Limitations: No inclusion of quality of life or other health outcomes; not all relevant costs are included as the costs of revision and other subsequent care were excluded. Uses observational data that is not included in the clinical review.</p>		

Overall applicability:^(c) Partially applicable **Overall quality:**^(d) Potentially serious limitations

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- 2 *Abbreviations: BOA: British Orthopaedic Association; NJR: National Joint Registry; NR: not reported; ODEP: Orthopaedic Data Evaluation Panel; THR: total hip replacement*
- 3 *(a) Directly applicable / Partially applicable / Not applicable*
- 4 *(b) Minor limitations / Potentially serious limitations / Very serious limitations*
- 5
- 6

1 Appendix I: Excluded studies

I.1.2 Excluded clinical studies

3 Table 9: Studies excluded from the clinical review

Study	Exclusion reason
Abbas 2018 ¹	Not a comparison of monitoring programs
Aleem 2011 ²	Study investigating compliance with follow-up program
Babcock 1994 ³	Not a comparison of monitoring programs
Balakrishnan 2010 ⁴	Not a comparison of monitoring programs
Berry 2001 ⁵	Review of venous thromboembolic disease after joint replacement
Bhatia 2003 ⁶	Case series rather than a comparison of monitoring strategies
Brothers 1997 ⁸	Not a comparison of monitoring programs
Carothers 2013 ⁹	Not a comparison of monitoring programs
Chaplin 2013 ¹⁰	Not a comparison of monitoring programs
Choi 2015 ¹¹	Incorrect comparison
Clohisy 2008 ¹²	Literature review
De pablo 2006 ¹⁴	Not a comparison of monitoring programs
Friedman 2001 ¹⁵	Study investigating electronic chart review for surveillance
Gioe 2009 ¹⁶	Comparison of patient self-report outcomes and physician reported outcomes
Goggin 2009 ¹⁷	Not a comparison of monitoring programs
Grammatico-guillon 2014 ¹⁸	Not a comparison of monitoring programs
Hacking 2010 ¹⁹	Not a comparison of monitoring programs
Hardoon 2006 ²⁰	Monitoring system for implant brands
Harrison 2009 ²¹	Not a systematic review or primary study
Huang 2017 ²²	Not English language
Huenger 2005 ²³	Not a comparison of monitoring programs
Jacobs 2015 ²⁴	Not a comparison of monitoring programs
Johnston 1973 ²⁵	Non comparative study
Keeney 2012 ²⁶	Study investigating outcomes of routine follow-up
King 2004 ²⁷	Incorrect comparison
Kingsbury 2016 ²⁸	Inappropriate comparison
Large 2014 ²⁹	Not a comparison of long term monitoring
Laumonerie 2017 ³⁰	Systematic review to find the rate of reoperation to inform follow-up
Lonner 1998 ³¹	Case series rather than a comparison of monitoring strategies
Lovelock 2018 ³²	Non comparative study
Lovelock 2018 ³³	Literature review
Low 2016 ³⁴	Not a comparison of monitoring programs
Luzzi 2018 ³⁵	Not a comparison of monitoring programs
Malchau 2008 ³⁶	Literature review
Mannien 2006 ³⁷	Not a comparison of monitoring programs
Marsh 2014 ³⁸	Incorrect comparison
Matharu 2018 ³⁹	Literature review
McGrory 1997 ⁴⁰	Not a comparison of monitoring programs

Study	Exclusion reason
McNeish 2007 ⁴¹	Non comparative study
Meding 2013 ⁴²	Risk factor study
Murray 1997 ⁴³	Incorrect population
Nogaro 2014 ⁴⁶	Not a comparison of monitoring programs
Nunez-Nunez 2018 ⁴⁷	Review of antimicrobial resistance and healthcare-associated infection surveillance across Europe
Park 2016 ⁴⁸	Not review population
Ritter 2002 ⁴⁹	Not a primary study or systematic review
Schneeberger 2002 ⁵¹	Not a comparison of monitoring programs
Schoch 2017 ⁵²	Not a comparison of monitoring programs
Sethuraman 2000 ⁵³	Assessment of people's preference for in person or telephone surveillance appointments
Shah 2018 ⁵⁴	Not a comparison of monitoring programs
Smith 2013 ⁵⁵	Assessment of people's preference for in person or telephone surveillance appointments
Stilling 2010 ⁵⁶	Not a comparison of monitoring programs
Szots 2016 ⁵⁷	Not an investigation of long term monitoring
Toogood 2016 ⁵⁸	Not a comparison of monitoring programs
Troillet 2017 ⁵⁹	Not a comparison of monitoring programs
Veysi 1998 ⁶⁰	Survey of current follow-up practice
Walton 2008 ⁶¹	Non comparative study
Wood 2011 ⁶²	Inappropriate comparison

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I.2.2 Excluded health economic studies

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Study	Exclusion reason
Bolz 2010 ⁷	This study was assessed as partially applicable with very serious limitations as the intervention effects were taken from a single observational study with a 12 month follow up and applied to a 7 year time horizon.
Walton 2008 ⁶¹	This study was assessed as partially applicable with very serious limitations as it relied heavily on assumptions without reasoning

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1 Appendix J: Research recommendations

J.1.2 Follow-up after shoulder replacement

3 **Research question: What is the optimum time between follow-up appointments for**
4 **people who have had shoulder replacement, who should lead follow-up and how this**
5 **should be organised between hospital and community care?**

6 **Why this is important:**

7 While hip, knee and shoulder replacements have demonstrated clinical and cost-
8 effectiveness in improving health-related quality of life for people, complications do occur.
9 These can be short-term, such as within the first 30 days after the operation, or longer-term
10 related to infection, joint loosening or revision. Across the UK there is considerable variability
11 in what mechanisms are used to monitor patients who have had these operations. Some
12 hospital trusts may choose to follow patients up from after their operation, and arrange
13 appointments to clinically and radiologically assess them at different intervals. Others may
14 routinely see their patients at 6 weeks after the operation and then not routinely arrange
15 further follow-up appointments. For these patients, community services and primary care are
16 often the first port of call for identifying and managing complications but this is a reactive
17 rather than pro-active approach. This therefore creates an inequality in consultation number,
18 but there is insufficient evidence to ascertain whether this translates in better detection of
19 complications and improved overall management. Given this variability, better understanding
20 which follow-up approach should be adopted would be useful.

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PICO question	<p>Population: People who have undergone shoulder replacement surgery.</p> <p>Intervention(s): Formal follow-up monitoring programme that includes different time points (e.g. 6 months, 1 year, 2 years and 5 years) where individuals are followed up by a health professional to assess for on-going health needs, joint complications and strategies to optimise the health of the joint replacement. This may include clinical or radiological investigation. This may be in a face-to-face consultation, in primary or secondary care, or using technology to permit remote consultations.</p> <p>Comparison: No routine follow-up with a healthcare professional following the standard 6 post-operative week follow-up appointment.</p> <p>Outcome(s): Complications; revision procedures; pain; function; health-related quality of life; health economic measures (direct and indirect costs).</p>
Study design	<p>[It should also specify the most appropriate study design to address the proposed question(s). Primary research or secondary research (for example, systematic reviews) can be recommended.]</p> <p>Pragmatic, multicentre, randomised controlled clinical trial including health economic and process evaluation methodologies.</p>
Other details	<p>Detail any of the following if they are appropriate: relevance to existing national priorities, importance to patients or the population, relevance to NICE guidance.</p>



This is an important research question given the paucity of literature on this question, and wide variability in the current UK provision of monitoring people following primary hip, knee and shoulder replacement.

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