National Institute for Health and Care Excellence

Final

Joint replacement (primary): hip, knee and shoulder

[P] Evidence review for inpatient hip and knee postoperative rehabilitation

NICE guideline NG157

Intervention evidence review underpinning recommendation 1.10.1 in the NICE guideline

June 2020

Final

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

Disclaimer

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or service users. The recommendations in this guideline are not mandatory and the guideline does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and, where appropriate, their carer or guardian.

Local commissioners and providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

NICE guidelines cover health and care in England. Decisions on how they apply in other UK countries are made by ministers in the Welsh Government, Scottish Government, and Northern Ireland Executive. All NICE guidance is subject to regular review and may be updated or withdrawn.

ISBN 978-1-4731-3722-6

Contents

1 Inpatient hip and knee postoperative rehabilitation

1.1 Review question: In adults who have undergone primary elective hip or knee replacement, what is the most clinical and cost-effective timing and duration for inpatient rehabilitation?

1.2 Introduction

Current practice would suggest that rehabilitation following hip and knee replacement begins as soon as possible after surgery. However, following surgery, patients may experience post-operative complications including nausea, hypotension, pain, delirium and confusion. The orthopaedic team aim to minimise these complications, to facilitate a good post-operative recovery and ultimately a safe hospital discharge.

Core post-operative rehabilitation interventions focus on exercises to improve joint range of motion and strength, gait re-education and functional retraining to maximise independence in transfer ability (bed to chair/getting on-off the toilet or out of the shower/bath), personal care (washing and dressing) and wider activities of daily living.

An assessment of post-discharge rehabilitation needs is undertaken during the individual's hospital stay, led by physiotherapy and occupational therapy teams but supported by the whole multidisciplinary team. This may lead to referrals for ongoing support to community physiotherapy or occupational therapy services, or to social services, or to third sector organisations.

Whilst there is consistency in the UK that individuals who have undergone primary elective hip or knee replacement receive some form of post-operative inpatient rehabilitation, there is variability and uncertainty in its content, when this should begin, and the frequency and duration of provision. Furthermore all these interventions have a cost to the NHS.

This review seeks to discover the most clinical and cost-effective in-patient rehabilitation interventions for people who have undergone hip and knee replacement, and in particular when this rehabilitation should begin.

1.3 PICO table

For full details, see the review protocol in Appendix A:

Table 1: PICO characteristics of review question

Population	Adults who have undergone primary hip or knee joint replacement.
Intervention	First rehabilitation on the day of surgery
Comparison	First rehabilitation after the day of surgery
Outcomes	**Critical** • Quality of life within 6 weeks for example EQ-5D, EQ-VAS. • Patient Reported Outcome Measures (PROMs) within 6 weeks • Revision of joint replacement • Reoperation including dislocation within 6 weeks **Important** • Deep Surgical site infection within 6 weeks

ISBN 978-1-4731-3722-6

	• Superficial surgical site infection within 6 weeks • Hospital readmissions: within 90 days • Thromboembolic events within 90 days • Length of stay To be extracted when not included within a PROM: • Function within 6 weeks • Pain within 6 weeks
Study design	Randomised controlled trials If no well-conducted RCTs are available, then observational studies with multivariate analysis will be investigated.

1.4 Clinical evidence

1.4.1 Included studies

A search was conducted for randomised trials comparing first rehabilitation on the day of surgery and first rehabilitation: after the day of surgery, in those undergoing primary hip or knee joint replacement. Three studies were included in the review;[2, 9, 17] these are summarised in Table 2 below. Evidence from these studies is summarised in the clinical evidence summary below (Table 3).

See also the study selection flow chart in Appendix C: study evidence tables in Appendix D: forest plots in Appendix E: and GRADE tables in Appendix H:

1.4.2 Excluded studies

See the excluded studies list in Appendix I:

ISBN 978-1-4731-3722-6

ISBN 978-1-4731-3722-6

1.4.3 Summary of clinical studies included in the evidence review

Table 2: Summary of studies included in the evidence review

Study	Intervention and comparison	Population	Outcomes	Comments
Bohl 2019[2]	Rehabilitation within 24hrs after surgery, n=193 Versus Rehabilitation after the day of surgery, n=201	Adults who have undergone primary knee joint replacement Mean age (SD) Within 24hrs – 63.7 (10.3) After the day of surgery – 63.6 (9.1)	No relevant could be extracted.	USA
Labraca 2011[9]	Rehabilitation within 24hrs after surgery, n=153 Versus Rehabilitation 48-72hrs after surgery, n=153	Adults who have undergone primary knee joint replacement Mean age (SD) = 65.92 (4.93)	• Function within 6 weeks • Length of stay • Pain with 6 weeks	Downgraded for population indirectness as the comparisons were rehabilitation within 24hrs after surgery versus 48-72hrs post-surgery Spain
Okamoto 2016[17]	Rehabilitation on day of surgery, n=58 Versus Rehabilitation after the day of surgery, n=68	Adults who have undergone primary hip joint replacement Mean age (SD) = 62.3 (13.4)	• Hospital readmission within 90 days • Length of stay	Austria

See Appendix D: for full evidence tables.

1.4.4 Quality assessment of clinical studies included in the evidence review

Table 3: Clinical evidence summary: Rehabilitation on day of surgery versus rehabilitation on the day after surgery

Outcomes	No of	Quality of the	Relativ	Anticipated absolute effects

	Participants (studies) Follow up	evidence (GRADE)	e effect (95% CI)	Risk with Control	Risk difference with Day of surgery versus after day of surgery (95% CI)
Quality of life	Not reported				
Patient Reported Outcome Measures (PROMs)	Not reported				
Revision	Not reported				
Hospital readmissions within 90 days	126 (1 study) 3 months	VERY LOW[1,2] due to risk of bias, imprecision	RR 2.34 (0.22 to 25.2)	15 per 1,000	20 more per 1,000 (from 11 fewer to 356 more)
Length of stay	126 (1 study)	MODERATE[1] due to risk of bias		The mean length of stay - on the day vs day after surgery in the control groups was 3.61	The mean length of stay - on the day vs day after surgery in the intervention groups was 0.41 lower (0.89 lower to 0.07 higher)

[1] Downgraded by 1 increment if the majority of the evidence was at high risk of bias and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.
[2] Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

Table 4: Clinical evidence summary: Rehabilitation within 24 hours versus rehabilitation 48 to 72 hours after surgery

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with Day of surgery versus after day of surgery (95% CI)
Quality of life	Not reported				
Patient Reported Outcome Measures (PROMs)	Not reported				
Revision	Not reported				
Reoperation	Not reported				
Length of stay	273 (1 study)	MODERATE[1] due to risk of bias		The mean length of stay - within 24hrs versus 48-72hrs in the control groups was 8.46	The mean length of stay - within 24hrs versus 48-72hrs in the intervention groups was

ISBN 978-1-4731-3722-6

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with Day of surgery versus after day of surgery (95% CI)
					2.09 lower (2.57 to 1.61 lower)
Function Barthel scale, mild dependence and independent function	273 (1 study) within 6 weeks	MODERATE[1] due to risk of bias,	RR 1.02 (0.97 to 1.09)	933 per 1,000	19 more per 1,000 (from 28 fewer to 84 more)
Pain VAS score. Scale from: 0 to 10.	273 (1 study) within 6 weeks	LOW[1,2] due to risk of bias, imprecision		The mean pain within 6 weeks, vas score in the control groups was 5.36	The mean pain within 6 weeks, VAS score in the intervention groups was 2.35 lower (2.93 to 1.77 lower)

[1] Downgraded by 1 increment if the majority of the evidence was at high risk of bias and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.
[2] Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

See Appendix F: for full GRADE tables.

ISBN 978-1-4731-3722-6

1.5 Economic evidence

1.5.1 Included studies

Two health economic evaluations were identified and have been included in this review. [20, 21] They are summarised in the health economic evidence profile below (Table 7 and Table 8) and the health economic evidence table in Appendix H:

1.5.2 Excluded studies

No health economic studies that were relevant to this question were excluded due to assessment of limited applicability or methodological limitations.

See also the health economic study selection flow chart in Appendix G:

1.5.3 Unit costs

Some potentially relevant unit costs are provided below to aid consideration of cost effectiveness.

Table 5: Cost per hour of a hospital based physiotherapy or occupational therapy teams by Band

Band 4	Band 5	Band 6	Band 7	Band 8a	Band 8b
£32	£35	£46	£55	£66	£78

(a) Source PSSRU 'Unit costs of Health and Social Care 2018[4]
(b) Note that the registered workforce starts at Band 5. Staff may also be on Band 3, however the PSSRU does not include unit costs for this Band

The weighted average of the HRG codes for primary elective hip and knee replacements in Table 6 are based upon the average length of stay and average cost of an excess bed day

Table 6. Weighted average unit cost for hip and knee HRG codes

Intervention/ Diagnosis	Reference cost HRG	Weighted national average	Weighted average length of stay	Weighted average cost of excess bed day
Very Major Hip Procedures for Non-Trauma	Weighted for complications and co morbidities for HRG codes: HN12A, HN12B HN12C HN12D HN12E and HN12F; as recorded for Elective Inpatients	£6,571	3.93	£406.63
Very Major Knee Procedures for Non-Trauma	Weighted for complications and co morbidities for HRG codes: HN22A, HN22B HN22C A34&"andHN22C; as recorded for Elective Inpatients	£6,336	3.94	£406.95

(a) Source: NHS Reference Costs 2017/18

ISBN 978-1-4731-3722-6

1.5.4 Summary of studies included in the economic evidence review

Table 7: Health economic evidence profile: Weekend and standard physiotherapy versus standard physiotherapy

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Pengas 2015[20] [UK]	Partially applicable[(a)]	Potentially serious limitations [(b)]	Population: People who have had knee and hip replacements Design: Prospective cohort study with multivariate analysis for health outcomes. Interventions: Patients either received standard care (only weekday physiotherapy) plus weekend physiotherapy or standard care alone. Time horizon: hospital stay	Hip group: Weekend and standard care physiotherapy saved £177.00 per person Knee group: Weekend and standard care physiotherapy saved £269.75 per person	Days to mobilise with two sticks: Hip group: 0.42 less in the weekend group Knee group: 0.58 less in the weekend group Days to discharge: Hip group: 0.27 less in the weekend group Knee group: 0.41 less in the weekend group	Weekend and standard care physiotherapy was dominant (less costly and more effective) compared to standard physiotherapy	No sensitivity analysis

(a) Weekend physiotherapy rather than early physiotherapy, no quality-adjusted life years
(b) Not based on a randomised controlled trial so not included in the clinical review, only hospital costs included and short time horizon. Unit cost sources not reported, not clear if cost was subject to multivariate analysis, unit cost of bed day seems rather high

ISBN 978-1-4731-3722-6

Table 8: Health economic evidence profile: Early postoperative ambulation versus late postoperative ambulation

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Pua 2014[21] [Singapore]	Partially applicable[(c)]	Potentially serious limitations [(d)]	Population: People who have had a primary, elective, unilateral total knee arthroplasty for knee osteoarthritis. Design: Retrospective cohort study with multivariate regression. Interventions: Patients either received early postoperative ambulation on day 1 or late postoperative ambulation on day 2. Time horizon: 90 days post-surgery	Early postoperative group saved £219 per person	Hospital length of stay: Early postoperative group had 0.44 days less	Early postoperative ambulation was dominant (less costly and more effective) compared to late postoperative ambulation	No sensitivity analysis

(a) Set in Singapore and no quality-adjusted life years
(b) Not based on randomised controlled trial so not included in the clinical review, only hospital costs, no sensitivity analysis and short time horizon.

ISBN 978-1-4731-3722-6

1.6 Evidence statements

1.6.1 Clinical evidence statements

Evidence from 2 RCTs compared rehabilitation starting on the day of surgery versus rehabilitation after the day of surgery. The only 2 outcomes extracted indicated a clinically important benefit for rehabilitation starting on the day of surgery in hospital readmissions and length of stay (moderate or very low quality, n=126). No evidence favoured delayed rehabilitation or indicated no difference between start times.

Evidence from 1 RCT compared rehabilitation starting within 24 hours after surgery versus rehabilitation starting 48 to 72 hours after surgery. A benefit of starting rehabilitation within 24 hours after surgery was found for length of stay and pain (very low quality, n=273). No outcomes indicated a benefit of rehabilitation starting 48 to 72 hours after surgery. No clinical difference was found in terms of function within 6 weeks (very low quality, n=273).

1.6.2 Health economic evidence statements

One cost-consequence analysis showed that 7-day physiotherapy for elective knee and hip replacement was dominant (less costly and more effective) compared with weekday-only physiotherapy. Seven day physiotherapy saved £177 per hip patient and £270 per knee patient. This analysis was assessed as partially applicable with potentially serious limitations.

One cost-consequence analysis showed that mobilisation on the day after surgery was dominant (less costly and more effective) compared with mobilisation on the second day surgery for people having a primary elective unilateral total knee arthroplasty for osteoarthritis. Mobilisation on the day of surgery saved £219 per patient. This analysis was assessed as partially applicable with potentially serious limitations.

1.7 The committee's discussion of the evidence

1.7.1 Interpreting the evidence

1.7.1.1 The outcomes that matter most

The critical outcomes were agreed to be quality of life (QOL), Patient Reported Outcome Measures (PROMs) within 6 weeks, time until joint replacement was revised, and reoperation including dislocation within 6 weeks.

The important outcomes were deep surgical site infection and superficial surgical site infection extracted within 6 weeks. Hospital readmissions, thromboembolic events and length of stay, however, were extracted within 90 days. It was agreed function and pain would be extracted when not included within a PROM.

1.7.1.2 The quality of the evidence

Three studies with relevant outcomes were included in the review, with quality ranging from very low to moderate due to risk of bias. The risk of bias was due to lack of blinding in the studies and unclear allocation concealment, imprecision or indirectness. The majority of the evidence was at a very low quality. One study was downgraded for population indirectness as it did not quite match usual care in an NHS setting. It compared rehabilitation within 24 hours after surgery to 48–72 hours after surgery and that this does not usually happen in usual practice unless there is a medical reason mobilisation needs to be delayed. The committee noted that this study seems to be setting itself up for a positive effect of early

ISBN 978-1-4731-3722-6

rehabilitation through its comparison time points. The committee took this into account when interpreting the evidence.

1.7.1.3 Benefits and harms

There were 2 comparisons within the review. One compared rehabilitation on the day of surgery versus rehabilitation the day after surgery, and the second compared rehabilitation within 24 hours versus 48–72 hours.

Both comparisons indicated a benefit of early mobilisation in terms of length of stay and the latter showed a benefit in terms of pain within 6 weeks and no clinically important difference in function at 6 weeks. The hospital readmissions outcomes favoured later rehabilitation though the committee noted that there were only 3 events within the study. This led to variance that made the results too uncertain to assign as a clinical important effect. The length of stay results strongly favoured early rehabilitation in the within 24 hours versus 48–72 hours comparison.

The second comparison of rehabilitation on the day of surgery versus rehabilitation the day after surgery found a reduction in length of stay of 0.41 days. The committee agreed that going home a mean of nearly 10 hours earlier was clinically important from both a personal perspective for the person having surgery and also an economic perspective. Early discharge was stated by a patient member of the committee, and agreed by all of the committee, to be important for a person's wellbeing after joint replacement surgery

The committee spoke more generally about aspects of the rehabilitation provided in-hospital after the surgery. Aspects highlighted were enabling the person to be competent in a home exercise program prior to discharge, being able to self-care, and also showing they are able to walk out of the ward. Once a person meets these rehabilitation requirements they can be discharged from hospital from a rehabilitation perspective. Physiotherapists and/or occupational therapists can advise on how to manage activities of daily living out of hospital after joint replacement.

The committee combined the evidence from the review with their experience and opinion to make a recommendation in favour of offering rehabilitation, including mobilisation, within 24 hours. The committee discussed how those implementing the early mobilisation are concerned they are putting a person who is fragile after surgery in more pain without good reason. However, it was agreed that the evidence strongly supported beginning rehabilitation in the first 24 hours after surgery and delaying rehabilitation after surgery does not appear to decrease adverse events in either the evidence or committee experience and opinion. Nonetheless, a person's specific clinical situation and functional ability at initial assessment would be considered and mobilisation delayed by the orthopaedic team if necessary.

The committee noted that while it is preferable for rehabilitation to occur on the day of surgery there may be barriers that could prevent this, such as operations at later time-points in the day. Therefore, the committee recommended rehabilitation be offered on the day of surgery if possible and no more than 24 hours after surgery. The committee also noted that for the recommendation to be delivered physiotherapy care at weekends would be necessary.

The committee discussed the type of exercises to prescribe. They agreed that these should be tailored to the person's needs and circumstances, taking into account their activities of daily living.

1.7.2 Cost effectiveness and resource use

No economic evaluations were found that exactly matched the protocol. However, 2 studies were included that were deemed to be sufficiently relevant.

ISBN 978-1-4731-3722-6

One study compared mobilisation on the day *after* surgery with mobilisation on the second day after surgery for people undergoing primary elective total knee replacement. This found earlier mobilisation by just 1 day to be cost saving by £219 per person. This study was a retrospective cohort study (with multivariate analysis to control for baseline confounding) and hence not included in the above clinical review. However, both the length of stay reduction was typical of studies in that review and the baseline length of stay was similar to the UK. The study had limited applicability: since it was conducted in a Singaporean setting, it did not evaluate QALYs and it only included hospital costs.

The second study compared 7-day physiotherapy with weekday only for adults undergoing elective hip or knee replacement. This found weekend physiotherapy to be cost saving by £177 in hip patients and £270 in knee patients. This study was a prospective cohort study and hence not included in the above clinical review. However, the length of stay reduction was typical of studies in that review and the setting was the UK. The study did have some significant limitations, since it did not evaluate QALYs and it only included hospital costs. Hence, we cannot be sure that the cost savings from reduced hospital stay were not offset by increased costs in the community. It was unclear how the costs were calculated and perhaps the cost impact was not controlled for confounding.

All patients who receive a hip or knee replacement (75,000 and 84,000 operations in 2017/18 according to Hospital Episode Statistic data) receive some form of physiotherapy and rehabilitation during their inpatient stay as part of current practice. This may be assessing the patient from the bed, assistance in mobilising from the bed and provision of exercises. Inpatient rehabilitation would usually be a 30-45 minute initial session for the majority of patients, from reading the notes to seeing the patient to finishing recording in the notes. For any surgery conducted on Monday, Tuesday, Wednesday or Thursday, the recommendation will not have a substantial resource impact as inpatient rehabilitation within 24 hours of surgery will take place on a weekday when physiotherapists and occupational therapists would be readily available as part of current practice. There was suggestion by the committee that more elective procedures would occur on weekdays, as opposed to weekends, due to greater accident and emergency pressures on the weekend.

All services currently offer a provision of weekend physiotherapists/occupational therapists. However, in some trusts these staff may not necessarily be seeing primary elective joint replacement patients as part of current practice. In trusts such as these, additional planning or reshuffling of physiotherapist and occupational therapists time may be needed, which should avoid any significant resource impact. Where additional planning is not adequate enough to provide rehabilitation for all elective joint replacement surgery on the weekend, more staff may be needed. The hourly unit costs for hospital based physiotherapy and occupational therapy team staff is £32-78 (Bands 4-8b), although the weekend costs may be more than those included. Registered physiotherapists and occupational therapists start at Band 5. Staff may also be on Band 3, however costs for this Band are not provided by the Personal Social Services Research Unit (PSSRU). There was discussion that it is important that an appropriately qualified physiotherapist or occupational therapist is available to give the first assessment. However, there are instances where staff on lower Bands who are well supported by members of the rehabilitation team can undertake subsequent inpatient care. It is not anticipated that additional staff will have a significant resource impact.

The economic evidence suggests that increasing weekend staff capacity and their associated costs will be at least partially offset by a reduction in length of stay due to faster recovery. The cost of an excess bed day for both hip and knee replacements is £407. The committee believed the recommendation would result in an overall cost saving.

1.7.3 Other factors the committee took into account

The committee noted that for people to be mobilised within 24 hours of surgery, they needed to be comfortable, including controlled pain, and not nauseous. It was discussed that

ISBN 978-1-4731-3722-6

mobilisation can be quite varied in terms of what it represents and perhaps further definition and explanation is required.

It was discussed that some patients vary in how they feel about mobilisation, and so preoperative education would be important to address this issue, with 1 lay member supporting the importance of education before joint replacement surgery. The committee agreed that people should be made aware of the benefits of early mobilisation.

The committee discussed how limiting the recommendation to mobilisation would affect the range of allied health practitioners at the weekend. This could therefore limit the service a person receives if their surgery is on a Friday night. The committee was of the opinion that all available staff during the week should also be available on the weekends, or operations should not perhaps happen at weekends, to ensure people who have elected joint replacements get the best possible rehabilitation.

ISBN 978-1-4731-3722-6

References

1. Anonymous. Treadmill training for partial body weight support - part of the rehabilitation after hip surgery (Project record). 2007. Available from: http://cochranelibrary-wiley.com/o/cochrane/clhta/articles/HTA-32007000815/frame.html

2. Bohl DD, Li J, Calkins TE, Darrith B, Edmiston TA, Nam D et al. Physical therapy on postoperative day zero following total knee arthroplasty: A randomized, controlled trial of 394 patients. Journal of Arthroplasty. 2019; 34(7):S173-S177.e1

3. Chen WH, Wang Q, Su JC. Postoperative rehabilitation exercise for the recovery of limb function after total hip replacement. Chinese Journal of Clinical Rehabilitation. 2004; 8(20):3926-3928

4. Curtis LA, Burns A. Unit costs of health and social care 2018. Project report. Kent. University of Kent, 2018. Available from: https://kar.kent.ac.uk/70995/1/Unit%20Costs%202018%20-%20FINAL%20with%20bookmarks%20and%20covers%20%282%29.pdf

5. den Hertog A, Gliesche K, Timm J, Muhlbauer B, Zebrowski S. Pathway-controlled fast-track rehabilitation after total knee arthroplasty: A randomized prospective clinical study evaluating the recovery pattern, drug consumption, and length of stay. Archives of Orthopaedic and Trauma Surgery. 2012; 132(8):1153-63

6. Fusco F, Campbell H, Barker K. Rehabilitation after resurfacing hip arthroplasty: Cost-utility analysis alongside a randomized controlled trial. Clinical Rehabilitation. 2019; 33(6):1003-1014

7. Guerra ML, Singh PJ, Taylor NF. Early mobilization of patients who have had a hip or knee joint replacement reduces length of stay in hospital: A systematic review. Clinical Rehabilitation. 2015; 29(9):844-54

8. Haas R, Sarkies M, Bowles KA, O'Brien L, Haines T. Early commencement of physical therapy in the acute phase following elective lower limb arthroplasty produces favorable outcomes: A systematic review and meta-analysis examining allied health service models. Osteoarthritis and Cartilage. 2016; 24(10):1667-1681

9. Labraca NS, Castro-Sanchez AM, Mataran-Penarrocha GA, Arroyo-Morales M, Sanchez-Joya Mdel M, Moreno-Lorenzo C. Benefits of starting rehabilitation within 24 hours of primary total knee arthroplasty: Randomized clinical trial. Clinical Rehabilitation. 2011; 25(6):557-66

10. Larsen K, Hvass KE, Hansen TB, Thomsen PB, Soballe K. Effectiveness of accelerated perioperative care and rehabilitation intervention compared to current intervention after hip and knee arthroplasty. A before-after trial of 247 patients with a 3-month follow-up. BMC Musculoskeletal Disorders. 2008; 9:59

11. Larsen K, Sorensen OG, Hansen TB, Thomsen PB, Soballe K. Accelerated perioperative care and rehabilitation intervention for hip and knee replacement is effective: A randomized clinical trial involving 87 patients with 3 months of follow-up. Acta Orthopaedica. 2008; 79(2):149-59

12. Li L, Wang Z, Yin MH, Li Q, Qi ZM. Effect of early gait training on the functional rehabilitation after total knee arthroplasty. Chinese Journal of Tissue Engineering Research. 2017; 21(27):4288-4293

ISBN 978-1-4731-3722-6

13. Masaracchio M, Hanney WJ, Liu X, Kolber M, Kirker K. Timing of rehabilitation on length of stay and cost in patients with hip or knee joint arthroplasty: A systematic review with meta-analysis. PloS One. 2017; 12(6):e0178295

14. Monaghan B, Cusack T. Effectiveness of delayed rehabilitation programmes in patients following total hip replacement. Physical Therapy Reviews. 2014; 19(2):94-104

15. Munin MC, Glynn N, Rudy TE, Crossett LS, Rubash HE. Randomized controlled trial of early inpatient rehabilitation after elective hip and knee arthroplasty. Archives of Physical Medicine and Rehabilitation. 1996; 77(9):928

16. National Institute for Health and Care Excellence. Developing NICE guidelines: the manual [updated 2018]. London. National Institute for Health and Care Excellence, 2014. Available from: http://www.nice.org.uk/article/PMG20/chapter/1%20Introduction%20and%20overview

17. Okamoto T, Ridley RJ, Edmondston SJ, Visser M, Headford J, Yates PJ. Day-of-surgery mobilization reduces the length of stay after elective hip arthroplasty. Journal of Arthroplasty. 2016; 31(10):2227-30

18. Oldmeadow LB, Edwards ER, Kimmel LA, Kipen E, Robertson VJ, Bailey MJ. No rest for the wounded: Early ambulation after hip surgery accelerates recovery. ANZ Journal of Surgery. 2006; 76(7):607-11

19. Organisation for Economic Co-operation and Development (OECD). Purchasing power parities (PPP). 2012. Available from: http://www.oecd.org/std/ppp Last accessed: 17/06/2019

20. Pengas IP, Khan WS, Bennett CA, Rankin KS. Impact of weekend physiotherapy service on the cost effectiveness of elective orthopaedic hip and knee arthroplasty. Open Orthopaedics Journal. 2015; 9:515-9

21. Pua YH, Ong PH. Association of early ambulation with length of stay and costs in total knee arthroplasty: Retrospective cohort study. American Journal of Physical Medicine and Rehabilitation. 2014; 93(11):962-70

22. Reilly KA, Beard DJ, Barker KL, Dodd CA, Price AJ, Murray DW. Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty--A randomised controlled trial. Knee. 2005; 12(5):351-7

23. Wasilewski SA, Woods LC, Torgerson WR, Jr., Healy WL. Value of continuous passive motion in total knee arthroplasty. Orthopedics. 1990; 13(3):291-5

ISBN 978-1-4731-3722-6

Appendices

Appendix A: Review protocols

Table 9: Review protocol: Timing and duration for inpatient rehabilitation after hip or knee joint replacement

ID	Field	Content
0.	PROSPERO registration number	Not yet registered
1.	Review title	Inpatient rehabilitation in those undergoing hip or knee joint replacement surgery
2.	Review question	In adults who have undergone primary elective hip or knee replacement, what is the most clinical and cost-effective timing and duration for inpatient rehabilitation?
3.	Objective	To determine whether early rehabilitation, starting within a day of surgery, is more effective than delayed rehabilitation that starts after the day of surgery.
4.	Searches	The following databases will be searched: Cochrane Central Register of Controlled Trials (CENTRAL) Cochrane Database of Systematic Reviews (CDSR) Embase MEDLINE Searches will be restricted by: English language Human studies Letters and comments are excluded. Other searches: Inclusion lists of relevant systematic reviews will be checked by the reviewer. The searches may be re-run 6 weeks before final committee meeting and further studies retrieved for inclusion if relevant. The full search strategies will be published in the final review.
5.	Condition or domain being	Hip/knee joint replacement inpatient rehabilitation

ISBN 978-1-4731-3722-6

ID	Field	Content
	studied	
6.	Population	Inclusion: Adults who have undergone primary hip or knee joint replacement. Exclusion: • 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.
7.	Intervention/Exposure/Test	First rehabilitation on the day of surgery
8.	Comparator/Reference standard/Confounding factors	First rehabilitation: after the day of surgery
9.	Types of study to be included	Randomised controlled trials 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)	Quality of life within 6 weeks (continuous) for example EQ-5D, EQ-VAS. Patient Reported Outcome Measures (PROMs) within 6 weeks (continuous) Revision of joint replacement (time to event) Reoperation including dislocation within 6 weeks (dichotomous)
13.	Secondary outcomes (important outcomes)	Deep surgical site infection within 6 weeks (dichotomous) Superficial surgical site infection within 6 weeks (dichotomous) Hospital readmissions: within 90 days (dichotomous) Thromboembolic events within 90 days (dichotomous) Length of stay (continuous)

ISBN 978-1-4731-3722-6

ID	Field	Content
		To be extracted when not included within a 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. 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. A second reviewer will quality assure the extracted data. Discrepancies will be identified and resolved through discussion (with a third reviewer where necessary).
15.	Risk of bias (quality) assessment	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) 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.
16.	Strategy for data synthesis	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. Heterogeneity between the studies in effect measures will be assessed using the I^2 statistic and visually inspected. We will consider an I^2 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.

ISBN 978-1-4731-3722-6

ID	Field	Content	
		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. 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%. Publication bias is tested for when there are more than 5 studies for an outcome. 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/type of joint replacement: total hip replacement knee replacement unicompartmental knee replacement Total knee arthroplasty anaesthetic technique regional general Intervention type: physiotherapy occupational therapy	
18.	Type and method of review	☒	Intervention
		☐	Diagnostic
		☐	Prognostic
		☐	Qualitative
		☐	Epidemiologic
		☐	Service Delivery
		☐	Other (please specify)

ISBN 978-1-4731-3722-6

ID	Field	Content		
19.	Language	English		
20.	Country	England		
21.	Anticipated or actual start date	01/06/18		
22.	Anticipated completion date	20/03/20		
23.	Stage of review at time of this submission	Review stage	Started	Completed
		Preliminary searches	☐	☑
		Piloting of the study selection process	☐	☑
		Formal screening of search results against eligibility criteria	☐	☑
		Data extraction	☐	☑
		Risk of bias (quality) assessment	☐	☑
		Data analysis	☐	☑
24.	Named contact	5a. Named contact National Guideline Centre 5b Named contact e-mail 5e Organisational affiliation of the review National Institute for Health and Care Excellence (NICE) and the National Guideline Centre		
25.	Review team members	From the National Guideline Centre: Mr Carlos Sharpin [Guideline lead] Mr Alex Allen [Senior Systematic Reviewer] Ms Rafina Yarde [Systematic reviewer] Mr Robert King [Health economist] Ms Agnès Cuyàs [Information specialist] Ms Eleanor Priestnall [Project Manager]		

ISBN 978-1-4731-3722-6

ID	Field	Content	
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 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	Inpatient rehabilitation, hip/knee joint replacement, first day surgery	
33.	Details of existing review of same topic by same authors	N/A	
34.	Current review status	☐	Ongoing
		☒	Completed but not published
		☐	Completed and published
		☐	Completed, published and being updated
		☐	Discontinued

ISBN 978-1-4731-3722-6

ID	Field	Content
35..	Additional information	N/A
36.	Details of final publication	www.nice.org.uk

ISBN 978-1-4731-3722-6

Table 10: 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	• 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	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 (e.g. non-OECD countries) or the USA will also be excluded. 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).[16] **Inclusion and exclusion criteria** • 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. **Where there is discretion** 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 the remaining studies selectively. All studies excluded based on applicability or methodological limitations will be listed with explanation in the excluded health economic studies appendix below. The health economist will be guided by the following hierarchies. *Setting:* • 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,

ISBN 978-1-4731-3722-6

	Switzerland). • Studies set in non-OECD countries or in the USA will be excluded before being assessed for applicability and methodological limitations. *Health economic study type:* • 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. *Year of analysis:* • 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 from before 2003 will be rated as 'Not applicable'. • Studies published before 2003 will be excluded before being assessed for applicability and methodological limitations. *Quality and relevance of effectiveness data used in the health economic analysis:* • 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.

ISBN 978-1-4731-3722-6

Appendix B: Literature search strategies

The literature searches for this review are detailed below and complied with the methodology outlined in Developing NICE guidelines: the manual.[16]

For more detailed information, please see the Methodology Review.

B.1 Clinical search literature search strategy

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

Table 11: 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 DARE, and NHSEED to 2015 Issue 2 of 4 HTA to 2016 Issue 4 of 4	None

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 endoprosthe* 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.

ISBN 978-1-4731-3722-6

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.	exp Rehabilitation/
26.	Rehabilitation Nursing/
27.	rehab*.ti,ab.
28.	(prehabilitat* or pre habilitat*).ti,ab.
29.	Early Ambulation/
30.	(early adj3 (ambulation or mobili*)).ti,ab.
31.	Physical Therapy Modalities/
32.	exp Exercise Therapy/ or Physical Conditioning, Human/ or Occupational Therapy/ or Recreation Therapy/ or Rehabilitation, Vocational/
33.	Motion Therapy, Continuous Passive/ or Muscle Stretching Exercises/ or Manipulation, Orthopedic/ or Resistance Training/
34.	((physical* or exercise* or motion or movement or occupational or recreation* or vocational) adj3 (therap* or condition*)).ti,ab.
35.	(manipulation or MUA).ti,ab.
36.	((standardi?ed or SE or continuous passive motion or CPM or slider board or SB or range of motion or ROM or resistance or weight bearing or equilibrium or flexibility or stretch*) adj2 (therap* or exercise*)).ti,ab.
37.	physiotherap*.ti,ab.
38.	Hydrotherapy/
39.	(hydrotherap* or aquatic physiotherap*).ti,ab.
40.	Transcutaneous Electric Nerve Stimulation/
41.	(electric* nerve stimulation or TENS).ti,ab.
42.	Patient Education as Topic/
43.	(patient* adj3 (education or information or advice)).ti,ab.
44.	or/25-43
45.	24 and 44
46.	randomized controlled trial.pt.
47.	controlled clinical trial.pt.
48.	randomi#ed.ti,ab.
49.	placebo.ab.
50.	randomly.ti,ab.
51.	Clinical Trials as topic.sh.
52.	trial.ti.
53.	or/46-52
54.	Meta-Analysis/
55.	exp Meta-Analysis as Topic/

ISBN 978-1-4731-3722-6

56.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
57.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
58.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
59.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
60.	(search* adj4 literature).ab.
61.	(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.
62.	cochrane.jw.
63.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
64.	or/54-63
65.	Epidemiologic studies/
66.	Observational study/
67.	exp Cohort studies/
68.	(cohort adj (study or studies or analys* or data)).ti,ab.
69.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
70.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
71.	Controlled Before-After Studies/
72.	Historically Controlled Study/
73.	Interrupted Time Series Analysis/
74.	(before adj2 after adj2 (study or studies or data)).ti,ab.
75.	or/65-74
76.	exp case control study/
77.	case control*.ti,ab.
78.	or/76-77
79.	75 or 78
80.	Cross-sectional studies/
81.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
82.	or/80-81
83.	75 or 82
84.	75 or 78 or 82
85.	45 and (53 or 64 or 84)

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.

ISBN 978-1-4731-3722-6

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.	exp rehabilitation/
24.	rehabilitation nursing/
25.	rehab*.ti,ab.
26.	(prehabilitat* or pre habilitat*).ti,ab.
27.	*mobilization/
28.	(early adj3 (ambulation or mobili*)).ti,ab.
29.	*physiotherapy/ or *kinesiotherapy/ or *exercise/ or *occupational therapy/ or *recreational therapy/ or *vocational rehabilitation/
30.	*movement therapy/ or *stretching exercise/ or *orthopedic manipulation/ or *resistance training/
31.	((physical* or exercise* or motion or movement or occupational or recreation* or vocational) adj3 (therap* or condition*)).ti,ab.
32.	(manipulation or MUA).ti,ab.
33.	((standardi?ed or SE or continuous passive motion or CPM or slider board or SB or range of motion or ROM or resistance or weight bearing or equilibrium or flexibility or stretch*) adj2 (therap* or exercise*)).ti,ab.
34.	physiotherap*.ti,ab.
35.	hydrotherapy/
36.	(hydrotherap* or aquatic physiotherap*).ti,ab.
37.	transcutaneous electrical nerve stimulation/
38.	(electric* nerve stimulation or TENS).ti,ab.
39.	*patient education/
40.	(patient* adj3 (education or information or advice)).ti,ab.
41.	or/23-40
42.	22 and 41
43.	random*.ti,ab.
44.	factorial*.ti,ab.
45.	(crossover* or cross over*).ti,ab.
46.	((doubl* or singl*) adj blind*).ti,ab.
47.	(assign* or allocat* or volunteer* or placebo*).ti,ab.
48.	crossover procedure/
49.	single blind procedure/
50.	randomized controlled trial/

ISBN 978-1-4731-3722-6

51.	double blind procedure/
52.	or/43-51
53.	systematic review/
54.	meta-analysis/
55.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
56.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
57.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
58.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
59.	(search* adj4 literature).ab.
60.	(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.
61.	cochrane.jw.
62.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
63.	or/53-62
64.	Clinical study/
65.	Observational study/
66.	family study/
67.	longitudinal study/
68.	retrospective study/
69.	prospective study/
70.	cohort analysis/
71.	follow-up/
72.	cohort*.ti,ab.
73.	71 and 72
74.	(cohort adj (study or studies or analys* or data)).ti,ab.
75.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
76.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
77.	(before adj2 after adj2 (study or studies or data)).ti,ab.
78.	or/64-70,73-77
79.	exp case control study/
80.	case control*.ti,ab.
81.	or/79-80
82.	78 or 81
83.	cross-sectional study/
84.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
85.	or/83-84
86.	78 or 85
87.	78 or 81 or 85
88.	42 and (52 or 63 or 87)

Cochrane Library (Wiley) search terms

#1.	MeSH descriptor: [Arthroplasty] this term only
#2.	MeSH descriptor: [Arthroplasty, Replacement] this term only

ISBN 978-1-4731-3722-6

#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 prosthe* or endoprosthe* or implant* or artificial or arthroplast* or hemiarthroplast*)):ti,ab
#14.	(or #7, #12-#13)
#15.	MeSH descriptor: [Rehabilitation] explode all trees
#16.	MeSH descriptor: [Rehabilitation Nursing] explode all trees
#17.	rehab*:ti,ab
#18.	(prehabilitat* or pre habilitat*):ti,ab
#19.	MeSH descriptor: [Early Ambulation] this term only
#20.	(early near/3 (ambulation or mobili*)):ti,ab
#21.	MeSH descriptor: [Physical Therapy Modalities] this term only
#22.	MeSH descriptor: [Exercise Therapy] explode all trees
#23.	MeSH descriptor: [Physical Conditioning, Human] this term only
#24.	MeSH descriptor: [Occupational Therapy] this term only
#25.	MeSH descriptor: [Recreation Therapy] this term only
#26.	MeSH descriptor: [Rehabilitation, Vocational] this term only
#27.	MeSH descriptor: [Motion Therapy, Continuous Passive] this term only
#28.	MeSH descriptor: [Muscle Stretching Exercises] this term only
#29.	MeSH descriptor: [Manipulation, Orthopedic] this term only
#30.	MeSH descriptor: [Resistance Training] this term only
#31.	((physical* or exercise* or motion or movement or occupational or recreation* or vocational) near/3 (therap* or condition*)):ti,ab
#32.	(manipulation or MUA):ti,ab
#33.	((standardised or standardized or SE or continuous passive motion or CPM or slider board or SB or range of motion or ROM or resistence or weight bearing or equilibrium or flexibility or stretch*) near/2 (therap* or exercise*)):ti,ab
#34.	physiotherap*:ti,ab
#35.	MeSH descriptor: [Hydrotherapy] this term only
#36.	(hydrotherap* or aquatic physiotherap*):ti,ab
#37.	MeSH descriptor: [Transcutaneous Electric Nerve Stimulation] this term only
#38.	(electric* nerve stimulation or TENS):ti,ab
#39.	MeSH descriptor: [Patient Education as Topic] this term only
#40.	(patient* near/3 (education or information or advice)):ti,ab
#41.	(or #15-#40)
#42.	#14 and #41

ISBN 978-1-4731-3722-6

B.2 Health Economics literature search strategy

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

Table 12: 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

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 endoprosthe* 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

ISBN 978-1-4731-3722-6

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

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

ISBN 978-1-4731-3722-6

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

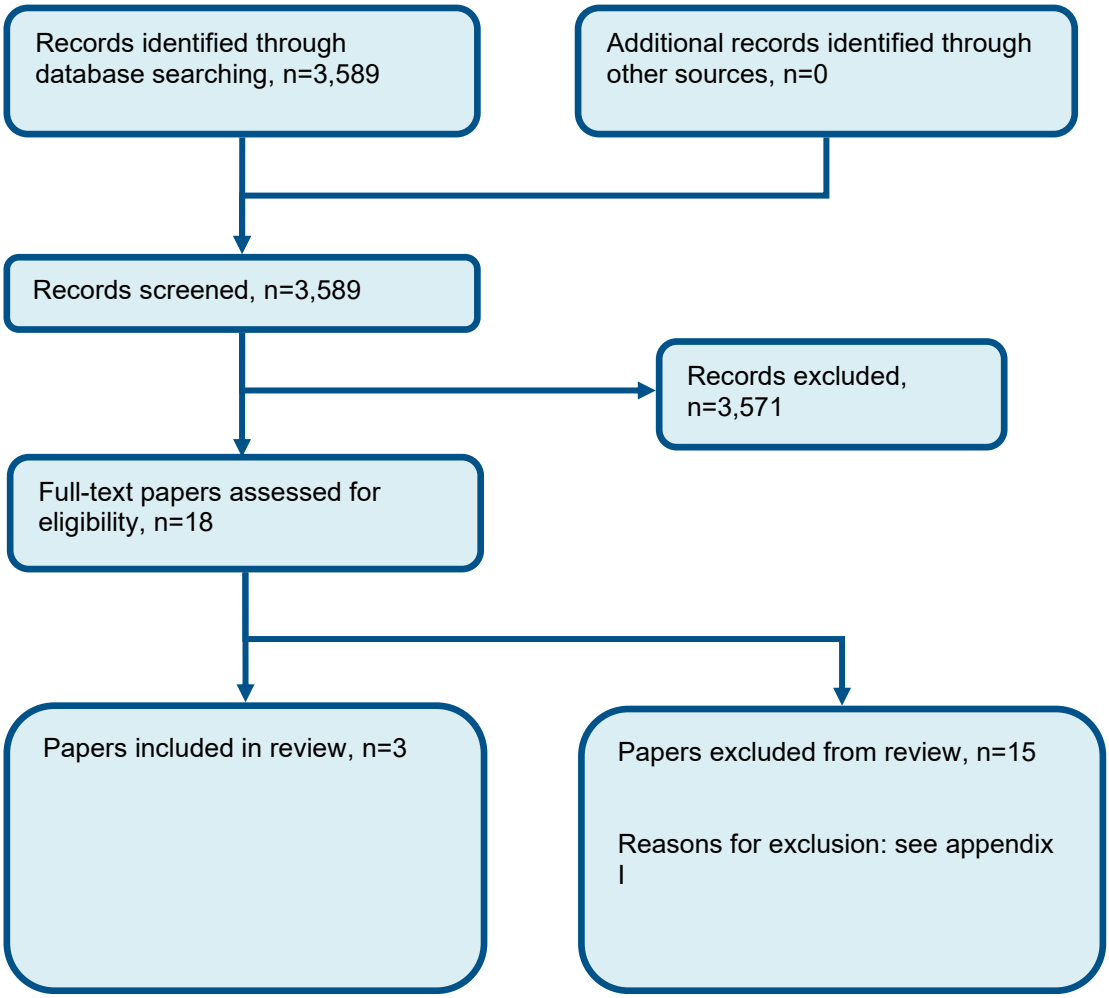
NHS EED and HTA (CRD) search terms

#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 endoprosthe* 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

ISBN 978-1-4731-3722-6

Appendix C: Clinical evidence selection

Figure 1: Flow chart of clinical study selection for the review of inpatient rehabilitation



ISBN 978-1-4731-3722-6

Appendix D: Clinical evidence tables

Study	Bohl 2019[2]
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=394)
Countries and setting	Conducted in USA
Line of therapy	Adjunctive to current care
Duration of study	Intervention time: 1 year
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Stratified then randomised
Inclusion criteria	over the age of 18, Primary TKA for degenerative disease with one of the 4 participating surgeons, a minimum 1 night stay planned in the hospital following surgery
Exclusion criteria	depending on a wheelchair or walker perioperatively, a plan for inpatient rehabilitation unit with specialized nurses facility after surgery
Recruitment/selection of patients	enrolment meant progresses until 394 patients had been randomized this required the assessment of 729 patients for eligibility, accordingly 335 out of 729 patient did not meet the inclusion /exclusion criteria
Age, gender and ethnicity	Age - Mean (range): intervention: 63.7 (10.3) control 63.6 (9.1). Gender (M:F): 156 males 222 females . Ethnicity: N/A
Further population details	1. Site/type of joint replacement: Total knee replacement (Primary TKA for degenerative disease). 2. Total knee arthroplasty anaesthetic technique: general (Primary TKA for degenerative disease).
Indirectness of population	No indirectness
Interventions	(n=193) Intervention 1: First rehabilitation - On the day of surgery. Physical therapy on postoperative day zero follow up, the patient joined the platform before discharge, orthopaedic nurses in the hospital guided patients or their relatives to interact with the specialist nurses on the home care orthopaedic platform. The patients were taught to use answer and question interactions to upload photographic and videos and appointment application AFTER DISCHARGE: besides routine continuous nursing methods the patient in the intervention group interacted with the same specialist nurse in the platform whenever or wherever needed and and clicked the question button when asking the nurse a question. The nurse replies within 24hrs meanwhile the patient could upload their own rehab photos and videos to the rehabilitation section and the nurse specialised views these in the rehabilitation exercise and provided guidance. When in doubt the nurse

ISBN 978-1-4731-3722-6

Study	Bohl 2019[2]
	could click consultation information to initiate consultation with selected experts or share the case with medical staff. The patient could click the appointment button for a telephone consultation with the nurse, the nurse would reply within 24 hours. Duration DAY 0 within 24 hours. Concurrent medication/care: all patients received an adductor canal block and a periarticular injection perioperatively, most received combined epidural and spinal anaesthesia wherein the epidural was placed but only dosed if pain control was inadequate in the recovery room or as a backup for extended operative time and a minority received general anaesthesia due to difficult lumbar anatomy or due to not enough regional anaesthesia. The groups didn't differ in their perioperative care. Indirectness: No indirectness Further details: 1. Intervention type: physiotherapy (n=201) Intervention 2: First rehabilitation - After the day of surgery. Routine nursing care was carried out after the discharge and included issuing outpatient manual performing telephone follow-ups and completing an outpatient review, the telephone follow up was performed within 1 month. Duration DAY 1. Concurrent medication/care: all patients received an abductor canal block and a periarticular injection perioperatively, most received combined epidural and spinal anaesthesia wherein the epidural was placed but only dosed when pain control was inadequate in the recovery room or as a backup for extended operative time and a minority received general anaesthesia due to difficult lumbar anatomy or due to not enough regional anaesthesia. The groups didn't differ in their perioperative care except with respect to the time of starting PT on either POD1 or POD0. Indirectness: No indirectness Further details: 1. Intervention type:
Funding	Other (one or more authors have disclosed institutional support or association with and entity in the biomedical field funding)
Protocol outcomes not reported by the study	Quality of life at within 6 weeks; Patient Reported Outcome Measures (PROMs) at within 6 weeks; Revision of joint replacement at time to event; Reoperation including dislocation at within 6 weeks; Deep surgical site infection at within 6 weeks; Superficial surgical site infection at within 6 weeks; Hospital readmissions at within 90 days; Thromboembolic events at within 90 days; Length of stay at time to event; Function at within 6 weeks; Pain at within 6 weeks

Study	Labraca 2011[9]
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	(n=306)

ISBN 978-1-4731-3722-6

Countries and setting	Conducted in Spain
Line of therapy	First line
Duration of study	Intervention time: 4 days
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Study inclusion criteria were age between 50 and 75 years, and receipt of elective knee joint replacement surgery due to unilateral osteoarthritis.
Exclusion criteria	Exclusion criteria were cardiac, renal or hepatic event in the previous year; prosthesis due to rheumatoid arthritis or cancer; and the presence of severe cognitive deficit, acute femoral fracture, infection, fever, low blood pressure or severe respiratory disease that might limit treatment or require implantation of a special prosthesis.
Recruitment/selection of patients	The target population comprised patients undergoing primary total knee arthroplasty for osteoarthritis at our hospital (in southern Spain).
Age, sex and family origin	Age - Mean (SD): 65.92 (4.93). Sex (M:F): 211 female, 62 male. Family origin: N/A
Further population details	1. Site/type of joint replacement: Total knee replacement 2. Total knee arthroplasty anaesthetic technique:
Indirectness of population	No indirectness: Downgrade for population indirectness? Within 24hrs vs 48-72hrs
Interventions	(n=153) Intervention 1: First rehabilitation - On the day of surgery. Rehabilitation onset within 24 hours of the surgery. Within the first 24 hours post operation, the patient and family members received a short briefing on the planned rehabilitation treatment. Duration 4 days minimum. Concurrent medication/care: The same rehabilitation treatment protocol was administered to all patients.. Indirectness: No indirectness Further details: 1. Intervention type: (n=153) Intervention 2: First rehabilitation - After the day of surgery. Rehabilitation onset between 48 hours and 72 hours post-surgery. Duration 4 days minimum. Concurrent medication/care: The same rehabilitation treatment protocol was administered to all patients.. Indirectness: No indirectness Further details: 1. Intervention type:
Funding	No funding (This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.)
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: ON THE DAY OF SURGERY versus AFTER THE DAY OF SURGERY Protocol outcome 1: Length of stay at time to event	

ISBN 978-1-4731-3722-6

- Actual outcome: Days of hospital stay at Postoperative; Group 1: mean 6.37 (SD 1.16); n=138, Group 2: mean 8.46 (SD 2.63); n=135 Risk of bias: All domain - Low, Selection - Low, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 15, Reason: Abandonment due to postoperative complications (Thromboembolic changes, infection of surgical wound or soft tissue lesion); Group 2 Number missing: 18, Reason: Abandonment due to postoperative complications (Infection of surgical wound, thromboembolic changes, soft tissue lesion, altered wound-healing due to hypersensitivity to suture material) Protocol outcome 2: Function at within 6 weeks - Actual outcome: Barthel Index scale - moderate to total dependence at Postoperative; Group 1: 6/138, Group 2: 9/135 Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 15, Reason: Abandonment due to postoperative complications (Thromboembolic changes, infection of surgical wound or soft tissue lesion); Group 2 Number missing: 18, Reason: Abandonment due to postoperative complications (Infection of surgical wound, thromboembolic changes, soft tissue lesion, altered wound-healing due to hypersensitivity to suture material) - Actual outcome: Barthel Index scale - mild to independent at Postoperative; Group 1: 132/138, Group 2: 126/135 Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 15, Reason: Abandonment due to postoperative complications (Thromboembolic changes, infection of surgical wound or soft tissue lesion); Group 2 Number missing: 18, Reason: Abandonment due to postoperative complications (Infection of surgical wound, thromboembolic changes, soft tissue lesion, altered wound-healing due to hypersensitivity to suture material) Protocol outcome 3: Pain at within 6 weeks - Actual outcome: VAS pain score at Postoperative; Group 1: mean 3.01 (SD 2.35); n=138, Group 2: mean 5.36 (SD 2.54); n=135 Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 15, Reason: Abandonment due to postoperative complications (Thromboembolic changes, infection of surgical wound or soft tissue lesion); Group 2 Number missing: 18, Reason: Abandonment due to postoperative complications (Infection of surgical wound, thromboembolic changes, soft tissue lesion, altered wound-healing due to hypersensitivity to suture material)	
Protocol outcomes not reported by the study	Quality of life at within 6 weeks; Patient Reported Outcome Measures (PROMs) at within 6 weeks; Revision of joint replacement at time to event; Reoperation including dislocation at within 6 weeks; Deep surgical site infection at within 6 weeks; Superficial surgical site infection at within 6 weeks; Hospital readmissions at within 90 days; Thromboembolic events at within 90 days

ISBN 978-1-4731-3722-6

Study	Okamoto 2016[17]
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	(n=126)
Countries and setting	Conducted in Austria; Setting: All surgeries were performed by one senior arthroplasty surgeon at one of 2 hospitals in Perth, Australia.
Line of therapy	First line
Duration of study	Intervention time: 2 days
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Patients with a BMI of ≤30, weight ≤120kg and the American Society of Anaesthesiologists score ≤11 are cared for at theses site. Only patients having surgery in the morning were invited to participate, as there was no evening physiotherapy roster.
Exclusion criteria	Patients excluded from further participation if they had persistent regional nerve block resulting in motor deficit, which was measured at being <3 of 5, uncontrolled pain or were medically unstable (unstable heart rate, blood pressure, or ongoing blood loss).
Age, sex and family origin	Age - Mean (SD): 62.3 (13.4). Sex (M:F): 76 male, 50 female. Family origin: N/A
Further population details	1. Site/type of joint replacement: Hip replacement 2. Total knee arthroplasty anaesthetic technique:
Indirectness of population	No indirectness
Interventions	(n=58) Intervention 1: First rehabilitation - On the day of surgery. Mobilized on day of surgery. Duration 1 day . Concurrent medication/care: Both groups received the same medical intervention and analgesia as determined by the postoperative management plans of each orthopaedic service. Indirectness: No indirectness Further details: 1. Intervention type: (n=68) Intervention 2: First rehabilitation - After the day of surgery. Mobilized the day after surgery. Duration 2 days. Concurrent medication/care: Both groups received the same medical intervention and analgesia as determined by the postoperative management plans of each orthopaedic service. Indirectness: No indirectness Further details: 1. Intervention type:
Funding	Other (One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an

ISBN 978-1-4731-3722-6

	entity in the biomedical field which may be perceived to have potential conflict of interest with this work.)
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: ON THE DAY OF SURGERY versus AFTER THE DAY OF SURGERY Protocol outcome 1: Hospital readmissions at within 90 days - Actual outcome: Hospital readmissions within 3 months at 3 months; Group 1: 2/58, Group 2: 1/68 Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0, Reason: N/A; Group 2 Number missing: 0, Reason: N/A Protocol outcome 2: Length of stay at time to event - Actual outcome: Length of stay (hrs) at Postoperative; Group 1: mean 76.9 (SD 30); n=58, Group 2: mean 86.7 (SD 35.4); n=68 Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0, Reason: N/A; Group 2 Number missing: 0, Reason: N/A	
Protocol outcomes not reported by the study	Quality of life at within 6 weeks; Patient Reported Outcome Measures (PROMs) at within 6 weeks; Revision of joint replacement at time to event; Reoperation including dislocation at within 6 weeks; Deep surgical site infection at within 6 weeks; Superficial surgical site infection at within 6 weeks; Thromboembolic events at within 90 days; Function at within 6 weeks; Pain at within 6 weeks

ISBN 978-1-4731-3722-6

Appendix E: Forest plots

E.1 Rehabilitation on day of surgery versus the day after surgery

Figure 2: Hospital re-admissions within 90 days

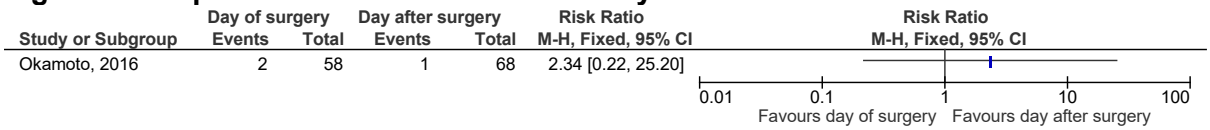
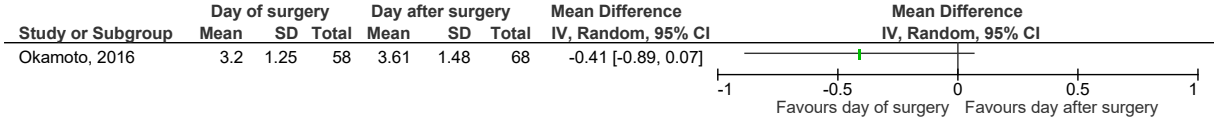


Figure 3: Length of stay, days



E.2 Rehabilitation within 24 hours versus the 48 to 72 hours after surgery

Figure 4: Length of stay, days

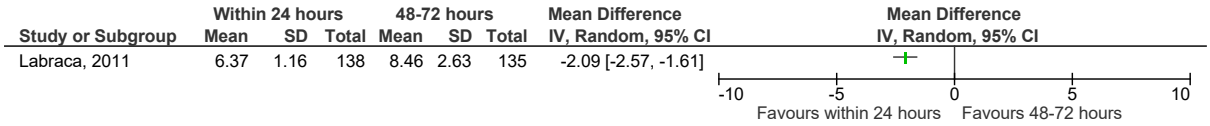


Figure 5: Function within 6 weeks, Barthel scale, mild to independent function

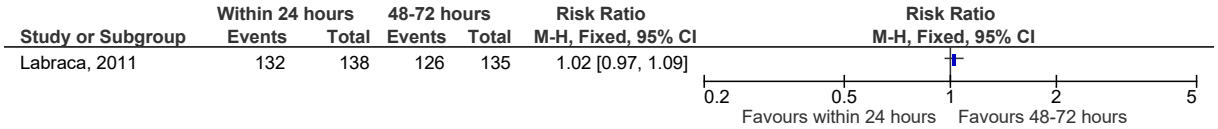
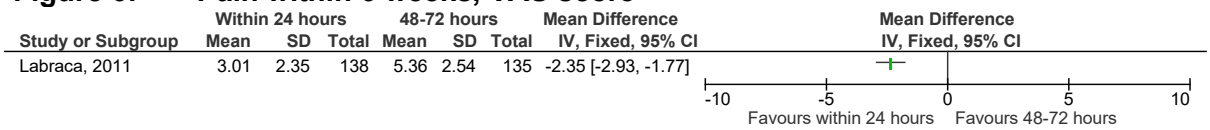


Figure 6: Pain within 6 weeks, VAS score



ISBN 978-1-4731-3722-6

Appendix F: GRADE tables

Table 13: Clinical evidence profile: Rehabilitation on the day of surgery versus the day after surgery

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Day of surgery versus after day of surgery	Control	Relative (95% CI)	Absolute		
Hospital re-admissions within 90 days (follow-up 3 months)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	very serious[2]	none	2/58 (3.4%)	1/68 (1.5%)	RR 2.34 (0.22 to 25.2)	20 more per 1000 (from 11 fewer to 356 more)	⊕OOO VERY LOW	IMPORTANT
Length of stay - On the day vs day after surgery (follow-up N/A; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	58	68	-	MD 0.41 lower (0.89 lower to 0.07 higher)	⊕⊕⊕O MODERATE	IMPORTANT

[1] Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs.

Table 14: Clinical evidence profile: Rehabilitation within 24 hours versus 48 to 72 hours after surgery

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Surgery within 24 hours	Surgery 48 to 72 hours	Relative (95% CI)	Absolute		
Length of stay - Within 24hrs vs 48-72hrs (follow-up N/A; Better indicated by lower values)												

ISBN 978-1-4731-3722-6

1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	138	135	-	MD 2.09 lower (2.57 to 1.61 lower)	⊕⊕⊕O MODERATE	IMPORTANT
Function (follow-up within 6 weeks; assessed with: Barthel scale, mild to independent function)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	132/138 (95.7%)	126/135 (93.3%)	RR 1.02 (0.97 to 1.09)	19 more per 1000 (from 28 fewer to 84 more)	⊕⊕⊕O MODERATE	IMPORTANT
Pain (follow-up within 6 weeks; measured with: VAS score; range of scores: 0-10; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	138	135	-	MD 2.35 lower (2.93 to 1.77 lower)	⊕⊕OO LOW	IMPORTANT

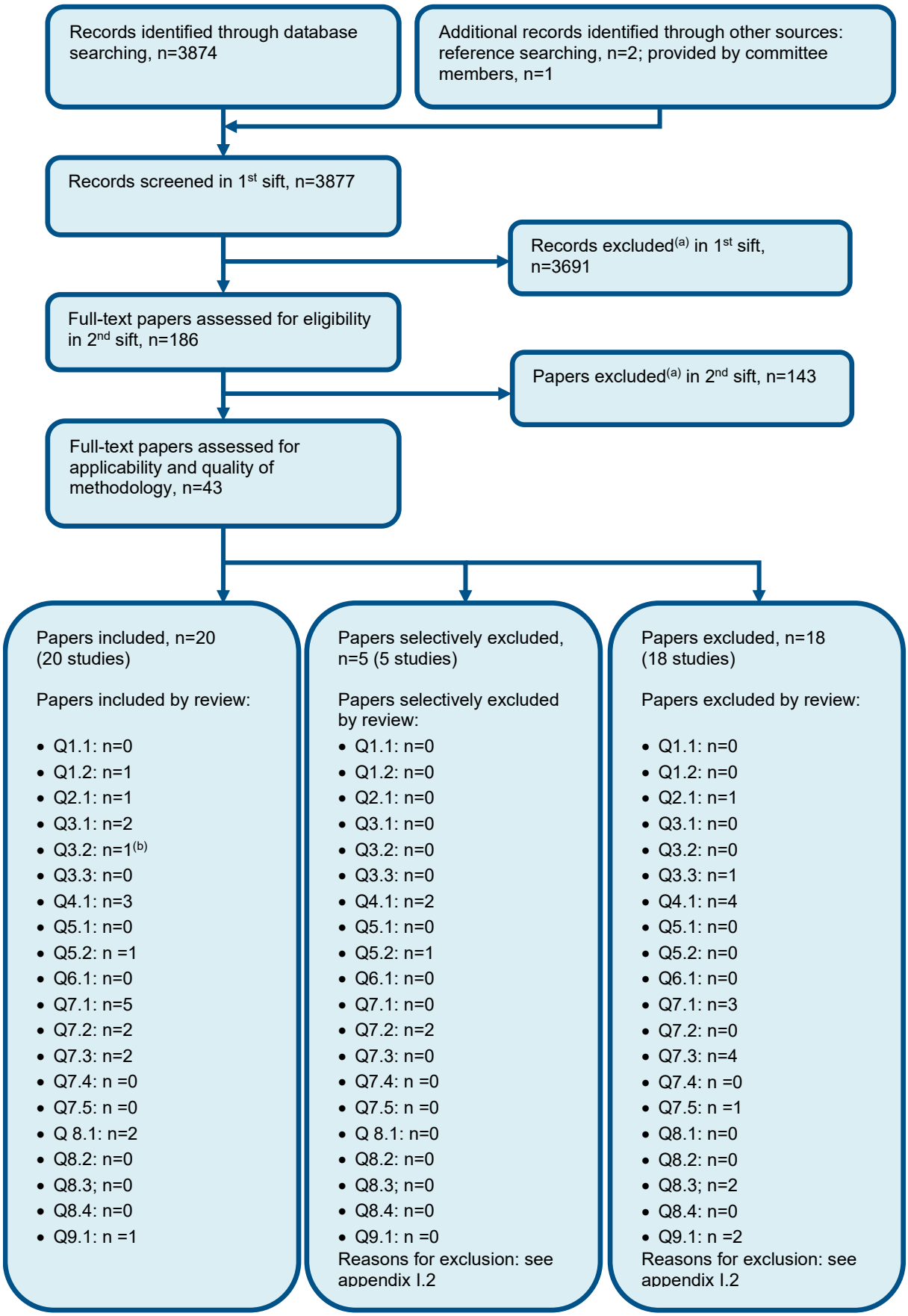
[1] Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs.

ISBN 978-1-4731-3722-6

Appendix G: Health economic evidence selection

Figure 7: Flow chart of health economic study selection for the guideline

ISBN 978-1-4731-3722-6



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

ISBN 978-1-4731-3722-6

Appendix H: Health economic evidence tables

Study	Pengas 2015[20]			
Study details	**Population & interventions**	**Costs**	**Health outcomes**	**Cost effectiveness**
Economic analysis: Cost-consequence analysis **Study design:** Prospective cohort study (with multivariate analysis for health outcomes) **Perspective:** UK NHS **Follow up:** Hospital stay **Discounting:** NR	**Population:** Patients who have undergone knee and hip replacements **Cohort:** Hip group (n=470): Mean age: 65.21 Male: 50% Knee group (n=321): Mean age: 70.95 Male: 54% **Intervention 1:** Standard care, not involving weekend physiotherapy. **Intervention 2:** Standard care plus Weekend physiotherapy, 3 hours a day.	**Weekend physiotherapy costs (mean per patient):** Incremental (2−1): £15.36 (95% CI: NR; p=NR) **Stay costs (mean per patient):** Hip group (2-1):- £192.36 Knee group (2-1): -£285.11 **Total cost (mean per patient):** Hip group (2-1): -£177.00 Knee group (2-1): -£269.75 **Currency & cost year:** UK pounds, year NR **Cost components incorporated:** Cost of physiotherapist time at the weekend, days in hospital cost[(a)].	**Days to mobilise with two sticks:** Hip group: 1: 3.53, 2: 3.11 (2−1): -0.42(95% CI: NR; p=0.0030) Knee group: 1: 3.87, 2: 3.29 (2−1): -0.58 (95% CI: NR; p=0.0037) **Days to discharge:** Hip group: 1: 5.22, 2: 4.95 (2−1): -0.27 (95% CI: NR; p=0.2071) Knee group: 1: 5.45, 2: 5.04 (2-1): -0.41 (95% CI: NR; p=0.2071)	Weekend and standard care physiotherapy was dominant (less costly and more effective) compared to standard physiotherapy **Analysis of uncertainty:** No sensitivity analyses were conducted.
Data sources				
Health outcomes: Based on the outcomes reported in the prospective cohort trial. **Cost sources:** The study did not report where costs were obtained. The cost of weekend physiotherapy was reported as £200 per weekend, and £10,400 over the year. The reported hospital cost savings were based on an extra day in hospital of £687. It is unclear how they obtained the total cost savings of £77,492 and £78,200 – the implied number of patients is different to the sample size reported. However, the NGC used these total cost savings and the reduction in length of stay to infer patient numbers and mean costs.				
Comments				
Source of funding: NR **Limitations:** Looks at weekend physiotherapy versus no weekend physiotherapy rather than early versus late rehabilitation. Prospective cohort study so not included in the clinical review – not randomised, no QALYs, only hospital costs, unit cost sources were not reported, cost per day seemed rather high, not clear if costs were subject to multivariate analysis, no sensitivity analysis.				
Overall applicability:[(a)] Partially applicable **Overall quality:**[(b)] Potentially serious limitations				

Abbreviations: 95% CI: 95% confidence interval; NR: not reported; QALYs: quality-adjusted life-years

ISBN 978-1-4731-3722-6

(a) The unit cost of a bed day assumed, £687, seemed excessive. However, the development team, have estimated that even if a more conservative cost of £300 per day were assumed, then, other things being equal, the study would have still found cost savings of £117 per knee replacement and £77 per hip replacement.
(b) Directly applicable / Partially applicable / Not applicable
(c) Minor limitations / Potentially serious limitations / Very serious limitation

Study	**Pua 2014[21]**			
Study details	**Population & interventions**	**Costs**	**Health outcomes**	**Cost effectiveness**
Economic analysis: Cost-consequence analysis **Study design:** Retrospective cohort study with multivariate regression **Perspective:** Singapore hospital service **Follow-up**: 90 days post-surgery **Discounting:** NR	**Population:** People who underwent a primary, elective, unilateral TKA for knee osteoarthritis, age 50 years and over. **Cohort:** Mean age: 66.4 Male: 20% **Intervention 1:** Late postoperative ambulation on day 2 after surgery, this included knee rage-of-motion and muscle strengthening exercises. n=701 **Intervention 2:** Early postoperative ambulation on day 1 after surgery, this included knee rage-of-motion and muscle strengthening exercises. n=803	**Total costs (mean per patient):** 1: £6,605, 2: £6,386 Incremental (2−1): - £219 (95% CI: -£64, -£383; p=NR) **Currency & cost year:** 2013 Singapore dollars and US dollars (presented here as 2013 UK pounds[(a)]) **Cost components incorporated:** Total hospital billed charges for each patient's entire admission (including readmission). This included room and ward charges, professional fees, laboratory investigations, pharmaceutical supplies, implant and rehabilitation services.	**Hospital length of stay (initial admission):** 1: 4.51, 2: 4.07 Incremental (2−1): -0.44 (95% CI: -0.29, -0.60; p=NR) **90 day readmission rate:** 1: 2.1% (15), 2: 2.4% (19) Adjusted odds ratio: 0.81 (95% CI: 0.40, 1.66, p=0.57)	Early postoperative ambulation was dominant (less costly and more effective) compared to late postoperative ambulation **Analysis of uncertainty:** No sensitivity analyses were conducted.
Data sources				
Health outcomes: Hospital records. **Cost sources:** Hospital data management system.				
Comments: Other outcomes reported were Ability to perform a straight leg raise and to achieve 90° flexion.				
Source of funding: NR. **Limitations:** Singapore setting, retrospective cohort study so not included in the clinical review, short time horizon, only hospital costs, no QALYs and no sensitivity analysis.				
Overall applicability:[(b)] Partially applicable **Overall quality:**[(c)] Potentially serious limitations				

ISBN 978-1-4731-3722-6

Abbreviations: 95% CI: 95% confidence interval; NR: not reported; QALYs: quality-adjusted life-years
(a) Converted from US dollars using 2013 purchasing power parities[19]
(b) Directly applicable / Partially applicable / Not applicable
(c) Minor limitations / Potentially serious limitations / Very serious limitations

ISBN 978-1-4731-3722-6

Appendix I: Health economic analysis

None.

Appendix J: Excluded studies

J.1 Excluded clinical studies

Table 15: Studies excluded from the clinical review

Study	Exclusion reason
Anonymous 2007[1]	Order was cancelled due to record not yet published and therefore being unobtainable
Chen 2004[3]	Not in English
den Hertog 2012[5]	Incorrect interventions
Fusco 2019[6]	Inappropriate comparison
Guerra 2015[7]	Incorrect interventions
Haas 2016[8]	Inappropriate comparison
Larsen 2008[10]	Incorrect interventions
Larsen 2008[11]	Incorrect interventions
Li 2017[12]	Not in English
Masaracchio 2017[13]	Systematic Review not suitable for inclusion. Included studies checked for inclusion in this review
Monaghan 2014[14]	Systematic Review not suitable for inclusion. Included studies checked for inclusion in this review
Munin 1996[15]	Conference abstract
Oldmeadow 2006[18]	Inappropriate comparison
Reilly 2005[22]	Inappropriate comparison
Wasilewski 1990[23]	Inappropriate comparison

J.2 Excluded health economic studies

None.

ISBN 978-1-4731-3722-6