ROYAL AUSTRALASIAN
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Rehabilitation Pathways Following Hip and Knee Arthroplasty

Final report

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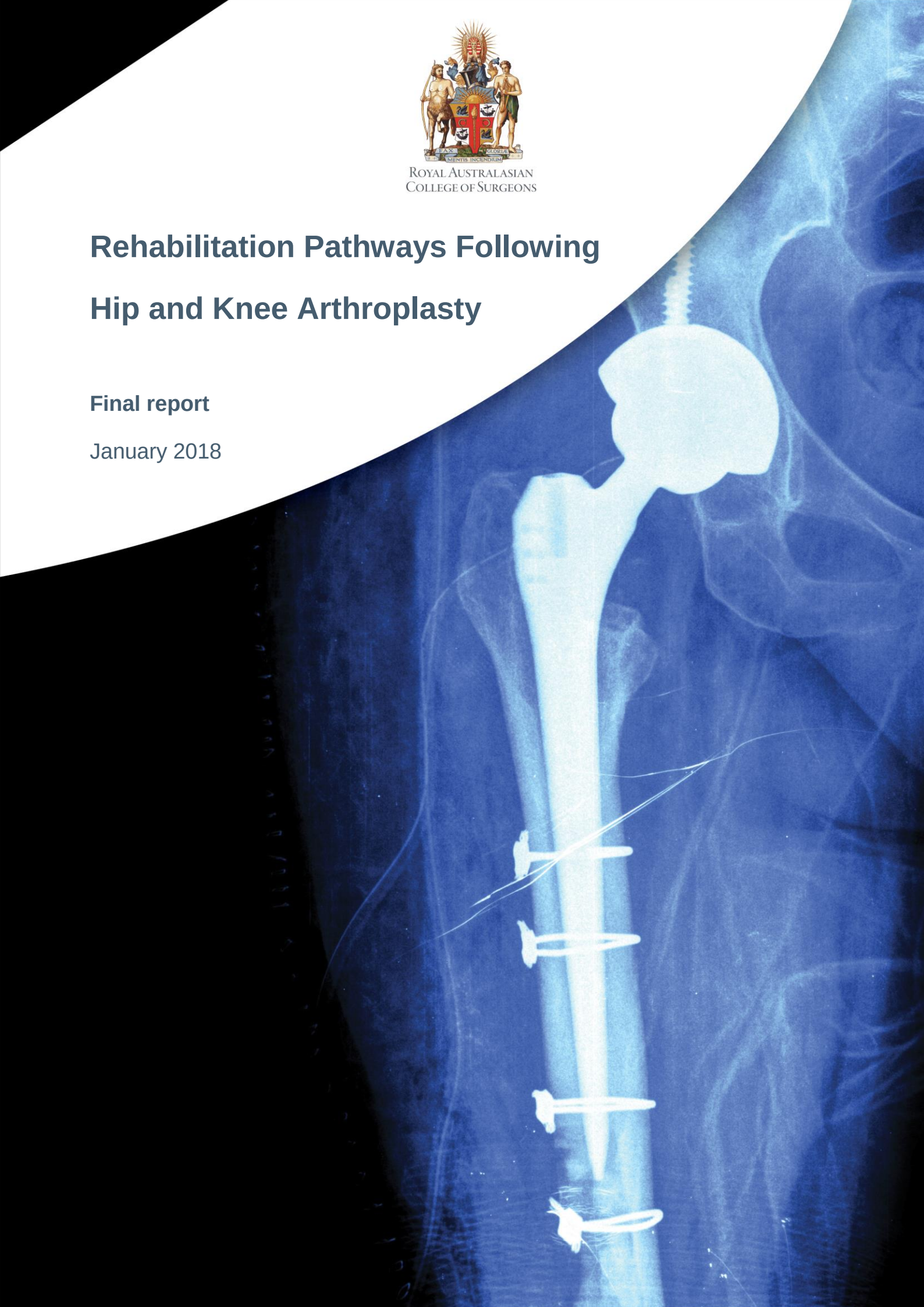

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List of Terms

6MWT	Six Minute Walk Test
ACORN	Arthroplasty Clinical Outcomes Registry National
ASA	American Society of Anesthesiologists
BMI	Body mass index
CCI	Charlson Comorbidity Index
CPG	Clinical practice guideline
COOP	Cooperative Functional Assessment Charts
FIM	Functional Independent Measure
HHS	Harris Hip Score
HIHO	Hospital Inpatient versus Home-based trial
HOOS	Hip Dysfunction Osteoarthritis Outcome Score
IRF	Inpatient rehabilitation facility
KOOS	Knee injury and Osteoarthritis Outcome Score
LHIN	Local Health Integration Network
OHS	Oxford Hip Score
OKS	Oxford Knee Score
OPD	Outpatient department
OR	Odds ratio
PICO	Population, Intervention, Comparator, Outcome
QoL	Quality of life
RACS	Royal Australasian College of Surgeons
RAPT	Risk Assessment and Prediction Tool
RCT	Randomised controlled trial
RGH	Repatriation General Hospital

SD	Standard deviation
SF-36	Short Form-36
SNF	Skilled nursing facility
THA	Total hip arthroplasty
TKA	Total knee arthroplasty
UK	United Kingdom
USA	United States of America
VAS	Visual analogue scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis index

Executive Summary

Background

In 2012/13, total hip and knee arthroplasties (THA/TKA) carried the highest overall cost to the Australian healthcare system of all medical procedures, driven primarily by volume.[1] By the year 2046, conservative projection models have forecast the incidence of hip replacements to rise from 307 to 510 per 100,000, and knees from 437 to 575 per 100,000.[2] Given the large and increasing financial burden of these procedures, potential efficiencies in the model of care for arthroplasty patients are a matter of considerable policy interest.

Rehabilitation services form a core component of the care pathway for THA and TKA patients, as a means of facilitating the recovery of functional independence after surgery.[3] While all Australian hospitals incorporate rehabilitation services into the model of care for joint arthroplasty in the public and private sectors, the setting and level of care provided varies greatly. The objective of this review is to demonstrate and promote current best practice for referral to rehabilitation in different settings following hip and knee arthroplasty, by addressing six research questions (summarised here for brevity):

1. At what rate are patients referred for rehabilitation in different settings after TKA and THA?
2. What are the relevant outcomes of rehabilitation after THA and TKA?
3. What factors impact patient-related outcomes following THA and TKA?
4. What factors influence the choice of setting for rehabilitation after THA and TKA?
5. How effective is inpatient rehabilitation after THA and TKA compared to other settings?
6. What levers have been used to promote alternative clinical pathways for rehabilitation?

Methods

This review was conducted using a combination of rapid and systematic review methods, depending on the requirements of each question. The key clinical questions regarding the factors that influence the choice of setting for rehabilitation, and the relative effectiveness of rehabilitation in different settings were evaluated using comprehensive systematic review methods (question 4 & 5). The rapid review method, which is an adaptation of the comprehensive systematic literature review technique, was used to address the secondary questions for the review (question 1, 2, 3, & 6).[4,5] Peer-reviewed literature was identified through systematic and targeted searches of three biomedical databases (PubMed, Embase and the Cochrane Library) up to 29 May 2017. Studies were selected for inclusion based on pre-defined inclusion PICO (population, intervention, comparator, outcome) criteria by two independent reviewers. Included studies for question 4 and 5 were critically appraised by two independent reviewers. Due to the presence of significant heterogeneity in the reported settings and outcomes, meta-analysis was not possible. The results for each question are reported narratively.

Results and Conclusions

Referral rates to rehabilitation settings

Four studies from Australia and 18 studies from the United States reported referral rates to different settings for rehabilitation.[6-26] Based on the best available data from Australia, it is estimated that 20% of public total TKA and THA patients were referred to an inpatient unit for rehabilitation from 2013–2015 on average,[9] compared to 40% of private patients in 2014.[8] There was, however, considerable variation within the public and private sectors; in the public sector, individual hospitals referred between ~3% and ~60% of patients to inpatient rehabilitation; in the private sector, referral rates for surgeons' patients varied from 0% to 100%, and between state/territory from 4% to 64%. Data from the United States of America (USA) were also highly heterogeneous. A median of 26.0% of TKA or THA patients were referred to an inpatient rehabilitation facility (range 3.1% – 58.0%), 23.8% to a skilled nursing facility (range 0.6% – 44.2%), 34.1% to home with supervision (range 13.3% – 71.6%), and 46.1% to home without supervision (range 2.7% – 74.0%).

Key outcomes

The primary outcomes of interest were pain, function and quality of life. Secondary outcomes included patient satisfaction, length of stay, and adverse events.

Factors affecting arthroplasty outcomes

Patient-related outcomes of joint arthroplasty can be affected by factors along the entire continuum of care, from pre-admission assessment to post-discharge rehabilitation. Factors that may impact patient-related outcomes at the pre-admission and peri-operative stage of the care pathway include baseline demographics, pre-operative rehabilitation pathways, surgical approach, and choice of prosthesis. Studies investigating the effect of rehabilitation on patient outcomes must adequately adjust for confounding factors in the pre-operative and peri-operative care stages.

Factors affecting referral to inpatient rehabilitation

A total of 14 studies investigated the factors influencing the choice of setting for rehabilitation, including a total sample of 164,875 patients.[6,10-13,16,17,22,24,27-31] Factors that predicted the need for inpatient rehabilitation included older age (low quality evidence), female gender (moderate quality evidence) lack of home/community support (low quality evidence), patient expectations (low quality evidence) and existing comorbidities (very low quality evidence). While the evidence base showed a clear association between patient factors and the choice of setting, the model of care that constituted "inpatient rehabilitation" varied across countries. In particular, it is unclear how applicable the skilled nursing facilities defined in studies from the USA are to the Australian context.

Effectiveness of rehabilitation in inpatient versus other settings

Four randomised controlled trials (RCTs) and eight non-randomised comparative studies investigated the effectiveness of rehabilitation in inpatient versus other settings.[30-39] The main outcomes measured in the trials were time walking tests, Oxford Hip/Knee Scores, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, health-related quality of life, Functional Independence Measures (FIM), and patient satisfaction. The inpatient facilities described

in the studies were broadly generalisable to the Australian context, noting that each study provided a different model of inpatient care; however, there was considerable uncertainty regarding the applicability of the skilled nursing facility setting (included in the non-randomised studies) to Australian clinical practice.

The included RCTs were of high to moderate quality, and carefully selected patients that were in relatively good health and were not predisposed to require inpatient care based on clinical need.[33,35,37] Therefore, for patients that are not otherwise indicated for inpatient rehabilitation, the RCTs provided a high to moderate level of evidence that inpatient rehabilitation provided no significant difference in clinical outcomes compared to a home-based rehabilitation with support.

In contrast, the non-randomised studies were more difficult to interpret, due to low quality, selection bias and variations in model of care reported in the studies (including SNFs and outpatient settings).[30-32,34,36,38-40] The results of the observational trials were also inconsistent; when patients with varied clinical status and predispositions were unselectively considered, clinical effectiveness of rehabilitation could not be clearly determined based on setting differences.

Levers and barriers to referral pathways

Tools exist that can be used to pre-operatively identify patients that may benefit from inpatient or home-based rehabilitation.[6,29,41] Preconceived advantages favouring inpatient rehabilitation combined with a sense of entitlement among privately insured patients, are two great barriers to outpatient and home-based rehabilitation. [11,42,43] Patient education throughout the continuum of care can help to reduce any unnecessary use of inpatient rehabilitation. Greater incentives, financial or otherwise, for all stakeholders including patients, surgeons, hospitals and private health insurers should be implemented to promote outpatient and home-based rehabilitation. There is a need for evidence based guidelines fitting for Australian context to be produced to guide and protect good practice in rehabilitation.

Conclusions and recommendations

There is wide variability in the use of inpatient rehabilitation after THA and TKA in both the public and private systems. There are patients who clearly benefit from inpatient rehabilitation. The studies reviewed in this report have identified these as older patients, those with limited social support and existing comorbid conditions. For other patients without clear indications for inpatient rehabilitation, home-based rehabilitation services offer an equivalent outcome. Tools exist to identify which patients are likely to benefit from inpatient or home-based rehabilitation. In order to increase the proportions of patients receiving home-based rehabilitation there will need to be education of the profession, public, patients, providers (hospitals) and payers. Key recommendations as to how this might be achieved and areas needing further research include:

1. Supported home-based rehabilitation services, including home assistance and access to community-based services, should be offered to patients who do not need inpatient rehabilitation.

2. Pre-operative screening tools should be completed in conjunction with patients and caregivers, to identify patients who will benefit from inpatient rehabilitation.
3. Patients and carers should be engaged in the decision about their likely discharge setting, combined with pre- and post-operative education about rehabilitation, in order to help facilitate the use of home-based rehabilitation where appropriate.
4. Influencing change in the care pathway will require multidisciplinary support.
5. Health payers should work with health providers and health practitioners (orthopaedic surgeons and rehabilitation specialists) to develop appropriate benchmarks for the selection of patients who have inpatient rehabilitation after joint arthroplasty.
6. Further research on the impact of pre-habilitation is recommended to inform the optimal pathway of care for TKA and THA patients.

Background

Joint arthroplasty, also known as joint replacement, is an intervention for treating pain and disability caused by degenerative diseases such as osteoarthritis. In 2012/13, total hip and knee arthroplasty (THA/TKA) carried the highest cost to the Australian healthcare system of all medical procedures.[1] The financial burden of TKA and THA procedures has increased over the past decade, primarily due to an increase in the number of procedures performed. Data from the Australian Orthopaedic Association's National Joint Replacement Registry indicate the total numbers of primary THA and TKA increased by 81.7% and 130.4% respectively between 2003 and 2015.[44,45] Conservative projection models have forecast the incidence of hip replacements to rise from an estimated 307 per 100,000 in 2013 to 510 per 100,000 in 2046.[2] Similarly, knee replacements are also projected to rise from 437 to 575 per 100,000 over the same period.[2] The ageing population, and an increase in the use of hip and knee replacements in younger patients due to obesity, are driving factors for the increase in demand.[45]

Rehabilitation is often recommended for TKA and THA patients as a means of facilitating the normalisation of functional independence after surgery.3 The core components for a rehabilitation service model, including the different settings in which rehabilitation may be delivered, are presented in Figure 1.[46] In Australia, TKA and THA patients may be referred to a specialised inpatient rehabilitation centre, an outpatient facility, or a home-based program.[8,9,44] Patients admitted to an inpatient facility typically receive care from a multidisciplinary team, which may include experts in Medicine, Nursing, Dietetics, Physiotherapy, Occupational Therapy, and Social Work. Other settings for rehabilitation offer a lower intensity of care, and include outpatient rehabilitation centres, skilled-nursing facilities (SNF), community-based rehabilitation centres and home-based services.[46-48] Many patients are discharged directly home after TKA and THA without formal supervision.

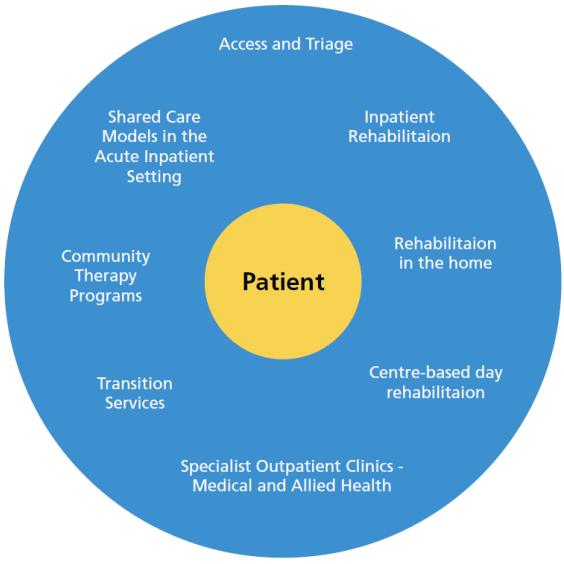

Figure 1 **Service elements of the Model of Rehabilitation in South Australia**

Source: SA Health (2011) Models of Care for Orthopaedic Rehabilitation.[46]

Inpatient rehabilitation services are a significant contributor to the overall cost associated with hip and knee arthroplasty in Australia; however, the use of inpatient facilities varies greatly. In 2016, the Royal Australasian College of Surgeons (RACS) and Medibank investigated surgical variation in Australian private practice.[8] The report found that rates of referral to an inpatient rehabilitation unit varied greatly for both hip (Figure 2) and knee (not presented) arthroplasty patients.[49] This variation was also described in a recent survey of 19 Orthopaedic Surgeons, with some referring all of their patients to a specialist inpatient rehabilitation unit, and others referring all of their patients for home-based rehabilitation.[42] Given the large and increasing cost of hip and knee replacement to the Australian health system, potential efficiencies in rehabilitation pathways are a matter of policy interest.

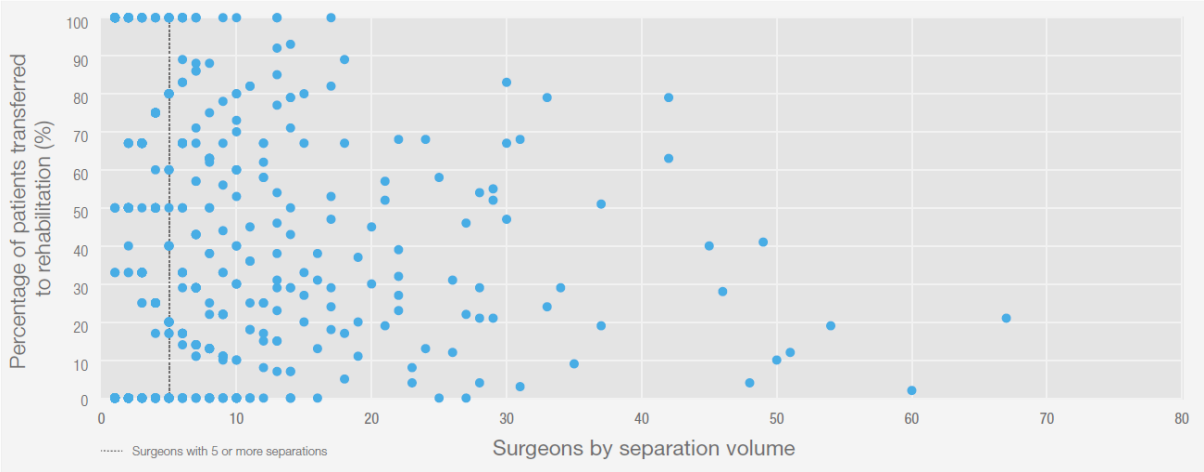

Figure 2 **Percentage of hip arthroplasty patients transferred to an inpatient rehabilitation facility**

Source: RACS and Medibank (2016) Surgical Variance Report - Orthopaedic Surgery.[8]

Research questions

The objective of this project is to demonstrate and promote current best practice for referral to rehabilitation following hip and knee arthroplasty. This objective will be addressed by investigating the following research questions:

1. At what rate are patients referred to inpatient rehabilitation following joint replacements internationally?
2. What are the relevant outcomes used to define a benefit in patients receiving rehabilitation after hip and knee arthroplasty?
3. What factors impact patient-related outcomes following hip or knee arthroplasty?
4. What factors influence the choice of setting for rehabilitation after knee and hip arthroplasty?
5. How effective is inpatient rehabilitation following hip or knee arthroplasty compared to outpatient rehabilitation, community rehabilitation, home-based rehabilitation, and no rehabilitation?
6. What levers have been used domestically and internationally to promote the use of alternative clinical pathways for rehabilitation (e.g. home-based rehabilitation) where clinically appropriate?

Methods

This review was conducted using a combination of rapid and systematic literature review methods. The primary clinical questions regarding the factors that influence the choice of setting for rehabilitation, and the relative effectiveness of rehabilitation in different settings were evaluated using comprehensive systematic review methods (question 4 & 5). The rapid review method, which is an adaptation of a comprehensive systematic literature review technique, was used to address the secondary questions for the review (question 1, 2, 3 & 6). The rapid review format allows the timely identification of the best quality evidence at the highest level to answer the research questions, but may not include the entirety of the available evidence on the topic.[4,5]

Literature search strategy

Peer-reviewed literature

Peer-reviewed literature was identified through a combination of systematic and targeted searches of three biomedical databases (PubMed, Embase and the Cochrane Library) up to 29 May 2017. The systematic literature search was used to identify the majority of evidence included in this review (see Appendix 1 for full details of the search strategy); however, the systematic search strategy was primarily designed to identify the available evidence for research questions 4 and 5. In order to ensure the evidence identified for the remaining research questions was comprehensive, targeted keyword searches of PubMed were conducted to identify additional literature that may have been missed by the primary literature search. The search results were exported into reference management software for study selection (EndNote X7).

Clinical practice guideline and grey literature searches

Separate searches were conducted to identify clinical practice guidelines (CPGs) and other grey literature resources not indexed in the biomedical databases. These resources were primarily sought to supplement the peer-reviewed evidence supporting research questions one, three, four and five. The CPGs and grey literature were sought from a range of grey literature databases, listed in Appendix 1. An article was deemed to be a clinical practice guideline if it met pre-specified criteria adapted from Graham et al.[50] CPGs published after 2011 were reviewed, since CPGs are considered out of date five years after publication.[51,52] Identified CPGs were shortlisted by one researcher based on quality, publication date and relevance to the research questions.

Study selection

The inclusion criteria for this review were based on the relevance of the study population, intervention, comparator, outcomes (PICO) and design to the proposed research questions.[53] Studies were selected by two authors independently (NM/TV) using the pre-defined inclusion criteria, with disagreements settled via consensus. The results of the study selection process are presented in Figure 8 (Appendix 1). All published comparative studies were included for questions 4 and 5. Published literature for questions 1, 2, 3 and 6 was prioritised for inclusion based on study design, date of publication and relevance to the research questions. Priority was given to higher

level evidence (systematic reviews, and randomised controlled trials where available). The inclusion criteria for published literature are summarised in Table 1. For CPGs, priority for inclusion was given to CPGs from Australia and New Zealand. Studies that were excluded at full-text review are listed in Appendix 9.

Table 1 Inclusion and exclusion criteria

PICO element	Inclusion/exclusion criteria
Population	Patients who underwent total hip or knee arthroplasty *Exclusion criteria: Emergency procedures*
Intervention	Inpatient rehabilitation in a specialist rehabilitation unit
Comparators	1. Outpatient rehabilitation 2. Community-based rehabilitation 3. Home-based rehabilitation 4. No rehabilitation
Outcomes	Patient-related outcomes: 1. Pain 2. Function 3. Quality of life 4. Patient satisfaction 5. Adverse events

Data extraction

Data extraction was conducted by one author (NM/TV), and checked for accuracy by a second author (NM/TV), using a standardised extraction template. Data were extracted for study characteristics, patient demographics, primary outcomes, and secondary outcomes. The included studies used to address the primary clinical questions (questions 4 and 5) were appraised for quality by two independent authors (TV, NM). Disagreements in scoring were settled via consensus. Included randomised and non-randomised comparative studies were appraised using the Downs and Black checklist (appraisal results are presented in Table. Ap. 12 (Appendix 6).[54]

Data analysis and synthesis

Meta-analysis was planned in cases where three or more studies report on the effect of similar interventions, on similar populations, using the same outcome measures, and in the absence of significant heterogeneity as measured by I^2 statistics. Significant heterogeneity was defined as I^2 statistic of 75% or higher.[55] As the included studies did not meet these criteria, the results were summarised narratively. The key clinical questions (questions 4 and 5) were summarised and graded using the GRADE tool.[56] Study outcomes were graded based on the quality of the combined evidence to inform a series of guidance recommendations (Table 4 and Table 8).

Working Group

In conducting this review, the Surgical Director of the RACS Research and Evaluation provided clinical input to guide research staff. In addition, representatives from RACS Fellows and Medibank participated as members of a Review Working Group (Appendix 8). This group provided guidance and feedback on the scope and results of the report.

Results

Question 1: At what rate are patients referred to inpatient rehabilitation following joint replacements internationally? Does this differ between public and private sectors?

Evidence highlights

- There is considerable variation in the literature around discharge rates to post-acute rehabilitation for TKA and THA patients.
- Since 2010, Australian discharge rates to an inpatient rehabilitation facility (IRF) ranged between 7.0% and 43.0%, while discharge home ranged from 76.7% to 90.0%. There was a considerable difference between the mean rate of discharge to an IRF in the private (40.1%) and public (20.0%) sectors.
- In the United States, a median of 26.0% of TKA or THA patients were referred to an inpatient rehabilitation facility (range 3.1% – 58.0%), 23.8% to a skilled nursing facility (range 0.6% – 44.2%), 34.1% to home with supervision (range 13.3% – 71.6%), and 46.1% to home without supervision (range 2.7% –74.0%).
- Overall, the data included in this section demonstrate a high degree of variation in the rates of referral for rehabilitation in Australia and the United Stated of America (USA). Factors that impact the choice of destination for rehabilitation, and the relative effectiveness of rehabilitation settings, are explored further in research questions 4 and 5.

Included literature

Literature to address this research question was sourced from the systematic literature search, and supplemented with targeted, non-systematic searches of Medline and grey literature resources. Studies that described the rate of discharge from acute care to different settings following hip or knee arthroplasty were included. In total, 23 studies were identified that reported the discharge destination in TKA and THA patients. Four of the included studies were from Australia,[6-9] 18 were from the USA,[10-25] and one was from Canada.[57]

The Australian data included a total sample of 15,519 hip or knee arthroplasty procedures conducted between 1998 and 2016; however, only two reports reported procedure type separately.[8,9] The included studies primarily reported data from large metropolitan public hospitals;[6,7,9] only one study reported claims data from the private health system.[8] The reported discharge destinations primarily included IRF or unsupervised home-based settings. Outpatient, SNF and supervised home-based rehabilitation were not reported in the identified studies. All four studies included patients who underwent either a primary or revision procedure.

Studies from the USA included a total sample of 1,507,949 hip or knee arthroplasty procedures conducted between 1993 and 2014. Seven studies reported discharge rates for TKA patients separately,[10,12,15,20,22,24,26,58] 12 reported THA discharge rates separately,[10-15,18,20,21,23,25,26] and seven reported combined discharge rates.[10,12,15-17,19,20] Discharge destinations included a mix of IRF, SNF,

and supervised or unsupervised home-based rehabilitation. Most studies separated the results for IRFs and SNFs, but four studies reported IRF and SNF combined as a "rehab facility/institution".[15,16,24,25] The payer was primarily Medicare, Medicaid or private health; however, seven studies did not report which body funded the procedures.

The final study was a report published by the Greater Toronto Area (GTA) Rehab Network, comprising 4,580 patients.[57] In addition to this report, data was sourced from the Ontario Ministry of Health to supplement the GTA report.[59]

Summary of results

The reported referral rates to different rehabilitation settings in Australia and the USA between 2010 and 2014 are summarised in Table 2. Detailed results for all of the included studies, including studies published prior to 2010, are presented in Appendix 2.

Table 2 Referral destinations for rehabilitation following hip or knee arthroplasty (2009–2014)

Indication	Data sets (sample size)	Referral rate %, median (range)			
		IRF	SNF	Home supervised	Home unsupervised
Australia [A]					
THA or TKA [B]	2	**23.55** (7.0 – 40.1)	-	-	**90.0** (N/A)
TKA	2	**32.2** (21.4 – 43.0)	-	-	**76.7** (N/A)
THA	2	**27.1** (17.1 – 37.0)	-	-	**80.8** (N/A)
Canada					
THA or TKA [B]	1	**33%** (13 – 45)	-	**47%** (N/A)	**38%** (N/A)
United States					
THA or TKA [B]	3	**30.8** (10.8 – 35.8)	**18.8** (N/A)	**0** (N/A)	**69.2** (64.2 – 70.4)
TKA	3	**19.75** (3.1 – 32.5)	**23.8** (22.5 – 25.1)	**47.2** (45.9 – 71.6)	**21.2** (2.7 – 67.5)
THA	4	**27.1** (13.1 – 52.9)	**44.2** (N/A)	**0** (N/A)	**58.9** (44.7 – 74.0)

Notes: A Reports from the Australasian Rehabilitation Outcomes Centre (AROC) were also identified in the search strategy, but were not included in this review. Discharge rates to different rehabilitation settings could not be determined from the data presented in AROC reports. **B** "TKA or THA" refers to datasets that reported discharge rates from TKA and THA procedures combined.

Abbreviations: **IRF** = inpatient rehabilitation facility; **N/A** = not applicable; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty.

Australia

Across the included datasets, between 7.0% and 46.0% of TKA/THA patients were discharged to an IRF, and 54.0% to 90.0% were discharged home without supervision. The choice of setting for rehabilitation differed considerably between the public and private sectors. Based on the reported discharge rates, it is estimated that 20.0% of public patients were referred for hospital inpatient rehabilitation after TKA/THA on average,[9] compared to 40.1% of private patients.[8] These estimates are based on the most robust data available, namely, the Arthroplasty Clinical Outcomes Registry National (ACORN) registry and Medibank clinical variation report.[8,9] Although the data suggest fewer patients are referred for inpatient rehabilitation in the public sector, the estimates are based on a sample of only eight public hospitals, with a large degree of between-hospital variation. Therefore, the rate of referral in the public sector may be different at the national level.

The upper range of IRF referrals for the combined group (i.e. 46.0%) was reported from public hospital data from 1998–2000; however, recent public hospital data from 2013–2015 reported a declining trends in the discharge rates to IRFs of 7.0% and 21.4% from two studies.[7,9] Indeed, the Arthroplasty Unit at the Repatriation General Hospital (RGH) in South Australia reported a strong trend towards the use of home-based rehabilitation over time (Figure 3). In the Oct–Dec quarter of 2006, the RGH reported a 38.8% discharge rate to inpatient rehabilitation, and 51.0% to home-based rehabilitation. Following the implementation of a clinical care pathway, the RGH reduced referrals to inpatient rehabilitation services to 7.0%, and increased referrals to home-based rehabilitation to 91.4% by the first quarter of 2008. These rates were maintained to 2016. Referral to an IRF was higher for revisions (15.0%) compared to primary (7.0%); however, this data could not be used in overall calculations due to uncertainty around the denominators.

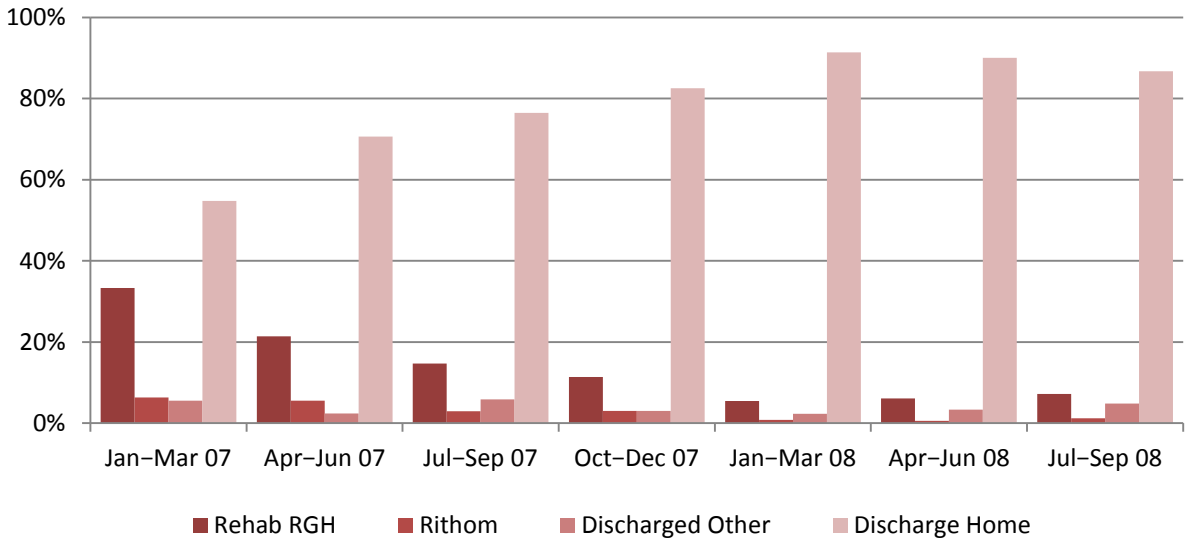

Figure 3 **Referral to different settings for rehabilitation following TKA and THA at the Repatriation General Hospital (RGH, Public Sector), South Australia.**

Source: Adapted from Repatriation General Hospital (2008) Quarterly report: July, August & September.[60]

The ACORN registry data found women were more likely to be discharged to inpatient rehabilitation following TKA or THA compared to men; however, there was considerable variation between hospitals, not only related to gender, but in overall referral rates to inpatient services (Figure 4).[9]

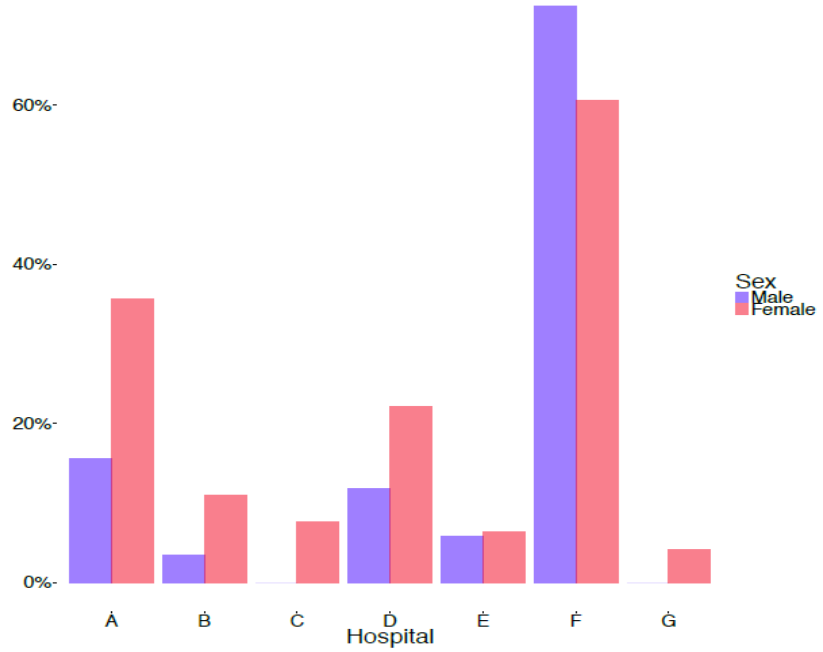

Figure 4 **Referral to inpatient rehabilitation following hip arthroplasty in Australia, by public hospital**

Source: ACORN (2016) Annual Report.[9] **Note**: Hospitals have been de-identified

In the private sector, there is also considerable variation by state. In 2014, 37% of THA patients were discharged from acute care to an inpatient rehabilitation facility in the private sector.[8] By state, discharge rates ranged between 4.0% in Tasmania to 53.0% in New South Wales (median 34.0% in South Australia).[8] Transfer rates for TKA patients were similar, with a mean transfer rate of 43%, a range of 14% to 64%, and a median of 33% (South Australia).

Canada

In 2009/10, the GTA Rehab Network reported rates of discharge to an IRF from five acute hospitals in the Toronto Central Local Health Integration Network (LHIN). The reported rates of discharge to an IRF ranged between 13% and 45%.[57] In addition, 38% of patients were sent home with no support, and 47% of patients were sent home with support from a Community Care Access Centre that provides access to in-home and community-based rehabilitation services.

Additional data from the Ontario Ministry of Health identified that other LHINs in Ontario discharge 91% of THA and 92% of TKA patients 'home' in 2013/14 (Figure 5).[59] However, this data does not describe what percent of "home" discharges required support from a Community Care Access Centre, nor what percentage of patients were referred to an IRF.

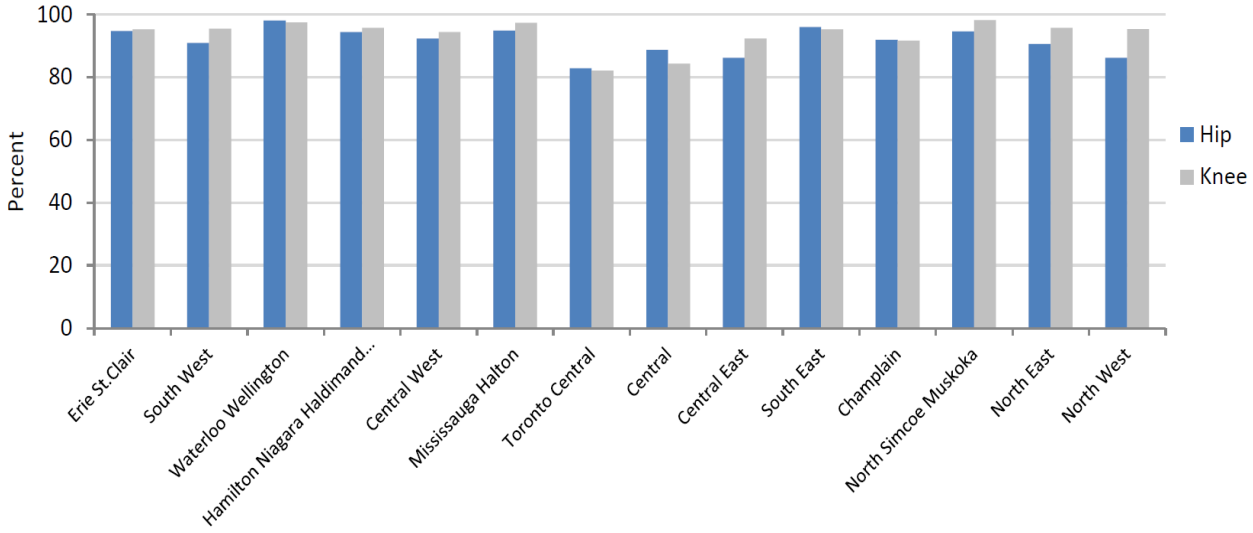

Figure 5 **Percent of patients discharged 'home' following hip arthroplasty (Q3 2013/14) in Ontario, Canada**

Source: Ontario Ministry of Health (2014) Orthopaedic Quality Scorecard Primary Hip Knee Replacement, Q3 2013/14.[59]

United States of America

Across the included data sets, the average rate of referral was 14.9% to an IRF (median 26.0%, range 3.1% to 58.0%), 26.7% to an SNF (median 23.8%, range 0.6% to 44.2%), 22.2% to supervised home care (median 34.1%, range 13.3% to 71.6%), and 36.0% to unsupervised home care (median 46.1%, range 2.7% to 75.0%). Three studies reported referral rates over time. Shah et al. (2017) and Ong et al. (2015) reported a trend towards fewer referrals to IRFs, and increasing use of SNFs and home health services between 2004 and 2009 (Figure 6).[58] Conversely, Ganz et al. (2003) demonstrated a trend over time towards inpatient rehabilitation, which was associated with shorter lengths of stay in acute care, but overall the majority of patients were discharged home.[14]

There are two key challenges in interpreting data from the USA:

1. **Funding arrangements** in the USA offer different incentives to refer patients into IRFs, SNF or home-based rehabilitation settings compared to Australia. For example, three studies reported Medicare patients in the USA were referred to an IRF for rehabilitation at a higher rate than privately insured patients; however, these funding arrangements are structured differently to the Australian healthcare system.[10,23,24]
2. **Skilled nursing facilities**, as they are defined in the literature, introduce a high degree of complexity and uncertainty to the rehabilitation settings reported from the USA. It is unclear whether rehabilitation in an SNF is equivalent to an inpatient, outpatient or community setting in Australia. As a result, the addition of the SNF category dilutes the overall rates as they are reported in Australia (i.e. inpatients versus home-based), making comparisons difficult. This issue is a key consideration throughout the report.

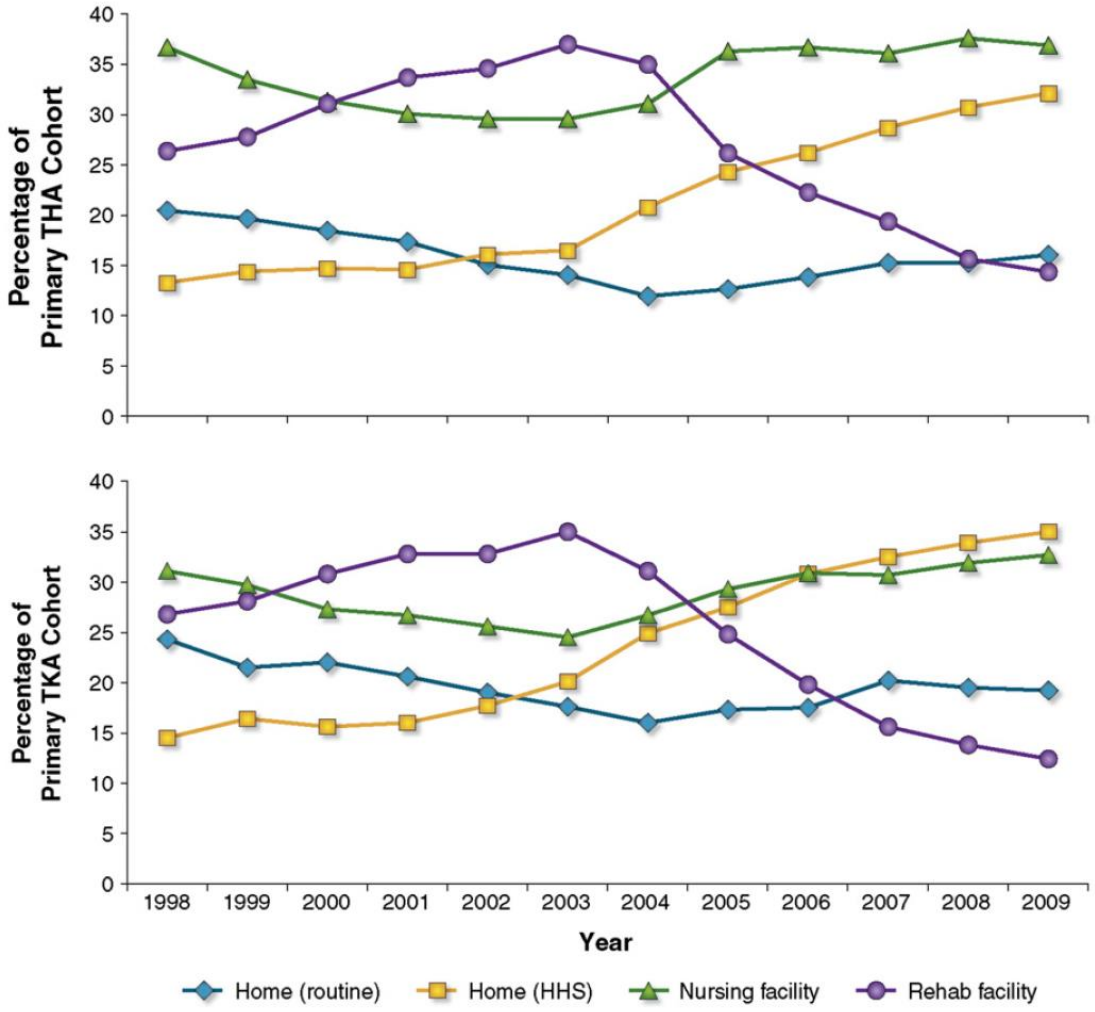

Figure 6 **Trends in discharge status following primary THA and primary TKA**

Abbreviations: **HHS** = Home Health Services; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty.

Source: Ong et al (2015).[26]

Question 2: What are the relevant outcomes used to define a benefit in patients receiving rehabilitation after hip and knee arthroplasty?

Evidence highlights

- The primary outcomes of interest are function, pain and quality of life (QoL).
- Functional outcomes of arthroplasty can be measured using many tools, of which the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC), the Harris Hip Score (HHS), the Oxford Hip Score (OHS), the Oxford Knee Score (OKS) and the Functional Independence Measure (FIM) are the most widely reported.
- Pain scores are incorporated into many functional measures, but may be measured independently using visual analogue scales.
- QoL outcomes are measured on generic visual or analogue scales, or with specific health-related tools such as the Short-Form 36 (SF-36) or Short-Form 15 (SF-15) questionnaires.

Included literature

In total, six systematic reviews that evaluated or reported on outcomes that are relevant to TKA and THA were included.[61-66] A summary of the reviews are presented in Appendix 3, noting that two reviews were conducted by the same authors and have been grouped.

Summary of results

In broad terms, the primary aim of rehabilitation, as defined previously, is to facilitate the restoration of functional independence. In addition, the main treatment goals of arthroplasty are to reduce pain, improve function and increase quality of life (QoL). The primary outcomes of interest can be measured by a range of tools and questionnaires, of which the most common are:

1. **Function**: Relevant measures for functional capacity include, but are not limited to: WOMAC, OHS, OKS, FIM, HHS, Hip Dysfunction Osteoarthritis Outcome Score (HOOS) and Knee injury and Osteoarthritis Outcome Score (KOOS).[61-66]

2. **Pain:** Relevant measures for pain include, but are not limited to: visual analogue scale (VAS), McGill Pain Questionnaire, WOMAC, OHS, OKS, and HHS.[61-66]

3. **Quality of Life:** Relevant scales to measure Quality of Life (QoL) include: 36-item Short Form Health Survey Questionnaire (SF-36), Dartmouth Cooperative Functional Assessment Charts (COOP), Nottingham Health Profile, and RAND 36-Item Health Survey (RAND-36).[64,65]

There is considerable heterogeneity in the tools used to score patient-reported outcomes. The OKS, HOOS, KOOS, WOMAC and SF-36 have demonstrated to be the most robust and reliable,[62] and are the most commonly reported in the literature.

Other outcomes that have been used to define a benefit in patients receiving rehabilitation for THA or TKA include: patient satisfaction, adverse events (e.g. infection, thrombosis, falls), cost of care, and readmission rates.

Question 3: Which factors impact patient-related outcomes following hip or knee arthroplasty?

Evidence highlights

- Patient-related outcomes of joint arthroplasty can be affected by factors along the entire continuum of care, from pre-operative assessment to post-operative rehabilitation.
- Existing systematic reviews have highlighted a number of factors that impact patient-related outcomes during different stages of the care pathway, including:
    - Pre-admission care (e.g. baseline demographics, pre-operative rehabilitation)
    - Peri-operative care (e.g. choice of prosthesis, early-mobilisation)
    - Post-discharge care (e.g. physiotherapy setting, assistive devices, pain management)
- Studies investigating the effect of rehabilitation on patient outcomes must adequately adjust for confounding factors in the pre-operative and peri-operative care stages.

Included literature

Literature to address this research question was sourced from targeted, non-systematic searches of Medline and the Cochrane Library, as well as grey literature searches for clinical practice guidelines and models of care. Systematic reviews that identified factors affecting the outcomes of patients during different steps in the care pathway, and guidelines or published models of care relevant to Australian clinical practice were included. In total, 17 systematic reviews were included, noting that many more exist that have evaluated the effects of different management decisions along the continuum of care. A summary of the included systematic reviews is presented in Appendix 4.

In order to evaluate the impact of rehabilitation on patient outcomes (i.e. question 5), an understanding of the factors that affect outcomes along the pathway of care for joint arthroplasty patients is needed. Although there is no standardised pathway of care for joint arthroplasty in Australia, there are three broad stages that are consistent across states: 1) pre-admission, 2) peri-operative, and 3) post-discharge care.[46-48] A simplified pathway illustrating the key stages in the care of joint arthroplasty patients is presented in Figure 7. This figure was informed by the models of care published by the South Australian, Western Australian and New South Wales Departments of Health.[46-48]

Management decisions along the continuum of care can have an impact on patient outcomes at different time points. Some management decisions have short-term impacts on specific outcomes; for example, an Enhanced Recovery After Surgery program may lead to reduced length of stay in the acute care setting, but does not affect patient-related outcomes beyond 30 days.[67] In this example, enhanced recovery programmes would not need to be accounted for in an evaluation of rehabilitation services unless they impacted the discharge destination from acute care.

In contrast, other factors have demonstrated effects on long-term patient outcomes, and therefore should be adjusted for in an evaluation of rehabilitation effectiveness.[68,69] These confounding factors occur in the pre- and peri-operative stages of the care pathway, and are described below.

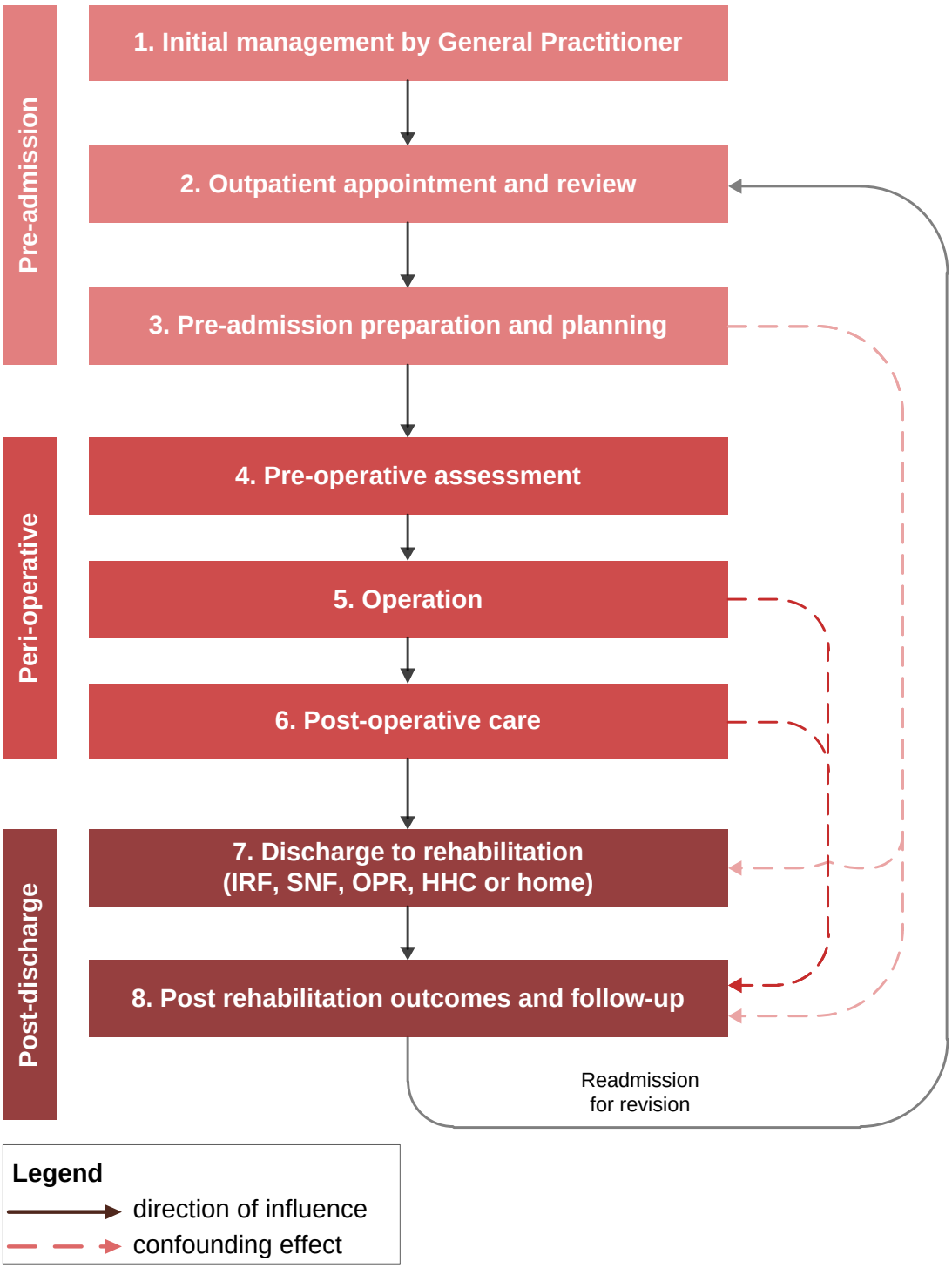

Figure 7 **Pathway of care for joint arthroplasty in Australian clinical practice**

Source: Modified form SA Health (2015).[46]

Abbreviations: **IRF** = inpatient rehabilitation facility; **HHC** = home health care; **OPR** = outpatient rehabilitations; **SNF** = skilled nursing facility.

Summary of results

Pre-admission factors

The pre-admission stage of the care pathway refers to the time that a patient first contacts their General Practitioner, up to admission to hospital for surgery. Pre-admission assessment typically includes multidisciplinary review of the need for surgery, triage onto a surgery waiting list, pre-operative rehabilitation (also known as "pre-hab"), self-management and education programs.[46-48] In particular, pre-hab has demonstrated a limited effect on post-operative outcomes compared to no pre-hab, but is associated with the post-surgery discharge destination for rehabilitation.[70-73]

In addition to management decisions, pre-admission patient demographics have been demonstrated to significantly impact outcomes across the care pathway.[70] Factors associated with patient-related outcomes include: age,[68,70,74-76] gender,[68,69,75,76] body mass index (BMI),[68,69,75-77] ethnicity,[69] American Society of Anesthesiologists (ASA) score,[70,78] comorbidities,[68-70,74,78] baseline pain and function scores,[68-70,79] mental health status,[69,70] educational status,[68] and indication for surgery (e.g. primary or revision).[74,76,79]

Peri-operative factors

The peri-operative stage of the care pathway refers to the time from admission on the day of surgery until discharge from acute care in the orthopaedic ward.[46-48] Factors associated with the peri-operative stage that can impact patient outcomes include the type of procedure (e.g. bilateral vs unilateral; posterior vs anterior),[76,80] procedure duration,[76] femoral head size,[74] choice of prosthesis (e.g. cemented or cementless),[76,79] surgeon volume,[74] type of anaesthetic block,[74] and early mobilisation techniques.[73] The long-term effects of procedure type are uncertain, but there is a demonstrated effect on short-term outcomes that may affect discharge destination for rehabilitation.

Post-discharge factors

The post-discharge stage of the care pathway refers to the time after patients are discharged from acute care in the orthopaedic ward.[46-48] Post-discharge factors that may have an impact on the long-term patient outcomes include physiotherapy exercises and setting (e.g. in an outpatient setting) or unmonitored (e.g. home-based),[43,81,82] and assistive devices, education about hip precautions and environmental modifications.[65]

Pre-admission, peri-operative and post-discharge factors have a demonstrated impact on patient outcomes along the continuum of care. Primary studies that aim to evaluate the effectiveness of rehabilitation in different settings must account for these confounding factors.

Question 4: What factors influence the choice of setting for rehabilitation after knee and hip arthroplasty?

Evidence highlights

- The evidence base showed a clear association between patient factors and the choice of setting for rehabilitation after total knee and hip arthroplasty.
- Which model of care constitutes "inpatient rehabilitation" varied across the included studies. Whether or not the evidence base is applicable to Australian context is uncertain.
- Referral to an inpatient rehabilitation facility was associated with old age, female gender, lack of home/community support, patient expectations, and pre-existing comorbidities.
- Race and insurance status may have an impact, but their influence is uncertain.
- The Risk Assessment and Prediction Tool, developed in Australia, can be used to determine patients' need for rehabilitation destination before surgery, especially for low risk patients.
- Factors influencing the choice of rehabilitation settings were multifaceted, and more evidence is needed for patients under medium to high risk categories.

Included literature

A total of 14 studies investigated factors influencing the choice of setting for rehabilitation after knee and hip replacement. The majority of studies (k = 11) were undertaken in the USA, and the other three were from Australia (k = 2) and France (k = 1). The year of publication ranged from 2005 to 2016 with over half published post-2010. Sample sizes of all included studies were over 100, the largest study evaluated medical records from 164,875 patients.[12] Eight studies investigated both TKA and THA.[6,10,12,16,17,28,29,31] Three studies only included THA,[11,13,30] and three studies only included TKA.[22,24,27] Six studies included revision procedures.[6,10,11,16,29]

Inpatient rehabilitation and home discharge (with or without supervision) were the primary destinations after arthroplasty; however, limited information regarding the level of care provided in different settings was reported. All but one of the included studies investigated home-based rehabilitation.[27] Six studies also had some patients discharged home without receiving any supervised or structured rehabilitation.[10,12,16,17,29,30] The level of care provided in hospital-based rehabilitation was more difficult to determine. As there were more studies from the USA, skilled nursing facilities (SNF) were reported widely across the included studies; however, there is considerable uncertainty regarding the applicability of the SNF setting to Australian clinical practice, as discussed earlier. Nine studies broadly categorised inpatient rehabilitation facilities (IRF) and SNFs as "extended care facilities".[10,12,13,16,17,24,28-30]

The quality of the included studies was medium to low (Table 3). All the studies were marked down due to their study design—lack of blinding, randomisation or allocation concealment—however, this is more reflective of the level of evidence rather than quality of the studies. All the included studies were non-comparative in nature, and they all conducted some level of statistical analyses to investigate factors impacting referral to different rehabilitation settings. The most common methods

used were logistic regressions, predicting settings (the independent variable) from a range of different factors (the predictors). Odds ratios were reported to indicate the likelihood of being discharged to specific rehabilitation settings when certain factors were present, absent or varied to a certain degree. However, some studies did not present sufficient detail of their models, or presented them in an obscure fashion.[30,31] Other studies did not specify their baseline categories in their reporting.[10,28,31] Furthermore, relevant point estimates were also omitted or reported unclearly in some studies.[24,31] These issues made the results difficult to interpret.

Table 3 Quality appraisal for all the included studies

Author	Year	Reporting	External Validity	Internal Validity: Bias	Internal Validity: Confounding	Power calculations	Overall
Bozic et al.	2006	8	3	4	3	1	19 of 27
Dauty et al.	2009	10	2	3	3	1	19 of 27
de Pablo et al.	2004	8	3	4	3	0	18 of 27
Freburger et al.	2011	8	1	4	3	0	16 of 27
Fu et al.	2017	8	3	4	3	0	18 of 27
Inneh et al.	2016	8	3	4	3	0	18 of 27
Halawi et al.	2015	9	3	4	3	1	20 of 27
Hansen et al.	2015	5	3	4	3	0	15 of 27
Keswani et al.	2016	9	3	4	3	0	19 of 27
Oldmeadow et al.	2003	7	0	4	2	0	13 of 27
Rissman et al.	2016	9	1	4	2	0	16 of 27
Schwarzkopf et al.	2016	7	3	4	3	0	17 of 27
Tian et al.	2010	9	3	4	4	0	20 of 27
Tribe et al.	2005	7	0	4	3	0	14 of 27

Summary of results

A number of factors were analysed by the included studies. Significant factors (marked with ✓), and factors which were analysed but remained nonsignificant (marked with ⃠) are presented in Table 5. For simplicity, numerical estimates (e.g. odds ratios and 95% CIs) were summarised narratively, and detailed data extractions are presented in Appendix 5. Patient demographic profiles were the widest investigated factors, followed by availability of caregivers, patient expectations and insurance status. Regarding patient demographic factors, age and gender were investigated by all of the included studies. Two studies investigated the accuracy of The Risk Assessment and Prediction Tool (RAPT) in predicting patients' rehabilitation destination, which will be discussed separately.[6,29] Table 4 provides a summary of findings for selected outcomes that were reported for question 4.

Table 4 GRADE of the evidence base on factors affecting rehabilitation setting

Factor	Participants (studies)	Relative effect (inpatient vs home)	Quality of the evidence (GRADE)	Comments
Older age	379,503 (14)	OR ranged from 3.62 (95% CI NR) to 19.90 (95% CI NR)	⨁⨁◯◯ LOW	Age groups were inconsistently stratified
Female gender	376,290 (13)	OR ranged from 1.14 (95% CI 0.91 to 1.43) to 3.62 (95% CI NR)	⨁⨁⨁◯ MODERATE	Included most of the studies, some are very large
Care-giver (assisted with: availability of caregiver at home)	172,979 (7)	not pooled	⨁⨁◯◯ LOW	Effects of some studies were inconclusive/ conditional
Greater comorbidity	202,019 (7)	OR ranged from 1.37 (95% CI 1.32 to 1.43) to 10.8 (95% CI NR)	⨁◯◯◯ VERY LOW	A variety of comorbidity measured were used
Worse pre-op functional status	164,704 (3)	OR ranged from 1.09 (91% CI 0.91–1.32) to 2.09 (95% CI = 1.85, 2.35)	⨁⨁◯◯ LOW	One of three studies found no significant difference
Worse post-op functional status	3,507 (1)	OR 5.60 (95% CI 3.52–8.92)	⨁⨁◯◯ LOW	Only measured by one study
Race-ethnicity (white/black/Asian; Hispanic)	201,646 (4)	not pooled	⨁◯◯◯ VERY LOW	Race/ethnicity groups were not consistently used/defined across studies
Insurance status (assessed with: Medicare/ Medicaid/ Privately insured)	201,422 (4)	not pooled	⨁◯◯◯ VERY LOW	The instrument used across studies was not consistent/clear
Patients' expectations	1,022 (2)	OR 169.53 (95% CI 60.67 to 473.76)	⨁◯◯◯ VERY LOW	Only one study reported the estimated effect size

Abbreviations: **CI** = Confidence interval; **NR** = not reported; **OR** = Odds ratio.

[a] GRADE Working Group grades of evidence.[83]

⨁⨁⨁⨁ **High quality:** We are very confident that the true effect lies close to that of the estimate of effect.
⨁⨁⨁⊙ **Moderate quality:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
⨁⨁⊙⊙ **Low quality:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
⨁⊙⊙⊙ **Very low quality:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.),

Factor: age

For age, elderly patients were more likely to be admitted to an extended care facility (inpatient or SNF) for rehabilitation; however, the likelihood between different ages (or age groups) was varied. Where odds ratios (OR) were estimated, very little differences were observed between patients younger or older than 55 years, except in the study by Bozic and colleagues.[10] Bozic et al. reported that THA patients aged between 40 to 46 years were 3.6 times more likely (95% CI not reported, $p < 0.01$) to be admitted to an extended care facility (versus home discharge), compared to patients 40 years or younger; however, this impact was not observed in TKA patients in the same study.

Four studies found the odds of going to inpatient rehabilitation increased dramatically for patients over the age of 70.[10,11,13,24] Bozic et al. (2006) reported THA patients over 80 years were almost 20 times more likely to be admitted to an extended care facility compared to those aged 40 years or younger (OR = 19.9, 95%CI not reported, $p < 0.01$).[10] This estimate was also observed by Rissman et al. (2016) (OR = 16.1, 95%CI = (3.4, 40.7), $p < 0.01$).[22] These studies also confirmed that there was a positive gradient in odds towards inpatient rehabilitation as patients grew older.[10,22] The other two studies reported a smaller but still significant impact comparing patients that were older (OR = 2.8, 95% CI [2.6, 2.9], $p < 0.001$) and younger than 70 years (OR = 1.6, 95% CI [1.3, 1.9], p value not reported).[11,13]

Factor: gender

Gender was another commonly analysed factor. Eight out of thirteen studies identified gender as a significant, independent factor for inpatient rehabilitation,[10,12,13,16,17,22,24,30] and findings for this factor appeared to be very consistent across these studies. Females were approximately 2 to 3 times more likely to receive rehabilitation in an inpatient facility. Interestingly, both RAPT studies did not find gender as a factor in predicting the need for an extended care facility in rehabilitation.[6,29]

Factor: race/ethnicity/socioeconomic status

Four studies, which were all from the USA, identified race (ethnicity) to be a significant factor towards inpatient rehabilitation, but reported variable results. Schwarzkopf and colleagues found that Hispanic ethnicity was 1.5 time more likely (95% CI = (1.4, 1.5), $p < 0.001$) to have inpatient rehabilitation at skilled nursing facilities.[24] Tian and colleagues reported white people were discharged significantly more to outpatient rehabilitation (OR = 4.7, 95% CI = (1.7, 12.8), $p < 0.01$) but not home (OR = 0.4, 95% CI = (0.2, 0.8) $p < 0.05$); however, the study was not clear which setting was used as the baseline being compared against. Therefore, these findings are difficult to interpret.

The most detailed comparison regarding race/ethnicity was undertaken by Freburger and colleagues from the USA. This study not only compared ethnic groups but also combined those groups with insurance status (Medicare/Medicaid insured or not, to be distinguished from the Australian Medicare Scheme) as well as private/public settings. Under different insurance providers and private/public settings, differences between races had varied impacts on the choice of rehabilitation

settings. Under a private and Medicare insured setting, black and Hispanic people, compared to white people, were more likely to receive inpatient rehabilitation (OR = 1.7 and 1.3 respectively, $p < 0.01$). Conversely, when patients were Medicaid insured or not insured at all, the black and Hispanic groups were less likely to receive inpatient rehabilitation compared to white people.

Three studies investigated the impact of socioeconomic status on rehabilitation settings.[11,12,16] One study did not find socioeconomic status to significantly influence the discharge destination.[11] Conversely, using the highest median income as the baseline, Freburger and colleagues (2011) found that the lower the income, the higher the likelihood of choosing inpatient rehabilitation. Patients in the lowest quartile (Q1) were 1.3 times more likely to have inpatient rehabilitation compared to the highest quartile (Q4) (95% CI = 0.3, 1.4, $p < 0.001$).[12] This finding was supported by Inneh and colleagues (2016).[16] Besides socioeconomic status, these two studies also investigated other factors such as geographic locations of patients, hospital profiles, rehabilitation service availabilities in hospitals and patients' local areas. Both studies found that patients living in large metropolitan areas were more likely to receive inpatient rehabilitation compared to micropolitan (defined as a population <50,000) and rural areas (OR = 1.3, 95% CI = [1.2, 1.4], $p < 0.001$, Freburger et al.).[12]

Factor: comorbidity

Seven studies investigated comorbidity as a factor for the choice of rehabilitation settings, and five of them found it significant. In general, patients with more and severe comorbidities were more likely to be referred to an inpatient facility; however, the measures of comorbidity were not consistent across the studies. Various composite comorbidity indices were used to measure the severity of comorbidities for patients.

The Charlson Comorbidity Index (CCI) was used by two studies.[13,24] Schwarzkopf and colleagues found that patients were 1.4 times more likely (95% CI = [1.3, 1.4], $p < 0.001$) to receive inpatient rehabilitation with one CCI score increase.[24] Similar findings was reported by Fu and colleagues (CCI > 5, OR = 2.0, 95% CI = [1.9, 2.2], $p < 0.001$).[13]

ASA scores (I–V) were used as a general indicator of comorbidity by two studies, which is appropriate given the vast majority of patients were treated for elective procedures.[10,13] Both studies found that higher ASA score was associated with a higher likelihood of receiving inpatient rehabilitation. Compared to ASA I patients, ASA IV patients undergoing THA were 10.8 times more likely to receive inpatient rehabilitation ($p < 0.01$), ASA III patients 3.5 more likely ($p < 0.01$) and ASA II patients 1.9 times more likely ($p < 0.01$). For TKA patients, the effect of comorbidities on inpatient rehabilitation was only statistically significant for ASA III patients (OR = 1.6, $p < 0.01$).

The RAPT study by Oldmeadow and colleagues only accounted for mobility related comorbidities in their prediction tool, without specifying what specific metrics were used.[6] They argued that comorbidities were pre-screened for surgery eligibility. Therefore, when patients were found to be

acceptable for elective joint arthroplasty, they did not have an increased need for rehabilitation due to existing medical conditions.

The remaining two studies found comorbidities had no significant impact on rehabilitation discharge.[11,30] de Pablo et al. (2004) reported ASA, whereas Tian et al. (2010) reported specific comorbid conditions (morbid obesity, hypertension, diabetes and ischaemic heart disease).[11,30]

Factor: caregivers' availability

For patients undergoing rehabilitation, the availability of caregivers (partners, children, relatives, friends or anyone who lived together with patients) had a significant impact on the choice of rehabilitation setting. Seven studies investigated this factor,[6,11,12,27-29,31] and six of them found it to be significant.[6,11,12,28,29,31] Where point estimates were reported, patients were 4 to 6 times more likely to receive inpatient rehabilitation when home help or caregivers were not present or inadequate.[6,28]

Factor: patients' expectations

Patient expectations were important to the choice of settings for rehabilitation. Although only two studies reported this factor, both found it significant.[6,28] Halawi and colleagues found that patient expectations could significantly impact the choice of rehabilitation setting by almost 170 times (OR = 169.5, 95% CI = [60.7, 473.8], $p < 0.001$). In other words, inpatient rehabilitation was 170 times more likely to take place if the patient preferred this option. One of the RAPT studies by Oldmeadow et al. (2003) acknowledged the substantial impact of patient expectation on choice of setting.[6] However, it was considered an unstable predictor to patient rehabilitation hence patient expectation was removed from the RAPT tool (discussed in detail below).

Factor: insurance status

Insurance status was investigated by three studies, all of which were based in the USA. As described above, Freburger and colleagues combined insurance status with ethnicity and private/public settings in their investigation. Under the same ethnicity groups, levels of insurance showed a clear pattern. Compared with Medicare insured patients (the USA insurance scheme), the likelihood of receiving inpatient rehabilitation decreased for Medicaid insured patients (OR ranged from 0.3 to 0.5, calculated during the review), and further decreased for uninsured patients (OR ranged from 0.1 to 0.5, calculated during the review). This trend was also confirmed in the study by Schwarzkopf et al. (2016).[24] In addition, Bozic and colleagues found that outpatient rehabilitation was 2.2 times more likely to be used (95% CI not reported, $p < 0.001$) if a patient was privately insured (presumably by a third party insurer) rather than through Medicare. This finding was neither reported nor investigated by the other included studies. None of the Australian studies investigated insurance status as a factor in the choice of rehabilitation settings. Although it appears that insurance status had a significant impact on the choice of rehabilitation destinations, these American-based findings may not be applicable to the Australian context.

The Risk Assessment and Prediction Tool: A method for triaging patients' rehabilitation destinations

Two studies discussed the Risk Assessment and Prediction Tool (RAPT) as an instrument to pre-operatively determine which setting might be most appropriate for patients to receive rehabilitation services. The first study, published in 2003 by Oldmeadow and colleagues from Australia, discussed the development of the tool.[6] A six-item questionnaire was designed, covering age, gender, mobility, the use of gait aid, the availability of community support and caregivers. Each question was answered with a specific score and the total score summed to 12. When a total score was over nine, patients were deemed to be low risk and were recommended for home discharge. When a total score was less than six, extended inpatient rehabilitation was recommended. Patients with scores between six and nine were considered median risk and discharged (to either setting) with discretion. The eventual discharge destination for both high and low risk patients included in the study were predicted with 89.2 % and 83.7% accuracy respectively.[6]

In 2015, Hansen and colleagues re-validated the RAPT tool with modifications for American patients by adjusting the thresholds for "medium" and "high" risk.[29] Clinically, the modified system was more conservative in discharging patients home, and more preferential towards inpatient rehabilitation. The study attributed this discrepancy to variations in care provided in inpatient rehabilitation facilities, differences of patient perceptions of rehabilitation, as well as variations in surgeons' practices and clinical standards between the two countries.[29] Therefore, there was more uncertainty around what settings were the most appropriate, especially for patients under medium to high risk.

Functional independence

Functional independence was considered as an independent factor for choices of rehabilitation in three studies.[11,13,17] The study by de Pablo et al. (2004) showed that postoperative functional independence status was associated with choices of rehabilitation setting. Patients who were less independent, adjusted for age, gender and other social factors, were more likely to be discharged to inpatient rehabilitation (OR = 5.6, 95% CI = [3.5, 8.9], $p < 0.05$).[11] However, preoperative independency was not significantly associated with choice of rehabilitation for arthroplasty. This was shown otherwise by Fu et al. (2017). The study demonstrated that patients with poorer preoperative independency were approximately 2 times more likely to receive inpatient rehabilitation (95% CI = [1.9, 2.2], $p < 0.001$).[13] Similar results were found by Kaswani et al. (2016) as well, showing that patient being functional dependent prior to arthroplasty was approximately 2 times more likely to be discharged to an inpatient rehabilitation facility (95% CI = [1.9, 2.3], $p < 0.01$).[17]

Other considerations

The indications for surgery (i.e. selecting the right patients to perform arthroplasty on), different surgical approaches and prostheses (i.e. laterality, anaesthesia etc.) and surgeon-related factors were not evaluated in this review. Also, geographic (services proximity and density) and hospital factors (staff availability etc.) were only touched on in limited detail. Hospital factors such as

healthcare staff availability (measured by units of total full-time equivalent) and volume of surgery did not seem to influence the choice of rehabilitation settings. Rehabilitation service availability (measured by numbers of physiotherapists, occupational therapists and SNF beds within local residential areas) had a minimal but positive impact ($p < 0.05$) on inpatient rehabilitation. One study (not formally included) showed that geographic factors could be an indicator of service supply and availability, hence affecting the choice of rehabilitation.[84]

Overall, the choice of settings for rehabilitation services after joint arthroplasty is multifaceted. Nevertheless, factors such as age, gender, patient health and living status were significantly predictive of inpatient rehabilitation. An expert consensus study published in 2014 identified 11 aspects of best practice regarding timing, providers (settings), scheme, duration as well as outcome measures which should be used.[85] Over 85% of experts agreed that patient and external factors would have a significant impact on the choice of settings for arthroplasty rehabilitation. Therefore, a carefully gauged rehabilitation program to suit a patient's needs is essential when choosing where patients should receive their rehabilitation services.

Table 5 Factors influencing referrals to inpatient rehabilitation

Study ID	Older age	Female gender	Non-white Race	Socioeconomic status	Higher BMI	Less care-giver assistance	Greater comorbidity	Patients' expectations	Poorer functional status	Medicare Insurance
Bozic et al. 2006	✓	✓	-	-	-	-	✓†	-	-	✓
Dauty et al. 2009	⊘		-	-	-	⊘	-	-	-	-
de Pablo et al. 2004	✓	⊘	-	⊘	✓	✓	⊘	-	Pre-op ⊘ Post-op ✓	-
Freburger et al. 2011	✓	✓	✓‡	✓	-	✓	-	-	-	✓
Fu et al. 2017	✓	✓	-	-	✓	-	✓	-	Pre-op ✓	-
Halawi et al. 2015	✓	⊘	-	-	⊘	✓	-	✓	-	-
Hansen et al. 2015	✓	⊘	-	-	-	✓	-	-	-	-
Inneh et al. 2016	✓	✓	✓	✓	-	-	-	-	-	-
Keswani et al. 2016	✓	✓	-	-	✓	-	✓-	-	Pre-op ✓	-
Oldmeadow et al. 2003	✓	⊘	-	-	-	✓	✓$	✓	-	-
Rissman et al. 2016	✓	✓	-	-	✓	-	-	-	-	-
Schwarzkopf et al. 2016	✓	✓	✓	-	-	-	✓	-	-	✓
Tian et al. 2010	✓	✓	✓	-	-	-	⊘	-	-	-
Tribe et al. 2005	⊘	⊘	-	-	-	✓	-	-	-	-
Total	**14**	**13**	**4**	**3**	**5**	**7**	**7**	**2**	**3**	**3**

Notes: ✓ = factors being significant; ⊘ = factor investigated but non-significant; † = comorbidity was indicated by ASA grade; ‡ = race, insurance status and public/private was combined together. $ = only mobility related comorbidity.
Abbreviations: **BMI** = body mass index.

Question 5: How effective is inpatient rehabilitation following hip or knee arthroplasty compared to outpatient rehabilitation, community rehabilitation, home-based rehabilitation, and no rehabilitation?

Evidence highlights

- The evidence base related to research question 5 is broad and complex.
- Variations in the model of care provided in different settings continued to be a prominent issue when considering outcomes of rehabilitation for knee and joint arthroplasty.
- Randomised controlled trials (RCTs) found that, compared to supervised home-based rehabilitation, inpatient rehabilitation did not demonstrate significantly better effectiveness in terms of pain, function and quality of life for patients who were in relatively good health and were not predisposed to inpatient rehabilitation.
- Observational studies reported inconsistent findings; when patients with varied clinical status and predispositions were unselectively considered, the clinical effectiveness of rehabilitation could not be clearly determined based on setting.

Included literature

Twelve studies met the inclusion criteria for research question 5, including four RCTs and eight non-randomised observational studies. The most recent RCT, called the **HIHO** (**H**ospital **I**npatient versus **HO**me-based) trial, was published in 2017 and was undertaken in Australia. There were two UK studies published in 1998 and 2000, and one Canadian study published in 2008. Eight non-randomised studies were identified. Among the non-randomised studies, the year of publication ranged from 2005 to 2017. Four studies were undertaken in the USA, the other four were from Australia, Turkey, and Switzerland. The study profiles are summarised in Table 6.

Randomised controlled trial study profile

The populations included by the RCTs were relatively consistent. The study populations had an average age over 65, over 60% were women, and the majority underwent primary unilateral TKA. Both Mahomed et al. (2008) and Shepperd et al. (1998) also included patients receiving THA, and Shepperd additionally included some patients receiving hysterectomy, treatments of chronic obstructive pulmonary disease and some other medical conditions associated with old age.[35,37] Palmer Hill et al. (2000) included knee arthroplasty patients irrespective of diagnosis or concomitant disease.[86] Osteoarthritis was the common indication for arthroplasty across the included RCTs. Mahomed et al. (2008) also included patients with inflammatory arthritis and osteonecrosis, but excluded fracture.

Importantly, all four RCTs recruited patients who were likely to be eligible for home discharge for post-operative rehabilitation. The HIHO trial explicitly excluded patients predisposed to inpatient rehabilitation due to lack of an able caregiver, and Shepperd et al. required patients to have suitable home conditions with the consent of caregivers as well.[33,37] Twenty-five out of 96 patients (26%) were excluded in the RCT by Palmer Hill et al. (2000) and, among them, ten patients were excluded

due to being medically unfit or attending rehabilitation outside the trial.[86] Although Mahomed et al. (2008) did not explicitly specify such eligibility in their trial, patients with complications or who were unable to follow the rehabilitation protocol for any reason (either home or inpatient rehabilitation) were excluded from the trial.

All the three RCTs compared hospital based inpatient rehabilitation against home-based rehabilitation with support from community centres. The inpatient rehabilitation schemes in the four RCTs were based on locally practiced standards and guidelines. Limited detail was reported in terms of what constitutes those practice guidelines. The two most recent RCTs reported that the time from post-operative discharge to admission to inpatient rehabilitation ranged from three to ten days, averaging 6 days for most patients.[33,35] For home-based rehabilitation, the four RCTs reported physical therapy as the main rehabilitation activity. The provision of care (physical therapy or otherwise) was undertaken either at home with visiting physiotherapists in a one-to-one fashion,[35,86] or at community centres in a group fashion.[33] The duration of rehabilitation was up to 8 weeks. The discharge from rehabilitation was determined by a physiotherapist when patients achieved sufficient functional improvement.[35]

There was some variation in the outcomes reported by the three included RCTs. The six-minute walking test and knee flexion range of motion test were only two simple clinical outcome measures, and were assessed by the HIHO trial.[87] A range of questionnaire-based composite outcomes was reported. The WOMAC Score was used in the Mahomed trial to assess pain, joint stiffness and physical function after rehabilitation.[88] Oxford Hip/Knee Scores were used to evaluate similar outcomes in the other two trials.[33,37] Palmer Hill et al. (2000) evaluated patients with scores of American Knee Society Clinical Rating System.[86] Health-related quality of life was assessed in all the three trials, although different scales were used. EQ-5D was used in the HIHO trial, SF-36 was used in the Mahomed study and COOP was used in the Shepperd study. Patient satisfaction was measured in three studies using different tools. Readmission was also reported in two trials and it was the only adverse event reported by the HIHO and the Shepperd trials.

Observational and non-randomised study profile

The population profile of the observational studies was much less homogenous compared to the RCTs, both within and between studies. Besides comparing outcomes between inpatient and outpatient rehabilitation, patient factors such as demographic and clinical characteristics were also investigated as attributes for these outcomes. The mean age of all the six studies was over 60 years, although three of the six observational studies specifically targeted patients over the age of 60. Consequently, the patients included in some studies were significantly older than others, by a mean age of up to 10 years. Degenerative joint diseases such as osteoarthritis were the most common indications; however, patients with joint fractures and injuries were also included, noting that hip fracture is not always treated with THA. Consequently, in studies where only total arthroplasty was investigated, patients with joint fracture were explicitly excluded.

The non-randomised studies compared inpatient rehabilitation with a range of outpatient settings. The comparators included outpatient and convalescence rehabilitation,[32] home-based rehabilitation with or without outreach physiotherapists,[30,31,36] any non-inpatient rehabilitation,[40] and home discharge without any rehabilitation services.[31] Two studies included more than two comparator arms.[30,36] The study by Mallinson et al. (2011) included an outpatient arm, a SNF arm, and home-based rehabilitation. Patients in the study by Tian et al. (2010) received up to eight different models of care in multiple settings, with combinations of inpatient, SNF, outpatient and home-based rehabilitation.[30] Finally, a study from Turkey also compared inpatient and outpatient rehabilitation but the choice of setting was based on the RAPT scores discussed in the previous research question.[39] The IRFs described in the studies were broadly generalisable to the Australian context, noting that each study provided a different model of inpatient care; however, there was considerable uncertainty regarding the applicability of the SNF and outpatients settings to Australian clinical practice.

The outcome measures reported in the included observational studies were relatively consistent with the results of the RCTs. Functional outcomes (related to mobility, independence etc.), and health related quality of life were the three main categories of outcomes reported in the six observational studies. None of the six studies reported Oxford hip and knee scores. Physical function was reported by four studies,[30,34,36,38] involving functional independence measures (FIM),[89] six-minute walk tests (6MWT) and Timed Up and Go tests.[30,34,36,38] Two studies reported WOMAC scores, and one study reported levels of patient satisfaction. In terms of health related quality of life measures, four studies utilised Short-form 12 and 36.[30,31,38,39]

A range of patient related factors such age, gender, ASA status, comorbidities and habitual status (with or without caregivers or a person to live with) were variable between intervention groups at baseline. Two studies failed to adjust for baseline imbalances in confounding factors when comparing outcomes of rehabilitation settings.[32,36] Two studies utilised univariate regression to adjust for imbalanced patient baselines. This is appropriate; however, the confounding effect towards the choice of rehabilitation setting was still not fully addressed. The study by Walsh et al. (2006) used a one-to-one match between the inpatient and the outpatient arms to recruit patients.[38] The matching criteria were based on age, gender, motor FIM scores and comorbidities. This linkage approach would allow for some control over potential confounders; however, whether or not the choices of the three linkage keys were sufficient in controlling for all potential confounders is questionable. The last study by Tian et al. (2010) was the only study to use an appropriate methodology to adjust for confounding.[30] They used a hierarchical regression model to investigate the effects of both patient factors and rehabilitation models of care on outcomes, and at the same time adjusting for the influences of patient characteristics over choices of rehabilitation settings. The result of this analysis informs the extent to which patient characteristics and choices of rehabilitation settings independently influence patient outcomes, with appropriate suppression of the confounding effects between patient factors and rehabilitation settings.

Table 6 Characteristics of studies comparing inpatient rehabilitation to other settings

Study ID Location	Study design	Patient characteristics	Intervention characteristics	Comparator characteristics	Outcomes measured	Time of follow-up/study duration
Randomised controlled trials						
Buhagiar et al. 2017 Australia	RCT	Older patients (mean 65 year) Mostly women (over 55%) Indicated for osteoarthritis Primary unilateral TKA Excluding patients predisposed to inpatient rehabilitation Sample size = 165	Inpatient rehabilitation followed by monitored home plus community group classes	Monitored home plus community group classes	6MWT, OKS, EQ-5D, KOOS, knee flexion range of motion, readmission, patient satisfaction	10, 26 and 52 weeks
Mahomed et al. 2008 Canada	RCT	Adult patients (over 18 year) Indicated for osteoarthritis or inflammatory arthritis and osteonecrosis Primary unilateral TKA and THA Suitable for discharge to home Excluding patients having fractures Sample size = 234	Inpatient rehabilitation	Home by physiotherapist visit (from community centres)	WOMAC, SF-36, patient satisfaction	Not reported
Shepperd et al. 1998 UK	RCT	Older patients (mean 70 years) Mostly women (over 60%) All types of TKA and THA, hysterectomy, chronic obstructive pulmonary disease, and elderly patients with a mix of conditions Sample size = 172	Inpatient rehabilitation	"Hospital at home" with available access to community care if needed	COOP, OHS, Bristol Knee Score, readmission	3 months
Palmer Hill et al. 2000 UK	RCT	Primary TKA Sample size = 60	Inpatient until wound healed	Home rehabilitation with physiotherapists and nursing visits	Scores for American Knee Society Clinical Rating System, patient satisfaction	12 months
Observational and non-randomised studies						
Benz et al. 2015 Switzerland	Prospective Cohort study	Older patients (over 50 years) Primary total or partial hip or knee arthroplasty Sample size = 201	Inpatient rehabilitation	Ambulatory and community centre based rehabilitation	WOMAC, Iowa Level of Assistance Scale, Timed Up and Go, patient factors	6 months

Study ID Location	Study design	Patient characteristics	Intervention characteristics	Comparator characteristics	Outcomes measured	Time of follow-up/study duration
DeJong et al. 2009 USA	Prospective Cohort study	General patients (over 21 years) Primary or revision THA and TKA Excluding indications for hip fracture Sample size = 2152	Inpatient rehabilitation	Skilled nurse facilities rehabilitation	FIM, Comprehensive Severity Index, patient factors	12 months
Mallinson et al. 2011 USA	Prospective Cohort study	Older patients (over 65 years) Primary or revision THA and TKA Excluding indications for hip fracture and patients readmitted for 48 hours or more over the duration of rehab Sample size = 230	Inpatient rehabilitation	1) Skilled nursing facilities rehabilitation 2) Home health agency rehabilitation	FIM, patient factors	Not reported
Naylor et al. 2017 Australia	Propensity score-matched cohort study	Primary TKA or THA Uncomplicated cases Sample size = 258	Inpatient rehabilitation	No inpatient rehabilitation	OKS, EQ-VAS	12 months
Tian et al. 2010 USA	Prospective Cohort study	General patients (over 21 years) Primary and secondary, elective or otherwise Total or hemi hip arthroplasty Indicated for fracture or degenerative conditions (including osteoarthritis) Sample size = 236	Extended rehabilitation at skilled nursing centres or inpatient facilities	Home with/without outpatient rehabilitation	Motor FIM, SF-12, complications, patient factors	Not reported
Tribe et al. 2005 Australia	Retrospective cohort study	General patients Primary THA and TKA indicated for osteoarthritis Sample size =118	Inpatient rehabilitation	Home without rehabilitation	SF-36, WOMAC, patient factors, economic outcomes	3 months and 12 months
Walsh et al. 2006 USA	Case controlled study	Older patients (mean 74 years) THA and TKA Sample size = 174	Inpatient rehabilitation	Skilled nursing facilities rehabilitation	FIM, length of stay, walking distance, additional service required	Not reported
Yildirim et al. 2005 Turkey	Prospective cohort study	General patients Elective primary TKA indicated for osteoarthritis Sample size = 374	Inpatient rehabilitation based on RAPT ≤ 6, receiving a set of rehabilitation services for 6 weeks	Home-based exercise program based on RAPT > 6	VAS, SF-36, Knee Society Clinical Rating System	6 weeks

Abbreviations: **6MWT** = six minutes walking test; **COOP** = Dartmouth Cooperative Functional Assessment Charts; **FIM** = Functional Independence Measure; **IRF** = inpatient rehabilitation facility; **KOOS** = Knee injury and Osteoarthritis Outcome Score; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **RAPT** = Risk Assessment and Prediction Tool; **RCT** = randomised controlled trial; **SF-12/36** = Short-Form 12/36; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty; **USA** = United States of America; **VAS** = visual analogue scale; **WOMAC** = Western Ontario and McMaster Universities Osteoarthritis Index.

The quality of the included RCTs was moderate to high (Table 7). The trials were also sufficiently powered from the sample size calculations. None of the included RCTs blinded patients, as patients were able to tell where they received the rehabilitation. There were some concerns surrounding the representativeness of the included patients in the HIHO trial, as only 165 of 525 eligible patients consented to be randomised; the main reason for not participating in the randomisation was a wish to return home quickly after surgery.[33]

For non-randomised observational studies, the quality was lower. Quality issues shared across the included studies were the lack of detail in rehabilitation scheme and how patients were recruited. External validity for non-randomised studies was at similar level with the RCTs. The studies were also marked down due to discrepancies between patient eligibilities specified and characteristics of the actual patient cohort included in those studies. For internal validity, bias was a limitation but not a significant concern. All studies were marked down on randomisation and allocation concealment to reflect the limitations of the study design; however, confounding was the greatest concern across the observational studies. Without adequate adjustment for confounding, the true clinical effects of rehabilitation at different settings could not be determined. Only two of the non-randomised studies performed a power calculation.

Table 7 Quality appraisal scores for the included comparative studies

Author	Year	Reporting	External Validity	Internal Validity - Bias	Internal Validity – Confounding	Power calculations	Total
RCTs							
Buhagiar et al.	2016	10	1	5	6	1	23 of 27
Mahomed et al.	2008	9	3	4	5	1	22 of 27
Palmer Hill et al.	2000	9	2	2	4	0	17 of 27
Shepperd et al.	1998	8	2	4	3	1	18 of 27
Pseudo-RCTs							
Naylor et al.	2017	7	1	4	2	1	15 of 27
Observational studies							
Benz et al.	2015	8	2	3	3	1	17 of 27
DeJong et al.	2009	9	3	4	3	0	19 of 27
Mallinson et al.	2011	9	1	4	3	0	17 of 27
Tian et al.	2010	9	3	4	4	0	19 of 27
Tribe et al.	2005	7	0	4	3	0	14 of 27
Walsh et al.	2006	6	0	4	3	0	13 of 27
Yildirim et al.	2015	8	2	4	3	0	17 of 27

Summary of results

Table 8 provides a summary of findings for selected outcomes that were reported for question 5.

Table 8 GRADE of the evidence base for question 5

Design	Outcomes	Participants (studies)	Relative effect (inpatient vs home)	Quality of the evidence (GRADE)	Comments
Walking distance					
RCTs	6MWT	165 (1)	No significant difference	⊕⊕⊕⊕ HIGH	Results were only available from one study
Observational studies	Ambulation distance	174 (1)	P = 0.004 favouring inpatient, mean difference NR	⊕⊕○○ LOW	Results were only available from one study
Hip/Knee Scores					
RCTs	OHS, OKS, AKSCRS	397 (3)	No significant difference	⊕⊕⊕○ MODERATE	Palmer Hill (2000) was poorly reported
Pseudo RCT	OKS	258 (1)	No significant difference	⊕⊕○○ LOW	Uncomplicated cases only
WOMAC					
RCTs	WOMAC	234 (1)	No significant difference	⊕⊕⊕⊕ HIGH	Results were only available from one study
Observational studies	WOMAC	319 (2)	Not pooled	⊕○○○ VERY LOW	Varied results in literature
Health related quality of life					
RCTs	EQ5D, SF-36 and COOP	571 (3)	No significant difference	⊕⊕⊕○ MODERATE	Varied outcomes but consistent direction of effect
Pseudo RCT	EQ-VAS	258 (1)	No significant difference@ 12 mo	⊕⊕○○ LOW	Uncomplicated cases only
Observational studies	SF-36 and SF-12	929 (4)	Not pooled	⊕⊕○○ LOW	Varied results in literature
FIM					
Observational studies	Primarily on motor FIM	2,791 (4)	Not pooled	⊕○○○ VERY LOW	Varied results in literature
Patient satisfaction					
RCTs	Hip and knee satisfaction scale, VAS	529 (3)	Not pooled	⊕⊕⊕○ MODERATE	Varied results in literature; Palmer Hill (2000) was poorly reported

Abbreviations: 6MWT = Six minute walking test; **AKSCRS** = American Knee Society Clinical Rating System; **COOP** = Cooperative Functional Assessment Charts**; EQ5D** = EquroQol-5 Dimension; **FIM** = Functional Independence Measure; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **RCT** = randomised controlled trial; **SF-36** = Short Form 36; **VAS** = visual analogue scale; **WOMAC** = Western Ontario and McMaster Universities Osteoarthritis Index.

[a] GRADE Working Group grades of evidence.[83]
⊕⊕⊕⊕ **High quality:** We are very confident that the true effect lies close to that of the estimate of effect.
⊕⊕⊕⊙ **Moderate quality:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
⊕⊕⊙⊙ **Low quality:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
⊕⊙⊙⊙ **Very low quality:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.)

Evidence summary from the RCTs

Inpatient rehabilitation did not demonstrate significantly better outcomes compared to home-based rehabilitation with support in terms of clinical outcomes, health scores, quality of life, patient satisfaction and adverse events. Outcome data was extracted and presented in Table 9. More detailed study data is presented in Appendix 6.

For the **six-minute walking test** measured in the HIHO trial, measurements at 10, 26 and 52 weeks (intent-to-treat and per protocol) were all non-significant between inpatient and home-based rehabilitation. Similarly, the knee flexion range of motion was also not significantly different between the two settings at all times.

Almost all score-based outcomes such as **Oxford knee/hip scores, WOMAC and quality of life** were not significant between inpatient and home-based rehabilitation. The only exception was reported by Shepperd et al. (1998),[37] who found that patients receiving TKA and rehabilitated at home achieved a significantly greater improvement in quality of life (mean score difference = 0.6, 95% CI = [0.02, 1.2], p value not reported).

Patient satisfaction was measured by two trials. In the HIHO trial patients receiving inpatient rehabilitations seemed to perceive a higher level of satisfaction compared to home-based rehabilitation (mean score difference = 8.9, 95% CI = [3.0, 14.9], p value not reported).[33] In the Mohamed et al. (2008) trial, there was no significant difference in patient satisfaction between groups at three or twelve months.[35]

Readmissions and complications, where reported, were rare. The proportions were similar between inpatient and home-based rehabilitation. Incidences of complications were reported in all four RCTs. In the HIHO trial, the most commonly reported adverse event was joint stiffness requiring manipulation during anaesthetic recovery. However, patient counts were not reported regarding this adverse event. Eight patients, four patients in each arm, visited an emergency department after hospital discharge, and six of these patients were readmitted. Further detail was not provided.[33] The trial by Mahomed et al. reported 2% of patients had a hip dislocation and 3% had deep venous thrombosis.[35] Infection among the inpatient group was 2% and none in the home-based group. No other complications or adverse events were observed. The study by Palmer Hill et al. reported three incidences of readmission. Two cases were considered relevant, one in each group.[86] Shepperd et al. reported slightly higher proportion of patients in home rehabilitation group being readmitted (9%) compared to patients in the hospital group (3%) but the difference was not statistically significant.[37]

Table 9 Summary results of the included RCTs

Study ID Location	Timed walking test	Hip/Knee Score	WOMAC	HRQoL	FIM	Patient satisfaction	Adverse events
Randomised controlled trials							
Buhagiar et al. 2017 (HIHO) Australia	**[6MWT]** Not significant between settings at any time	**[OKS]** Not significant between settings at 52 weeks	NR	**[EQ-5D]** Not significant between settings at 52 week	NR	**[VAS %]** Significant at 52 weeks: Mean difference = 8.9, 95% CI = (3.0, 14.9), p = 0.004, favours inpatient	**[Readmission]** Not significant between settings, time frame unknown
Mahomed et al. 2008 Canada	NR	NR	Pain, stiffness and physical function, not significant at any time between settings	**[SF-36]** Not significant between settings at any time	NR	**[Hip and knee satisfaction score]** Not significant at 3 or 12 months between settings	NR
Shepperd et al. 1998 UK	NR	**[OHS]** Not significant between settings at 3 months	NR	**[COOP-knee]** Not significant between settings at 3 months **[COOP-hip]** Not significant at 3 months except change in quality of life: MD = 0.61, 95% CI = (0.02, 1.20)	NR	NR	**[Readmission]** Hip and knee both not significant at 3 months

Study ID Location	Timed walking test	Hip/Knee Score	WOMAC	HRQoL	FIM	Patient satisfaction	Adverse events
Palmer Hill et al. 2000 UK	NR	**[AKSCRS]** 1 year follow-up No significant differences	NR	NR	NR	**[Self-developed Questionnaire]** Proportion of patients felt happy due to well-supported rehabilitation [I] = 90.32% [C] = 64.29%	NR

Abbreviations: **6MWT** = Six-Minute Walk Test; **AKSCRS** = American Knee Society Clinical Rating System; **BMI** = body mass index; **COOP** = Cooperative Functional Assessment Charts; **EQ-5D** = EuroQol-5D; **FIM** = Functional Independence Measure; **HRQoL** = Health-related quality of life; **IRF** = inpatient rehabilitation facility; **MD** = mean difference; **NR** = not reported; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **SF-36** = Short Form-36; **VAS** = Visual Analogue Scale; **WOMAC** = Western Ontario and McMaster Universities Osteoarthritis Index.

Evidence summary from observational non-randomised studies

The observational studies showed a varied picture of rehabilitation outcomes; however, due to limitations in the study designs, the observational studies provided less robust evidence base for the research question. A summary of the observational trials is presented in Table 10.

The **WOMAC** index was reported in two studies.[31,32] Benz and colleagues (2015) reported that there was no significant difference (both global and subscales) at 6 month follow up between inpatient rehabilitation, convalescence or home-based rehabilitation.[32] The study included both THA and TKA but did not undertake any subgroup analyses respectively. The finding in this study was consistent with the RCTs. On the contrary, the other study from Australia, which also studied both hip and knee procedures, disagreed on some WOMAC subscales. For hip replacement, patients who were discharged home without supervision showed greater improvement on knee stiffness at 3 months ($p = 0.029$), whereas inpatients had greater reductions in pain at 12 months ($p = 0.020$). No other WOMAC scores showed significant differences. Both studies reported substantial baseline imbalances in patient characteristics at admission to surgery, and none of them adjusted for those baseline imbalances. Patients who received ambulatory or home rehabilitation were significantly younger,[32] male,[32] and less likely to live alone compared to their inpatient counterparts.[31,32] In addition, both studies reported significant baseline imbalances in pre-operative clinical characteristics. Both global WOMAC and pain subscales were significantly different between settings at admission,[32] yet neither were incorporated when follow-up outcomes were measured.

The **FIM** was reported in the observational studies but not in the RCTs. The study by DeJong et al. (2009) reported significantly better FIM scores in the inpatient setting compared to an SNF for both hip ($p = 0.005$) and knee ($p = 0.014$) replacement;[34] however, this finding disagreed with the study by Mallinson et al. (2011),[36] which reported that patients were less capable of providing self-care at home (e.g. eating, dressing, toileting etc.) after inpatient rehabilitation compared to those who treated in a SNF.[36] It is worth noting that both studies adjusted for covariates (patient characteristics, baselines etc.) but the adjusted variables attributable to the outcomes were inconsistent. Comorbidities were adjusted for in both models but by different conditions and scales. For patient demographics, age and gender were adjusted for in the Mallinson study, and race (white or otherwise) was adjusted for by DeJong and colleagues. Nevertheless, these simple adjustments were not sufficient to supress strong correlations between choices of rehabilitation settings and patient characteristics. Therefore, confounding bias is likely to have influenced these findings.

Walsh et al. (2006) found that inpatient rehabilitation provided improved capabilities for patients' ambulation compared to SNF, evidenced by longer walking distance ($p = 0.004$) and greater locomotion FIM scores ($p = 0.029$). Population characteristics in this study were balanced due to the unique one-to-one matching methodology described previously.[38] In contrast, Tian et al. (2010) engaged an advanced statistical model (the hierarchical ordinary least square model) that isolated patient factors and choices of rehabilitation settings, thereby controlling for the main sources of

confounding. The study found home-based rehabilitation resulted in better mobility outcomes for patients compared to inpatient rehabilitation. Further, outpatient rehabilitation was significantly superior over home rehabilitation (p = 0.020). Comorbidities were negative predictors for motor and cognitive FIM outcomes; hypertension, diabetes and ischemic heart diseases (only for FIM) had the greatest effect. This was a significant finding since comorbidity did not appear to influence the choice of rehabilitation settings in this study (discussed in question 4). This might indicate that the effect of comorbidity would carry through regardless where patients received their rehabilitation services. Unsurprisingly, patients' initial motor and cognitive FIM scores at admission (pre-operative) were also significant predictors for both outcomes.

The study by Naylor et al. (2017) reported **Oxford Knee Scores**, and found no significant difference between inpatient and home-based rehabilitation at 90 days (MD = 0, p = 0.54) or 12 months (MD = 0, p = 0.40).[40] However, 92 patients that experienced a complication (including readmission) within 90 days of surgery, and six that had slow progress, were excluded from the analysis. It was not reported which study arm these excluded patients were from, suggesting there may be a high likelihood of selection bias in the results; however, additional information provided by the study authors indicated that there were no systematic differences in the number of excluded patients in each group. Therefore, the results suggest that in patients with uncomplicated procedures, there is no additional benefit to inpatient rehabilitation services.

Health related quality of life was investigated by four studies, in which two of them measured HRQoL with the SF-36 tool, one used SF-12, and one used EQ-VAS. Physical component scores of the SF-12/36 questionnaires were reported by two studies; however, the two studies did not have the same finding. Tian and colleagues found that there was no significant difference in SF-12 physical component scores between rehabilitation settings.[30] In contrast, Yildirim et al. (2015) reported greater improvements in inpatients (SP-36 physical component, MD = 30.0, p < 0.001).[39] The Australian study by Tribe et al. (2005) reported the overall SF-36 score and found no difference between inpatient and home rehabilitation.[31] Naylor et al. (2017) reported inpatients had lower (i.e. poorer) average HRQoL scores at 35 days (MD = -5, p = 0.01) and 90 days (MD = 02.5, p = 0.09), but not at 12 months (MD = 0, p = 0.32).[40]

Substantial inconsistencies were observed in the observational studies.[30,38,40] This demonstrated that when a general population were unselectively considered, especially including patients who were predisposed to more intensive rehabilitation or poorer general health, the interrelationships between patient characteristics, choice of rehabilitation settings and rehabilitation outcomes become complicated; however, the RCTs and observational trials their own limitations. Without randomisation, unobserved or unknown confounders in the Walsh study may still exist, hence making the study findings still potentially biased.[38] On the other hand, motor FIM and SF-12 physical component score were unfortunately the only two outcomes investigated in the Tian study.[38] Whether or not rehabilitation models of care would influence other clinical outcomes (pain, adverse events etc.) remains unclear.

Table 10 Summary results of the included observational studies

Study ID Design Location	Timed walking test	OKH/OHS	WOMAC	HRQoL	FIM	Patient and clinical factors
Non-randomised controlled trials						
Benz et al. 2015 Switzerland	NR	NR	Pain, stiffness and physical function, not significant between inpatient to other settings at 6 months (outpatient or convalescence centres)	NR	NR	**[Sig baseline imbalance]** Age, gender, comorbidities, caregiver status, type of surgery.
DeJong et al. 2009 USA	NR	NR	NR	NR	**[Motor]** For TKA, IRF > SNF (MD = 0.901, p = 0.014) For THA, IRF > SNF (MD = 1.639, p = 0.005)	**[Sig baseline imbalance]** Initial pre-operative FIM scores, age, race (white or otherwise), BMI, comorbidities, post-operative-rehabilitation time gap, habitual status, insurance status (Medicare or not)

Study ID Design Location	Timed walking test	OKH/OHS	WOMAC	HRQoL	FIM	Patient and clinical factors
Mallinson et al. 2011 USA	NR	NR	NR	NR	**[Score of mobility function]** Not significant across settings **[Self-care function]** Significantly less independent when receiving inpatient (p not reported), but not so for home rehabilitation, both compared to SNF.	**[Sig baseline imbalance]** Age, BMI, comorbidities, post-operative-rehabilitation time gap, habitual status
Naylor et al. 2017 Australia	NR	**[OKS]** Mean difference @ 90 days = 0 (IQR = -6 to 5); p = 0.54 Mean difference @ 365 days = 0 (IQR -4 to 3); p = 0.40	NR	**[EQ-VAS]** Significant at 35 (MD = -5 [IQR -19 to 10], p = 0.01) and 90 days (MD = -2.5 [IQR -15 to 10], p = 0.09). Not significant at 365 days (p = 0.32).	NR	NR

Study ID Design Location	Timed walking test	OKH/OHS	WOMAC	HRQoL	FIM	Patient and clinical factors
Tian et al. 2010 USA	NR	NR	NR	**[SF-12 physical component score]** Not significant across all settings (IRF ± home ± outpatient & SNF ± home ± outpatient, in total of 6 models of care)	**[Motor]** Home rehabilitation (IRF + Home) significantly better than inpatient (IRF + IRF/SNF) (MD = 8.20, p < 0.01) but significantly worse than outpatient (IRF + outpatient) (MD = 3.08, p = 0.020) at 6 months, each comparison accounted for approximately 2.5% of the outcome variation.	**[Sig baseline imbalance]** Initial pre-operative FIM scores, age, gender, race (white or otherwise), comorbidities, types of surgery (elective or otherwise)
Tribe et al. 2005 Australia	NR	NR	For THA at 3 months, stiffness was improved significantly for home patients (p =0.029); For TKA at 12 months, pain was improved significantly for inhabitation patients (p = 0.020)	**[SF-36]** Not significant between settings at 12 months for both THA and TKA	NR	**[Sig baseline imbalance]** Gender (only for knee), post-operative-rehabilitation time gap, habitual status (only for hip)

Study ID Design Location	Timed walking test	OKH/OHS	WOMAC	HRQoL	FIM	Patient and clinical factors
Walsh et al. 2006 USA	**[Ambulation distance (metres)]** Significant better in IRF settings (MD = 91†, p = 0.004)	NR	NR	NR	**[locomotion score]** Significant better in IRF settings (score MD = 0.81†, p = 0.029)	None significant
Yildirim et al. 2015 Turkey	NR	NR	NR	**[SF-36 physical component score]** Significant better in inpatient group, score difference = 30.0†, p < 0.001 **[SF-36 mental component score]** not significant	NR	[Sig baseline imbalance] Female gender was significantly larger in both arms.

Note: Specific outcomes were denoted in square brackets if outcomes vary under each column. † = values were not reported by the study but evaluated during the review; ‡ results (mean differences, odds ratios etc.) were estimated during the review due to inappropriate methodologies used by the study. P values are not reliable as the calculation was not performed based on original data.

Abbreviations: **6MWT** = Six-Minute Walk Test; **BMI** = body mass index; **COOP** = Cooperative Functional Assessment Charts; **EQ-5D** = EuroQol-5D; **FIM** = Functional Independence Measure; **HRQoL** = Health-related quality of life; **IRF** = inpatient rehabilitation facility; **MD** = mean difference; **NR** = not reported; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **SF-36** = Short Form-36; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty; **USA**= United States of America; **VAS** = Visual Analogue Scale; **WOMAC** = Western Ontario and McMaster Universities Osteoarthritis Index.

Question 6: What levers have been used domestically and internationally to promote the use of alternative clinical pathways for rehabilitation (e.g. home-based rehabilitation) where clinically appropriate?

Evidence highlights

- Tools exist that can be used to pre-operatively identify patients that may benefit from inpatient or home-based rehabilitation, as well as pre-habilitation pathways;
- Preconceived advantages favouring inpatient rehabilitation combined with a sense of entitlement among privately insured patients are two great barriers for outpatient rehabilitation. Patient education throughout the entire pathway of care may reduce unnecessary use of inpatient rehabilitation services.
- More incentives, financial or otherwise, for all stakeholders including patients, surgeons, hospitals and private health insurers should be implemented to promote pathways directed to outpatient rehabilitation;
- There is a need for evidence based guidelines suited to the Australian context to guide and protect good practice in rehabilitation after TKA and THA.

Included literature

Literature to address this research question was sourced from targeted, non-systematic searches of Medline and The Cochrane Library, as well as grey literature searches for clinical practice guidelines and other resources. Studies that identified factors that might impact the discharge destination for arthroplasty patients were included. Each of the included studies was reviewed for relevant themes relating to the levers used to promote clinical pathways for rehabilitation. Resources were extracted until no new themes were identified. As such, while every effort was made to identify relevant factors, the reference list used to inform question 6 should not be seen as all-encompassing, rather as an illustrative sample.

Summary of results

The results from research question 4 identified several key factors that predicted discharge to an inpatient facility. Among all the factors identified, insurance status and patient expectations seemed to have significant impact yet with greatest uncertainty. On the other hand, the results from research question 4 also suggested that, for relatively healthy and well supported patients, discharge destination makes no difference on patient recovery. Therefore, for those patients, outpatient rehabilitation appeared to be a better choice from a cost-effectiveness perspective. Factors associated with decisions made by clinicians and patients are prone to intrinsic and external influences such as financial incentives and practice doctrines. In answering this research question, a number of barriers was identified and hence may be leveraged to promote outpatient therapies. To achieve a more cost-effective rehabilitation care, a collective effort is required from all stakeholders.

Levers

Using validated prediction tools to provide optimised rehabilitation pathways

During this review a number of clinical tools that aim to predict suitable rehabilitation settings for patients with different demographics and clinical conditions were identified. The RAPT,[6,29,41] The Orthopaedic Surgical Assessment Questionnaire (South Australia) and The Hip and Knee Questionnaire (Victoria) are the three representative examples used in Australia. All the three questionnaires are to be completed at the time of surgical booking or pre-admission, and re-evaluated as needed in response to changing patient factors. Scores generated by the questionnaires are used as a reference point to determine rehabilitation setting. The predicted results also provide confidence for patients and healthcare providers. The tools have been in practice since 2008, and have a high accuracy for predicting discharge supports/destination. Utilising these clinical tools will be helpful for planning post-operative rehabilitation to appropriate settings.

Patient education

Patient preference and insurance status are strong factors influencing the choice of settings for rehabilitation.[42,90,91] Some degree of patient preferences for inpatient rehabilitation may be due to misconceptions around the benefits of inpatient rehabilitation. Therefore, raising patient awareness of the safety and effectiveness of outpatient or home-based rehabilitation can be an important lever to promote appropriate rehabilitation practice. An RCT recently published by Siggeirsdottir and colleagues compared usual hip arthroplasty rehabilitation care pathways to a combination of a pre-to-post-operative education program plus home rehabilitation.[92] The study showed that it was beneficial when patients were familiarised beforehand with postoperative exercise regimens, assistive devices and pain management. With the support of home-visiting physiotherapists, home-based rehabilitation was safe and more effective regarding functional improvement and quality of life for hip arthroplasty patients, and patients' hospital stay was also significantly shortened.

For appropriate patients, there are many approaches that can be used to promote rehabilitation in an outpatient setting and manage patient expectations. At the pre-admission stage, patients should be thoroughly assessed, and risk factors that may predispose them to inpatient rehabilitation should be discussed. Laying out predictable pathways and clarifying uncertainty at this stage is helpful for managing patients' expectations around rehabilitation.[93-95] Any concerns or differences of opinions regarding where patients should receive rehabilitation services should be resolved before arthroplasty. If arthroplasty was performed as planned with no complications, patients should follow the pre-determined care pathway to receive the rehabilitation in the designated setting if needed. While receiving rehabilitation services, frequent follow-ups (clinical visits or communication via other routes) should be maintained.[96] Supportive information and services should also be made available if patients have questions or concerns. Educating patients about the care pathway essentially acts as a lever to outpatient rehabilitation by reducing unknown variables for patients. When patients are equipped with sufficient information and empowered with control over their

recovery process, they will feel more comfortable to go home or, or to a community centre to receive their rehabilitation.

Role of orthopaedic surgeons

Results from question 1 and some surveys showed inpatient rehabilitation is becoming less common in some settings;[91,97] however, whether or not to refer a patient for inpatient rehabilitation after hip and knee arthroplasty often varies among surgeons.[98,99] It is important to recognise that surgeons' recommendations are a substantial driving factor for discharge to different rehabilitation settings.[42] A semi-structured survey by Buhagiar and colleagues pointed out that patient preferences and beliefs towards the benefits of inpatient rehabilitation are not rejected, rectified, or endorsed by some surgeons.[42] Further, some surgeons also don't see the need to modify patient beliefs that favour inpatient rehabilitation without justifiable reasons.[93,100] In one surgeon's own words: "If they (patients) want it (inpatient rehabilitation), they get it."[42] Therefore, changing surgeons' attitudes towards the suitability of outpatient rehabilitation in targeted patient groups can be a substantive lever to promote more cost-effective rehabilitation practice.

Utilisation of care pathways

Utilisation of care pathways can be a significant lever to provide certainty around rehabilitation for patients and healthcare providers. In South Australia, the Arthroplasty Unit at the Repatriation General Hospital (RGH) maintained an average discharge rate to home of ~90% from 2008 to 2016. A core driver of the success of this discharge pathway was the multi-disciplinary approach to pre-operative rehabilitation and discharge planning. The care pathway included access to community support agencies that promoted independence at home, educating patients on discharge plans well in advance of surgery, providing educational resources about rehabilitation (such as specific patient mobilisation and pain management plans), and daily multi-disciplinary ward discharge planning meetings. Almost 70% of patients were discharged on post-operative day two (32%) or three (35%). It is important to note that the RGH is a public hospital and therefore operates under different funding and incentives to the private sector; however, the utilisation of care pathways can be realised when all the levers discussed above are in place. Therefore, this lever can be considered as a collective effort to promote cost-effective rehabilitation practice, regardless of whether it is in the public or private setting.

Barriers

Lack of evidence based guidelines or an expert consensus statement for best practices around arthroplasty rehabilitation

The present review did not identify any relevant guidelines or consensus statements from Australia regarding the best practice for rehabilitation after arthroplasty.[101] Destinations for rehabilitation are largely dependent on the combination of surgeons' discretion, patients' preference, patient factors (described in Section 4), and proximity and availability of rehabilitation services. Therefore, unwarranted variation regarding what rehabilitation services a patient receive, and where they

receive them, are a relevant issue.[49,102] There is a need to develop an evidence-based clinical guideline to inform surgeons and patients regarding rehabilitation after arthroplasty. In particular, such a guideline should rationalise rehabilitation referrals, to either acute hospitals or otherwise, and cater for specific needs of patients. A published clinical consensus statement from the USA and Canada proposed 20 recommendations for rehabilitation after arthroplasty.[85] Detailed recommendations are attached at the end of this report in Appendix 7. While accounting for Australian national health insurance policies (Medicare and private insurance) and local context, this publication is a useful benchmark that could be used to inform an Australian guideline.

Availability of rehabilitation services

As noted above, factors of rehabilitation service availability such as travel distance between home and rehabilitation facilities (especially in rural areas) play a role in determining patient preferences towards inpatient rehabilitation.[73,93,103] The time and costs associated with travel are common barriers to utilising outpatient rehabilitation services.[93] Community supported or supervised outpatient rehabilitation could become scarce in terms of both proximity to patients and numbers of services available for some patients. This is a particularly true in rural and remote areas with low population density in Australia.

Patient preferences for inpatient rehabilitation

Several studies reported that the positive personal experiences of a family member or friend who had inpatient rehabilitation is an identifiable factor towards the preference for inpatient rehabilitation.[11,42,43] Patients consider that inpatient rehabilitation is advantageous because all the care they need is kept conveniently within a hospital.[104,105] Patients also reportedly describe inpatient rehabilitation having "peer-pressure" that keeps them motivated.[93,106] Some patients and carers also expressed a strong sense of belief that continuity of care is better delivered in an inpatient rehabilitation setting, and they consider it as an essential component of arthroplasty.[42,43] Other factors, such as travel distance between home and rehabilitation facilities (especially in rural areas) also played a role in patient preferences towards inpatient rehabilitation.[73,93,103] However, when a patient is not characterised with genuine needs for inpatient rehabilitation, equivalent outcomes of rehabilitation can be realised at home or in an outpatient setting. These preconceived beliefs become a barrier to outpatient rehabilitation.

Incentives favouring inpatient rehabilitation services

Insurance status was a strong predictor/factor for inpatient rehabilitation as reported in question 4. From patient perspectives, outpatient rehabilitation was described by privately insured patients with a sentiment of "*expensive premiums paid for nothing*".[42] This mindset is understandable from a consumer point of view, but it acts as a barrier to cost-effective practice. If health services that appropriately refer patients to outpatient rehabilitation are not recognised and rewarded, it places upward pressure on private health insurance premiums due to the high demand for these services.

In turn, this further fosters the mindset of getting money back from premiums paid, effectively creating a positive feedback loop.

There are currently no Australian clinical practice guidelines on rehabilitation setting after TKA and THA. As a result, surgeons rely on their professional judgement and some clinical evidence to inform where they discharge patients for rehabilitation.[42] A recent survey of 19 Orthopaedic Surgeons found some have no particular opinions about specific rehabilitation setting and may refer patients based on the individual patient or carer preferences.[42] Further, there may be disincentives to refer for outpatient rehabilitation because of patient or carer preferences and expectations.

Finally, the business model of private hospitals may have some influence on rehabilitation destination. Often rehabilitation was presented as "a package deal" to patients.[42] There may also be positive financial implications for hospitals to transfer patients to their inpatient rehabilitation services after arthroplasty.[42]

Conclusions

The high degree of heterogeneity reported in the Surgical Variance Report is not unique to the private sector in Australia, nor Australian clinical practice in general.[107] Data from a limited number of Australian public hospitals also reported a high degree of between-hospital variation; however, referral rates to inpatient facilities were lower in the public sector overall compared to the private sector. If clinical variation is a sign of inefficiencies in a system, the data identified in this report suggests that improvements can be made in both hospital sectors.

Unfortunately, the Australian referral data do not offer an insight into the case-mix of patients, so it is difficult to say whether patient factors had an impact on referral to an inpatient setting. In the broader literature, several patient factors were identified as being predictive of referral to an IRF, including female gender, older age, higher comorbidity burden, worse functional independence and a lack of home/community support. Interestingly, but perhaps not surprisingly, the strongest non-clinical factor predicting discharge setting was patient expectations. This may be a strong driver behind the high utilisation of inpatient rehabilitation services in the Australian private sector.

It is clear from the RCT evidence that, in patients who are not predisposed to needing inpatient rehabilitation, home-based rehabilitation with support offers similar pain, function and quality of life outcomes. Pre-operatively identifying patients that may be suited to home-based rehabilitation means patients can be given targeted education about pre-operative support programs, sets an expectation for discharge destination after surgery, and allows patients to plan for their post-operative rehabilitation. However, this strategy alone places the burden of improving system efficiencies on surgeons. Structural changes to the care pathway and incentives will be needed to support surgeons in providing pre-operative education to patients and promoting rehabilitation in appropriate settings.

Recommendations

1. Supported home-based rehabilitation services, including home assistance and access to community-based services, should be offered to patients who do not need inpatient rehabilitation.
2. Pre-operative screening tools should be completed in conjunction with patients and caregivers to identify patients who will benefit from inpatient rehabilitation.
3. Patients and carers should be engaged in the decision about their likely discharge setting, combined with pre- and post-operative education about rehabilitation, in order to help facilitate the use of home-based rehabilitation where appropriate.
4. Influencing change in the care pathway will require multidisciplinary support.
5. Health payers should work with health providers and health practitioners (orthopaedic surgeons and rehabilitation specialists) to develop appropriate benchmarks for the selection of patients who have inpatient rehabilitation after joint arthroplasty.
6. Further research on the impact of pre-habilitation is recommended to inform the optimal pathway of care for TKA and THA patients.

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Appendix 1 Search Strategies

Table. Ap. 1 PubMed search strategy

Keywords and syntax	Search results
(((((("Arthroplasty, Replacement/rehabilitation"[Mesh]) OR "Arthroplasty, Replacement, Hip/rehabilitation"[Mesh]) OR "Arthroplasty, Replacement, Knee/rehabilitation"[Mesh])) OR ((((("Rehabilitation"[Mesh] OR "Rehabilitation Nursing"[Mesh] OR "Rehabilitation Centers"[Mesh] OR "Physical and Rehabilitation Medicine"[Mesh] OR "Exercise Therapy"[Mesh] OR "Activities of Daily Living"[Mesh] OR "Rehabilitation"[Mesh]))) AND ((((((("knee"[Title/Abstract] OR "hip"[Title/Abstract])) AND replace*[Title/Abstract]))) OR ("Arthroplasty, Replacement, Knee"[Mesh] OR "Arthroplasty, Replacement, Hip"[Mesh] OR "Arthroplasty, Replacement"[Mesh] OR "Arthroplasty"[Mesh])))))) AND ((((((("Inpatients/rehabilitation"[Mesh]) OR ((inpatient*[Title/Abstract]) AND rehabilit*[Title/Abstract])) OR ((hospital[Title/Abstract]) AND rehabilitation[Title/Abstract]))) OR (((((("Home Care Services, Hospital-Based"[Mesh]) OR "Home Care Services"[Mesh])) OR ((((((home base*[Title/Abstract]) OR homebase*[Title/Abstract]) OR home-base*[Title/Abstract])))))) OR (((house calls[MeSH Terms]) OR home visit*[Title/Abstract]) OR house call*[Title/Abstract])) OR ((physiotherap*[Title/Abstract]) AND assist*[Title/Abstract])))	551

Table. Ap. 2 Embase search strategy

Keywords and syntax	Search result
(('arthroplasty'/exp OR 'knee arthroplasty'/exp OR 'hip arthroplasty'/exp OR 'knee replacement'/exp) AND [embase]/lim) AND ('rehabilitation'/exp OR 'rehabilitation nursing'/exp OR 'rehabilitation center'/exp OR 'rehabilitation medicine'/exp OR 'kinesiotherapy'/exp OR 'daily life activity'/exp)) AND ((inpatients:ab,ti OR (inpatient*:ab,ti AND rehabilit*:ab,ti) OR (hospital:ab,ti AND rehabilitation:ab,ti)) OR ('home care'/exp OR (home:ab,ti AND base*:ab,ti OR homebase*:ab,ti OR 'home base*':ab,ti) OR (physiotherap*:ab,ti AND assist*:ab,ti) OR 'home visit'/exp OR ((home:ab,ti AND visit*:ab,ti OR house:ab,ti) AND call*:ab,ti)))	773

Table. Ap. 3 The Cochrane Library search strategy

Keywords and syntax	Search results
"arthroplasty" or "arthroplasties" or "replacement" AND “hip" or "knee" AND “rehabilitation” AND "inpatient" or "inpatient unit" or "inpatient ward" or "inpatient hospital"	154

Table. Ap. 4 Clinical practice guideline and grey literature resources

Website	Search terms
https://www.guideline.gov	Arthroplasty; knee replacement; hip replacement
https://www.nhmrc.gov.au/guidelines	Arthroplasty; knee replacement; hip replacement
https://www.evidence.nhs.uk/	Arthroplasty; knee replacement; hip replacement
https://www.health.gov.au	Arthroplasty; knee replacement; hip replacement
http://www.sign.ac.uk	Arthroplasty; knee replacement; hip replacement
http://www.g-i-n.net	Arthroplasty; knee replacement; hip replacement
http://www.worc.org.au/	Arthroplasty; knee replacement; hip replacement
https://www.aaos.org/	Arthroplasty; knee replacement; hip replacement
https://inghaminstitute.org.au/	Arthroplasty; knee replacement; hip replacement
http://ahsri.uow.edu.au/aroc	Guideline; discharge
http://www.acornregistry.org/	Guideline
https://www.aoa.org.au/	Guideline

Search results

CPGs

No relevant, up-to-date CPGs were identified through grey literature searches. It is acknowledged that the American Academy of Orthopaedic Surgeons and the National Institute of Clinical Excellence in the UK have published guidelines on the treatment of hip and knee osteoarthritis, and management of hip fractures in the elderly. These guidelines do not incorporate recommendations for the choice of rehabilitation setting following TKA or THA.

Grey literature

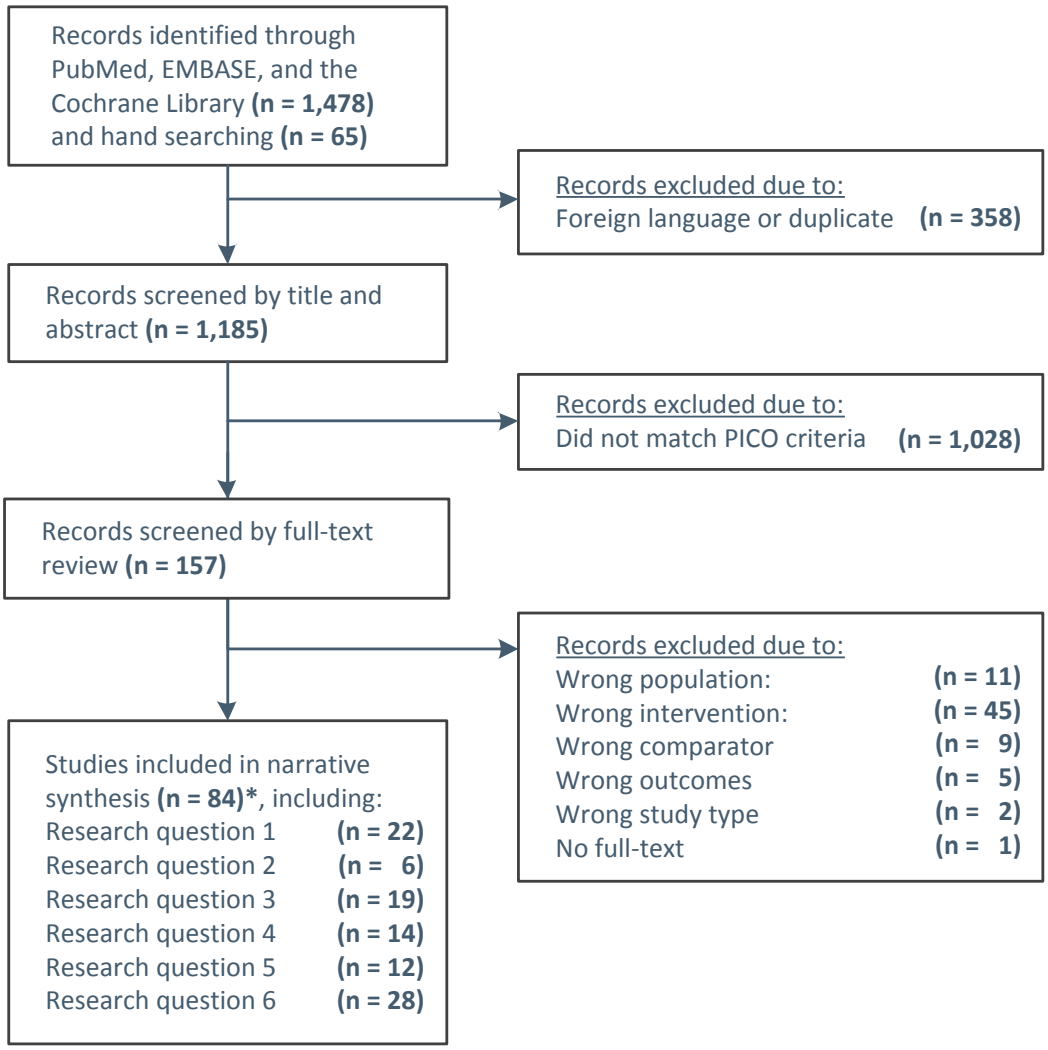
Three reports were identified through targeted searches for grey literature, which were included for question 1:

1. The RACS/Medibank report on clinical variation in orthopaedic procedures.[8]
2. The ACORN registry annual report.[9]
3. A quarterly report from the Repatriation General Hospital Orthopaedic Unit.[7]

Peer-reviewed literature results

A PRISMA flow chart for the formal peer-reviewed search is presented in Figure 8. The results of targeted keyword searches (i.e. hand searching) are indicated in the top box.

Figure 8 PRISMA flow chart of study inclusion



*Some studies were included for more than one research question, hence the total adds up to more than 84

Appendix 2 Data from research question 1

Table. Ap. 5 Reported rate of referral to different settings for rehabilitation following hip and knee arthroplasty

Study	Year	Study design	Payer	Time period	Indication	Primary; revision	Sample size	Discharge Destination, % (n)			
								IRF	SNF	Home Supervised	Home Unsupervised
Australia											
RACS and Medibank [8]	2016	Cross-sectional	Private	Jan 2014 – Dec 2014	TKA	Both	6,102	42.6 (2,602)	NR	NR	NR
ACORN Registry [9]	2015	Prospective cohort	Public	Jan 2013 – Dec 2015	TKA	Both	2,718	21.4 (595)	NR	NR	76.7 (2123)
RACS and Medibank [8]	2016	Cross-sectional	Private	Jan 2014 – Dec 2014	THA	Both	4,423	36.7 (1,623)	NR	NR	NR
ACORN Registry [9]	2015	Prospective cohort	Public	Jan 2013 – Dec 2015	THA	Both	1,329	17.1 (227)	NR	NR	80.8 (1074)
Repatriation General Hospital [7]	2017	Prospective cohort	Public	Jul 2015 – Jul 2016	THA/TKA	Both	427	7.0 (30) [A]	NR	NR	90.0 (384)
RACS and Medibank [8]	2016	Cross-sectional	Private	Jan 2014 – Dec 2014	THA/TKA	Both	10,525 [B]	40.1 (4,225)	NR	NR	NR
Oldmeadow et al. [6]	2003	Prospective cohort	Public	Jan 1998 – Dec 2000	THA/TKA	Both	520	46.0 (239)	NR	NR	54.0 (281)
United States											
Schwarzkopf et al. [24]	2016	Cross-sectional	Medicare, MediCal, Medicaid, private	2010	TKA	Unclear	28,611	29.9 (8,555) [D]	NR	45.9 (13,132)	24.2 (6,924)
Rissman et al. [22]	2016	Prospective cohort	Medicare, Medicaid, private	Apr 2011 – Apr 2013	TKA	Primary	738	3.1 (23)	22.5 (166) [C]	71.6 (529)	2.7 (20)

Study	Year	Study design	Payer	Time period	Indication	Primary; revision	Sample size	Discharge Destination, % (n)			
								IRF	SNF	Home Supervised	Home Unsupervised
Gholson et al. [15]	2016	Retrospective cohort	NR	2011 – 2013	TKA	Primary	64,237	32.5 (20,984) [D]	NR	NR	67.5 (43,653)
Jorgenson et al. [58]	2015	Retrospective cohort	Medicare, Medicaid, private	2001–2012	TKA	Primary	129,522	9.6 (12,463)	25.1 (32,450)	47.2 (61,102)	18.2 (23,507)
Ponnusamy et al. [20]	2017	Cross-sectional	Medicare	2008	TKA	Primary	329,233	10.4 (34,093)	30.8 (101,369)	37.5 (123,601)	21.0 (70,170)
Bozic et al. [10]	2006	Cross-sectional	Medicare, Medicaid, private	Jan 2000 – Dec 2002	TKA	Both	3,333	15.0 (500)	14.4 (479)	12.0 (401)	58.6 (1,953)
Freburger et al. [12]	2011	Cross-sectional	Medicare, non-Medicare	2005 – 2006	TKA	Both	111,291	15.8 (17,586)	28.3 (31,539)	31.4 (34,985)	24.5 (111,291)
Shah et al. [25]	2011	Retrospective cohort	NR	2011 – 2014	THA	Primary	3,120	53.9 (1,682) [D]	NR	NR	46.1 (1,438)
Sabeh et al. [23]	2017	Retrospective case control	Medicare, private	2011 – 2012	THA	Primary	257,120	13.1 (33,433)	44.2 (107,594)	NR	44.7 (113,809)
Gholson et al. [15]	2016	Retrospective cohort	NR	2011 – 2013	THA	Primary	42,663	28.3 (12,066) [D]	NR	NR	71.7 (30,597)
Ponnusamy et al. [20]	2017	Cross-sectional	Medicare	2008	THA	Primary	138,842	13.3 (18,220)	35.0 (48,603)	34.3 (47,635)	17.6 (24,384)
de Pablo et al. [11]	2004	Cross-sectional	Medicare	1995	THA	Both	1,276	58.0 (740)	NR	NR	42.0 (536)
Riggs et al. [21]	2010	Retrospective cohort	NR	Jan 2004 – Sep 2006	THA	Both	606	31.2 (189)	29.5 (179)	15.7 (95)	22.4 (136)
Fu et al. [13]	2017	Retrospective cohort	NR	2011 – 2014	THA	Both	54,837	26.0 (14,261)	NR	NR	74.0 (40,576)

Study	Year	Study design	Payer	Time period	Indication	Primary; revision	Sample size	Discharge Destination, % (n)			
								IRF	SNF	Home Supervised	Home Unsupervised
Bozic et al. [10]	2006	Cross-sectional	Medicare, Medicaid, private	Jan 2000 – Dec 2002	THA	Both	4485	12.6 (566)	16.2 (727)	14.3 (642)	56.9 (2,550)
Freburger et al. [12]	2011	Cross-sectional	Medicare, non-Medicare	2005 – 2006	THA	Both	53,584	16.5 (8,819)	32.4 (17,332)	31.6 (16,921)	19.5 (10,454)
Ganz et al. [14]	2003	Retrospective cohort	NR	1995 – 2000	THA	Unclear	10,383	26.8 (2,782)	0.6 (67)	NR	72.9 (7,568) [E]
Mears et al. [26]	2009	Prospective cohort	Medicare, Medicaid, private	Jun 2002 – Dec 2005	THA	Unclear	661	6.0 (46)	4.7 (31)	14.4 (95)	74.0 (489)
Gholson et al. [15]	2016	Retrospective cohort	NR	2011 – 2013	THA/TKA	Primary	107,300	30.8 (74,250)	NR	NR	69.2 (33,050) [D]
Keswani et al. [17]	2016	Retrospective cohort	NR	2011 – 2013	THA/TKA	Primary	106,360	10.8 (11,464)	18.8 (20,017)	NR	70.4 (74,879)
Ponnusamy et al. [20]	2017	Cross-sectional	Medicare	2008	THA/TKA	Primary	468,075	11.2 (52,313)	32.0 (149,972)	36.6 (171,236)	20.2 (94,554)
Bozic et al. [10]	2006	Cross-sectional	Medicare, Medicaid, private	Jan 2000 – Dec 2002	THA/TKA	Both	7,818	13.6 (1,066)	15.4 (1,206)	13.3 (1,043)	57.6 (4,503)
Freburger et al. [12]	2011	Cross-sectional	Medicare, non-Medicare	2005 – 2006	THA/TKA	Both	164,875	16.0 (26,405)	29.6 (48,822)	31.5 (51,906)	22.9 (37,742)
Inneh et al. [16]	2016	Retrospective cohort	NR	Sep 2011 – Oct 2014	THA/TKA	Both	7,924	35.8 (2,836) [D]	NR	NR	64.2 (5,088)
Munin et al. [19]	1995	Cross-sectional	Medicare, Medicaid, private	Jan 1993 – Dec 1993	THA/TKA	Both	162	40.1 (65)	NR	NR	59.9 (97)

Notes: [A] 3% other, numbers are approximations based on reported %. [B] Sample was separations not patients. [C] Includes 86 (11.7%) patients treated as "Swing Bed" patients in an SNF. [D] Included IRF and SNF combined. [E] Included supervised or unsupervised, 746 cases missing from dataset.

Abbreviations: **ACORN** = Arthroplasty Clinical Outcomes Registry National; **IRF** = inpatient rehabilitation facility; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty.

Appendix 3 Data from research question 2

Table. Ap. 6 Systematic reviews that outlined or evaluated outcomes related to hip or knee arthroplasty

Review ID; Location	Scope of review	Included studies	Outcomes identified
Jones et al. 2014 [63] UK	Systematically review patient reported outcomes and patient experience in enhanced recovery after orthopaedic surgery	K = 8	1. Patient satisfaction questionnaires 2. Patient-reported QoL: • EuroQol 5-D™ (EQ-5D) • Short Form 36™ (SF-36) 3. Qualitative interview data
Alviar et al. 2011 [61,62] Australia	The aim of this study was to systematically review and compare the measurement attributes of multidimensional, patient-reported outcome measures used in hip and knee arthroplasty rehabilitation.	K = 68	1. Western Ontario and McMasters University Osteoarthritis Index (WOMAC) 2. EQ-5D 3. SF-36 4. Short-Form 12 (SF-12) 5. Short-Form 6D (SF-6D) 6. Oxford Knee Score (OKS) 7. Oxford Hip Score (OHS) 8. Sickness Impact Profile 9. Nottingham Health Profile 10. Knee injury and Osteoarthritis Outcome Score (KOOS) 11. Health Assessment Questionnaire 12. Modified Health Assessment Questionnaire 13. Hip Dysfunction Osteoarthritis Outcome Score (HOOS) 14. Lequesne Algofunctional Index 15. Quality of Well-Being 16. Health Utilities Index 17. Functional Status Index 18. Arthritis Impact Measurement Scales 19. Shortened Arthritis Impact Measurement Scales 20. World Health Organization Quality of Life instrument 21. Pain and Function of the Hip 22. Lower Extremity Activity Profile 23. London Handicap Scale 24. Hip Rating Questionnaire 25. Functional Status Questionnaire 26. Short Musculoskeletal Function Assessment Questionnaire 27. Musculoskeletal Outcomes Data Evaluation and Management Systems Hip/Knee Core Scale 28. McKnee

Review ID; Location	Scope of review	Included studies	Outcomes identified
Thorborg et al. 2009 [66] Denmark	To recommend the most suitable patient reported outcome questionnaires for the assessment of hip and groin disability based on a systematic review of evidence of validity, reliability and responsiveness of these instruments.	K = 41	1. WOMAC 2. HOOS 3. OHS 4. American Academy of Orthopaedic Surgeons Hip Score 5. Hip Outcome Score 6. Hip Rating Questionnaire 7. Inguinal Pain Questionnaire 8. Lequesne Index of Severity for Osteoarthritis of the Hip 9. Modified Harris Hip Score 10. Nonarthritic Hip Score 11. Patient Specific Index 12. Reduced Western Ontario and McMaster Universities Osteoarthritis index Function Score 13. Total Hip Arthroplasty Outcome Questionnaire
Khan et al. 2008 [64] UK	To assess the evidence for effectiveness of organised multidisciplinary rehabilitation in adults (aged 18 years and above) following hip or knee joint replacement surgery	K = 5	1. Impairments/Activity limitation: • OHS • WOMAC • Functional Independence Measure (FIM) • Harris Hip Sore (HHS) • Barthel Self Care Index • Bristol Knee Score • Days to sitting out of bed • Days to ambulation • Functional Status Index • Meurle d'Abuigne and Postel 2. Restriction in participation (e.g. extended activities of daily living, societal re-integration or quality of life) • Dartmouth COOP Charts • Nottingham Health Profile • RAND 36-Item Health Survey • 36-item Short Form Health Survey Questionnaire (SF-36)
Smith et al. 2016 [65] UK	To assess the effects of provision of assistive devices, education on hip precautions, environmental modification and training in activities of daily living (ADL) and extended ADL (EADL) for people undergoing THA	K = 3	1. Pain 2. Function (e.g. WOMAC, OHS, HHS, SF-36, SF-12) 3. HRQOL (e.g. SF-36, SF-12, Frenchay Activities Index, EuroQoL) 4. Global assessment of treatment success 5. Hip dislocation 6. Reoperation 7. Adverse events

Abbreviations: COOP = Cooperative Functional Assessment Charts; **EQ-5D** = EuroQol 5D; **FIM** = Functional Independence Measure; **HHS** = Harris Hip Score; **HOOS** = Hip Dysfunction Osteoarthritis Outcome Score; **KOOS** = Knee injury and Osteoarthritis Outcome Score; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **SF-26** = Short Form-26; **WOMAC** = Western Ontario and McMasters University Osteoarthritis Index.

Appendix 4 Data from research question 3

Table. Ap. 7 Systematic reviews investigating factors affecting patient-related outcomes of arthroplasty

Author, year; Country	Aim	Population	Intervention; Comparator	Included studies	Key findings	Funding and conflicts
Artz et al. 2015 [43] UK	Determine the effectiveness of post-discharge physiotherapy exercise.	TKA	Outpatient physio; Unsupervised home-based physio	K = 18	Short term benefit of physiotherapy vs no physiotherapy, no additional benefit of outpatient physiotherapy compared to home-based physiotherapy after 6 months.	Funding: NR Conflicts: None
Buirs et al. 2016 [70] Netherlands	Identify predictors of functional outcome after THA.	THA	N/A	K = 33	Predictors of better functional outcomes included (1) lower BMI (2) younger age (3) fewer comorbidities (4) better pre-operative physical function (5) better mental health.	Funding: NR Conflicts: Declared
Cabilan et al. 2016 [71] Australia	Evaluate the effectiveness of pre-operative rehabilitation (prehab) on functional status.	TKA and THA	Prehab; Usual care	K = 13	No significant improvements in functional status, QoL, pain or readmissions were noted in TKA or THA patients who underwent Prehab. Prehab was significantly associated with reduced utilization of admissions for acute inpatient rehabilitation.	Funding: NR Conflicts: None
Coulter et al. 2013 [81] Australia	Determine the effectiveness of physiotherapist directed rehabilitation exercises.	THA	Supervised outpatient; Unsupervised home-based	K = 5	Physiotherapist-directed rehabilitation was similarly effective whether performed unsupervised at home or supervised by a physiotherapist in an outpatient setting.	Funding: Declared Conflicts: None
Elings et al. 2015 [78] Netherlands	Identify pre-operative patient-related predictors of inpatient recovery of functioning and length of stay.	THA	N/A	K = 14	No strong predictors of inpatient recovery of function were identified. Longer length of stay was associated with (1) higher ASA score (2) increased number of comorbidities (3) heart disease (4) lung disease.	Funding: None Conflicts: None
Kerkhoffs et al. 2012 [77] Netherlands	Determine whether obesity has a negative influence on outcomes after TKA.	TKA	BMI < 30 kg/m^2; BMI ≥ 30 kg/m^2	K = 20	Higher BMI was associated with greater risk of and infection, deep infection requiring surgical intervention, any revision and worse Knee Society Score.	Funding: Declared Conflicts: Declared

Author, year; Country	Aim	Population	Intervention; Comparator	Included studies	Key findings	Funding and conflicts
Li et al. 2017 [82] China	Compare the effects of home-based versus hospital-based rehabilitation.	TKA	Hospital-based; Home-based	K = 10	No significant difference between hospital and home-based rehab at 12 or 52 weeks in relation to WOMAC, physical function, stiffness, walk test, and OKS.	Funding: Declared Conflicts: None
Lungu et al. 2016 [68] Canada	Determine pre-operative factors associated with post-operative patient-reported pain and function up to 2 years after primary unilateral THA for osteoarthritis.	THA	N/A	K = 22	Pre-operative determinants of worse pain and function up to 2 years after THA included (1) lower educational status (2) older age (3) female gender (4) more socioeconomic deprivation (5) worse pre-operative pain/function (6) higher BMI (7) more comorbidity (8) worse general health (9) lower radiographic osteoarthritis severity.	Funding: Declared Conflicts: None
Lungu et al. 2016 [69] Canada	Determine pre-operative factors associated with early and medium-term patient-reported pain and disability following TKA.	TKA	N/A	K = 33	Pre-operative determinants of worse pain and function up to 2 years after TKA included (1) female gender (2) non-white ethnicity (3) greater social deprivation (4) depression (5) anxiety (6) back pain (7) worse pre-operative pain/function (8) higher BMI (9) more comorbidity (10) worse general health.	Funding: NR Conflicts: None
Meermans et al. 2017 [80] UK	Evaluate the effectiveness of the anterior approach compared to the posterior, lateral and anterolateral approaches in THA.	THA	Anterior approach; Posterior, lateral and anterolateral approaches	K = 42	The anterior approach demonstrated superior WOMAC scores up to six weeks post-operatively, but no additional benefit from six weeks to a year. Three studies reported better Harris Hip Scores associated with the anterior approach up to 4 months after surgery, but not longer.	Funding: Declared Conflicts: None
Montin et al. 2008 [79] Finland	Determine the factors related to patient outcomes of THA.	THA	N/A	K = 17	Factors associated with worse post-operative pain and function included (1) poor pre-operative function (2) type of prosthesis (cemented vs cementless) (3) patient characteristics (4) type of operation (revision vs primary).	Funding: NR Conflicts: NR
Prokopetz et al. 2012 [74] USA	Summarise the main risk factors for revision of primary THA.	THA	N/A	K = 86	Factors associated with revision included (1) younger age (2) greater comorbidity (3) avascular necrosis vs osteoarthritis (4) low surgeon volume (5) larger femoral head size.	Funding: Declared Conflicts: None

Author, year; Country	Aim	Population	Intervention; Comparator	Included studies	Key findings	Funding and conflicts
Santaguida et al. 2008 [75] Canada	Evaluate patient characteristics that influence the outcomes of total joint arthroplasty.	TKA and THA	N/A	K = 64	Revision was associated with younger age and male gender. All-cause mortality was associated with age ≥ 80 years and male gender. Better function was associated with younger age, male gender, and lower BMI.	Funding: NR Conflicts: Declared
Smith et al. 2016[65] UK	Evaluate the effectiveness of assistive devices, education on hip precautions, and environmental modifications on activities of daily living (ADL) and extended ADL.	THA	1) Assistive devices 2) Education about hip precautions 3) Environmental modifications	K = 3	Hip precautions, assistive devices and functional restrictions improved patient satisfaction at 12-months follow-up. Due to the low quality of the evidence available, the certainty of this effect was questioned.	Funding: Declared Conflicts: None
Van Herck et al. 2010 [73] Belgium	Determine the efficacy of joint arthroplasty clinical pathways.	TKA and THA	Clinical care pathways; Standard care without clinical pathway	K = 34	Mixed results on the impact of clinical pathways on clinical outcomes and patient satisfaction; outcomes for clinical pathways were either favourable or non-inferior compared to standard care. Process and financial outcomes were favourable to clinical pathways.	Funding: NR Conflicts: NR
Wang et al. 2016 [72] Canada	Determine the clinical impact of pre-operative rehabilitation (prehab) on recovery after joint replacement.	TKA and THA	Prehab; Usual care	K = 22	Prehab was associated with reduced pain up to 4-weeks after surgery. WOMAC scores, time to climb stairs, toilet use and chair use were greater at 6, 8 and 12 weeks after surgery in the prehab groups. No impact on QoL scores.	Funding: Declared Conflicts: None
Zhang et al. 2015 [76] China	Determine the risk factors for venous thromboembolism following TKA and THA.	TKA and THA	N/A	K = 54	Risk factors associated with venous thromboembolism included (1) older age (2) female gender (3) higher BMI (4) bilateral surgery (5) surgery time > 2 hours. History of thromboembolism was a factor for THA but not TKA. Cement fixation was a factor for TKA not THA. TKA surgery was a risk factor compared to THA.	Funding: Declared Conflicts: None

Abbreviations: **BMI** = Body Mass Index; **OKS** = Oxford Knee Score; **QoL** = Quality of Life; **THA** = Total Hip Arthroplasty; **TKA** = Total Knee Arthroplasty; **N/A** = Not Applicable; **NR** = Not Reported; **USA** = United States of America; **UK** = United Kingdom; **WOMAC** = Western Ontario and McMaster Universities Osteoarthritis index score.

Appendix 5 Data from research question 4

Table. Ap. 8 Study profile table for research question 4

Author	Year	Country	Study design and aim	Patient profiles	Surgery included	Sample size	Hospital setting	Outpatient setting
Bozic et al.	2006	USA	Retrospective cohort study; Analysing factors for post-operative discharge destination	General patients, indication not reported	Unilateral TKA and THA, both primary and revision included	N = 7818	Extended care facility	1) Home discharge without rehabilitation 2) Home health agency
Dauty et al.	2009	France	Single arm case series; Analysing factors for inpatient rehabilitation duration.	Patients indicated for osteoarthritis excluding indications of arthritis, bone tumours, fractures and osteonecrosis.	Primary TKA	N = 244	Inpatient rehabilitation	NA
de Pablo et al.	2004	USA	Cohort study Analysing factors of rehabilitation discharge	Older patients (over 65 years), indication not reported	Elective primary and revision THA	N = 3,507	Inpatient rehabilitation	Home discharge rehabilitation not clear
Freburger et al.	2011	USA	Cross-sectional study; Analysing factors influencing rehabilitation settings	Middle aged to older patients (over 45 years), indication not reported	TKA and THA, primary and revisions, excluding hip fracture	N = 164,875	Extended care facility	1) Hospital care at home 2) Home discharge without rehabilitation
Fu et al.	2017	USA	Retrospective study Analysing short-term mobility influencing rehabilitation settings	General patients indicated for osteoarthritis	THA no otherwise specified	N = 54,837	Inpatient rehabilitation including acute rehabilitation care, SNF, unskilled facilities or inpatient rehabilitation no otherwise specified	Home discharge rehabilitation not clear

Author	Year	Country	Study design and aim	Patient profiles	Surgery included	Sample size	Hospital setting	Outpatient setting
Halawi et al.	2015	USA	Retrospective study; Analysing factors affecting the choice of rehabilitation destinations	General patients, indication not reported	All types primary TKA and THA	N = 372	Extended care facility	Home base rehabilitation without physiotherapists
Hansen et al.	2015	USA	Prospective cohort study; Analysing factors affecting the choice of rehabilitation destinations	General patients, indication not reported	All types of TKA and THA	N = 3213	Extended care facility	Home-based rehabilitation
Inneh et al.	2016	USA	Retrospective cohort study Analysing factors attributable to different rehabilitation settings	General patients, indication not reported	Primary and revision THA and TKA	N = 7924	Institutional rehabilitation (hospital based, SNF and other inpatient rehabilitation facility)	Home with or without rehabilitation
Keswani et al.	2016	USA	Investigating post-TKA and THA adverse events and risk factors for influencing rehabilitation settings	General patients, indication not reported	Elective THA and TKA	N = 106,360	Extended care facilities	Home with or without rehabilitation
Oldmeadow et al.	2003	Australia	Prospective cohort study; The Risk Assessment and Prediction Tool	General patients, indication not reported	Elective hip and knee arthroplasty, including revision	N = 650	Inpatient rehabilitation	Home-based rehabilitation
Rissman et al.	2016	USA	Prospective cohort study; Analysing factors affecting the choice of rehabilitation destinations	General patients, indication not reported	Primary unilateral TKA	N = 738	Inpatient rehabilitation	Home-based rehabilitation
Schwarzkopf et al.	2016	USA	Cross-sectional study; Analysing factors of choices of rehabilitation settings	General patients indication not reported	TKA no otherwise specified	N = 28,611	Extended care facility	Home with physical therapy and nursing services

Author	Year	Country	Study design and aim	Patient profiles	Surgery included	Sample size	Hospital setting	Outpatient setting
Tian et al.	2010	USA	Prospective cohort study; Analysing factors (both patients and rehabilitation settings) influencing clinical outcomes	General patients, including indications for fracture or degenerative conditions e.g. osteoarthritis.	THA or hemiarthroplasty	N = 236	Extended care facility continued **after** SNF/IRF	Home with/without outpatient rehabilitation **after** SNF/IRF
Tribe et al.	2005	Australia	Retrospective cohort study; Comparing rehabilitation settings upon clinical outcomes with inclusion of patient factors	General patients indicated for osteoarthritis	Primary THA or TKA	N = 118	Inpatient rehabilitation	Home without rehabilitation

Abbreviations: IRF = inpatient rehabilitation facility; **NA** = not applicable; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty; **USA** = United States of America.

Table. Ap. 9 Factor summary table for research question 4

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
Bozic et al.	2006	USA	Baseline@<40yrs **THA:** For 80+yrs OR = 19.90, p < 0.01; For 65-79yrs OR = 8.57 p < 0.01; For 40-46yrs, OR = 3.62, p < 0.01. **TKA:** For 80+yrs OR = 5.40, p < 0.01, For 65-79yrs OR = 2.00, p < 0.01; For 40-64yrs not significant	Baseline@male. **THA:** OR = 1.834, p < 0.01 **TKA:** OR = 2.265, p < 0.01	NR	Baseline@ASA = I **THA:** ASA = IV OR = 10.795, p < 0.001; ASA = III OR = 3.498. p < 0.001; ASA = II not significant **TKA:** ASA = IV OR = 2.775, p < 0.001; ASA = III OR = 1.562, p < 0.001; ASA = II not significant	NR	NR	NR	Baseline@private, **THA:** Medicare OR = 2.210, p < 0.01 **TKA:** Medicare OR = 1.959, p < 0.01
Dauty et al.	2009	France	Not significant	Baseline@male mean = 2.36, SE = 4.23, p = 0.02	NR	NR	NR	Living with versus without other people: not significant		

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
de Pablo et al.	2004	USA	Baseline@<=72yrs Primary THA: For 72+yrs RR = 1.36, 95%CI = (1.11, 1.66), p value not reported; Revision THA: For 72+yrs RR = 1.09, 95%CI = (0.98, 1.78), not significant	Baseline@male Primary THA: RR = 1.14, 95%CI = (0.92, 1.43), not significant Revision THA: RR = 1.32, 95%CI = (0.98, 1.78), not significant	NR	ASA, functional status, underlying diseases not significant for both primary and revision surgeries (unadjusted)	lowest:highest quartile Pre-op THA: OR 1.09 (95% CI 0.91-1.32) Walking independently no:yes Post-op THA: 5.60 (95% CI 3.52-8.92)	Baseline@not alone Primary THA: RR = 1.23, 95%CI = (1.004, 1.5) Revision THA: RR = 1.22, 95%CI = (0.93, 1.61), not significant	NR	NR
Freburger et al.	2011	USA	Baseline@45-55 yrs 10-year incremental OR = 2.42, 95% CI = (2.38, 2.45), p < 0.01	Baseline@male OR = 2.02, 95% CI = (1.96, 2.07), p < 0.01	(Combined with insurance status) Significant yet inconsistent patterns across insurance settings[1]		NR	Baseline@rural /micropolitan, Large metro area OR = 1.27, 95% CI = (1.17, 1.37), p < 0.01		(Combined with insurance status) Baseline@Medicare likelihood downward ranking: Medicaid, uninsured, all significant.

[1] For Medicare insured/private patients, likelihood of inpatient rehabilitation was Black > Hispanic > White; for Medicaid and uninsured patients, the likelihood was reversed, i.e. White > Hispanic > Black.

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
Fu et al.	2017	USA	Baseline@<75yrs 75 and over: OR = 2.76, 95% CI = (2.61, 2.91), p < 0.001	Baseline@male OR = 1.90, 95%CI = (1.82, 1.98), p < 0.001	NR	Baseline@CCI<5 CCI>5 OR = 2.02, 95% CI = (1.90, 2.15), p < 0.001; Baseline@ASA<3 ASA>3 OR = 1.91, 95%CI = (1.92, 2.00), p < 0.001	**Pre-op**: OR 2.09 (95% CI = 1.85, 2.35, p < 0.001)	NR	NR	NR
Halawi et al.	2015	USA	Age incremental (years by default) OR = 1.10, 95% CI = (1.02, 1.18), p = 0.008	Not significant in multivariate analysis	NR	NR	NR	Baseline @assistant available, OR = 4.43, 95% CI = (1.02, 19.18), p = 0.046	Baseline@home discharge expected Extended care facility discharge expected OR = 169.53, 95% CI = (60.67, 473.76), p < 0.01	
Hansen et al.	2015	USA	Attributable, no extractable data	Attributable, no extractable data	NR	NR	NR	Attributable, no extractable data	NR	NR

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
Inneh et al.	2016	USA	Age incremental (years by default) OR = 1.054, 95%CI = (1.049, 1.060), p < 0.001	Baseline@male OR = 1.693, 95% CI = (1.515, 1.892), p < 0.001	Baseline@black White OR = 0.847, 95% CI = (0.721, 0.980), p = 0.027; Other OR = 0.796, 95%CI = (0.670, 0.946), p = 0.009;	NR	NR	NR	NR	NR
Keswani et al.	2016	USA	Age incremental (years by default) OR = 1.07, 95%CI = (1.06, 1.08), p < 0.001	Baseline@female OR = 0.55, 95% CI = (0.54, 0.57), p < 0.001	NR	Specific comorbidities were listed, including diabetes, pulmonary disease, hypertension, renal disease, use of steroid, blood disorders and ASA, all significant (p < 0.001)	Non-home discharge destination: OR 2.04 (95% CI 1.84-2.25, O<0.001)	NR	NR	NR
Oldmeadow et al.	2003	Australia	Age incremental, predicting home discharge (assumed by years) OR = 0.959, 95%CI = (0.966, 0.982), p < 0.05	Not significant	NR	Mobility positively predicting home discharge OR = 1.672, 95%CI = (1.165, 2.398), p < 0.005	NR	Caregiver positively predicting home discharge OR = 6.476, 95% CI = (3.884, 10.799), p < 0.001	Patient expectation positively predicting home discharge, OR = 12.94, 95% CI = (7.65, 21.89), p < 0.001	NR

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
Rissman et al.	2016	USA	Baseline@<=55, For 70-74 OR = 4.95, 95% CI = (2.08, 11.78), p < 0.01; For 75-79 OR = 11.13, 95% CI = (4.61, 26.84), p < 0.01; For 80+ OR = 16.12, 95% CI = (6.38, 40.69), p < 0.001	Baseline@male OR = 2.67, 95% CI = (1.68, 4.23), p <0.01	NR	NR	NR	NR	NR	NR
Schwarzkopf et al.	2016	USA	Incremental age increase RR = 1.46, 95% CI = (1.42, 1.49), p < 0.001	Baseline@female RR = 0.43, 95% CI = (0.40, 0.46), p < 0.001	Baseline@white Black RR = 2.44, 95% CI = (2.03, 2.92) p < 0.001; Asian RR = 2.66, 95% CI = (2.15, 3.30), p < 0.001; Ethnicity significant	Incremental score OR = 1.37, 95% CI = (1.32, 1.43), p < 0.001	NR	NR	NR	Baseline unclear, home versus SNF Medicare OR = 1.69, 95% CI = (1.53, 1.86), p < 0.001; Medicaid not significant

Author	Year	Country	Age	Gender	Race/ethnicity	Comorbidity	Functional independence	Co-habitual status	Patient expectation	Insurance status
Tian et al.	2010	USA	Incremental age increase Multiple comparison for outpatient rehabilitation OR = 0.97, 95%CI = (0.94, 0.99), p < 0.05	Baseline@male Multiple comparison for outpatient ± home rehabilitation OR =0.36, OR = 0.49 respectively, both significant	Not significant	Not significant	NR	NR	NR	NR
Tribe et al.	2005	Australia	Not significant	**THA:** Not significant; **TKA:** Baseline@male, OR = 3.62, p = 0.035, (calculated during the review, test unclear)	NR	Included as a factor but results not reported in the article	NR	**THA:** Not significant; **TKA:** Baseline@alone, Living alone OR = 7.33, p = 0.005, (calculated during the review, test unclear)	NR	Not significant

Abbreviations: **ASA** = American Society of Anesthesiologists score; **CCI** = Charlson Comorbidity Index; **CI** = confidence interval; **NR** = not reported; **OR** = odds ratio; **RR** = relative risk; **TKA** = total knee arthroplasty; **THA** = total hip arthroplasty; **USA** = United States of America.

Table. Ap. 10 GRADE of the evidence base on factors affecting rehabilitation setting

Quality assessment							Effect size OR Range*	Quality
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
Age								
14	observational studies	not serious	not serious	not serious	serious [a]	strong association [b]	OR ranged from 3.62 to 19.90	⊕⊕◯◯ LOW
Gender								
13	observational studies	not serious	not serious	not serious	not serious	strong association [b]	OR ranged from 2.0 to 3.0	⊕⊕⊕◯ MODERATE
Care-giver (assessed with: Availability of caregiver at home)								
7	observational studies	not serious	not serious	not serious	not serious	none	not pooled	⊕⊕◯◯ LOW
Comorbidity								
7	observational studies	not serious	serious [c]	serious [d]	not serious	none	OR ranged from 1.37 to 3.50	⊕◯◯◯ VERY LOW
Race/ethnicity (white/black/Asian; Hispanic)								
4	observational studies	serious	serious [e]	serious [f]	not serious	none	not pooled	⊕◯◯◯ VERY LOW
Insurance status (assessed with: Medicare/Medicaid/Privately insured)								
4	observational studies	serious	not serious	not serious	not serious	none	not pooled	⊕◯◯◯ VERY LOW
Functional independence								
3 (pre-op)	observational studies	not serious	not serious	not serious	not serious	none	OR ranged from 1.85 to 9.13	⊕⊕◯◯ LOW
1 (post-op)	observational studies	not serious	not applicable	not serious	not serious	none	OR 1.09 (91% CI 0.91-1.32)	⊕⊕◯◯ LOW
Patients' expectations								
2	observational studies	serious	not serious	serious [g]	serious [h]	none	OR 169.53 60.67 to 473.76	⊕◯◯◯ VERY LOW

*Odds Ratios are calculated with inpatient as the base case

Appendix 6 Data from research question 5

Table. Ap. 11 Study outcome summary table for question 5

Author/Year/Country	6MWT	OHS/OKS	WOMAC	HRQoL	FIM	Patient satisfaction	Clinical	Others
Buhagiar et al. 2017 Australia	ITT (imputed), 26 week, not significant [I] n = 81, mean = 402.7, 95% CI = (370.9, 434.5) [C] n = 84, mean = 403.7, 95% CI = (372.0, 435.4)	NR	NR	**[EQ5D]** at 52 weeks: [I] n = 80, mean = 0.70, 95% CI = (0.66, 0.75) [C] n = 80, mean = 0.73, 95% CI = (0.69, 0.78)	Before-after, time unknown, [C] not reported	**NR**	**[VAS %]** Mean difference = 8.9, 95% CI = (3.0, 14.9), p = 0.004, favours inpatient	**[readmission]** Not significant between settings, time frame unknown
Palmer Hill et al. 2000 UK	NR	**[AKSCRS]** 1 year follow-up No significant differences	NR	NR	NR	**[Self-developed Questionnaire]** Proportion of patients felt happy due to well-supported rehabilitation [I] = 90.32% [C] = 64.29%	NR	**[readmission]** 3 incidence with 2 arthroplasty-related infection in each arm

Author/Year/Country	6MWT	OHS/OKS	WOMAC	HRQoL	FIM	Patient satisfaction	Clinical	Others
Mahomed et al. 2008 Canada	NR	NR	12 month scores No significant differences	**[SF-36]** 12 month scores No significant differences	NR	**[Hip and Knee Satisfaction Scale]** 3 and 12 month scores No significant differences	NR	NR
Shepperd et al. 1998 UK	NR	**[OHS]** At 3 months, PP, MD = 1.64, 95% CI = (-1.23, 4.50), not significant; [I] n = 31, change = 4.77, SD not reported; [C] n = 43, change = 3.13, SD not reported Bristol Knee Score, not significant	NR	**[COOP]** Hip - Not significant at 3 months except change in quality of life: MD = 0.61, 95% CI = (0.02, 1.20) Knee - No significant differences at 3 months	NR	NR	NR	**[Readmission]** Hip - mean = 3%, 95% CI = (-0.05, 0.12) Knee - mean = 6%, 95% CI = (-0.03, 0.15)
Benz et al. 2015 Switzerland	NR	NR	No significant differences were found between inpatient and outpatient rehabilitation	NR	NR	NR	NR	NR

Author/Year/Country	6MWT	OHS/OKS	WOMAC	HRQoL	FIM	Patient satisfaction	Clinical	Others
DeJong et al. 2009 USA	NR	NR	NR	NR	**[Motor FIM]** TKA_MD = 0.901, p = 0.014; THA_MD = 1.639, p = 0.005;	NR	NR	NR
Mallinson et al. 2011 USA	NR	NR	NR	NR	Functional mobility adjusted by factors was not significant across settings;	NR	NR	NR
Naylor et al. 2017 Australia	NR	**[OKS]** Mean difference @ 90 days = 0 (IQR = -6 to 5); p = 0.54 Mean difference @ 365 days = 0 (IQR -4 to 3); p = 0.40	NR	**[EQ-VAS]** Significant at 35 (MD = -5 [IQR -19 to 10], p = 0.01) and 90 days (MD = -2.5 [IQR -15 to 10], p = 0.09). Not significant at 365 days (p = 0.32).	NR	NR	NR	NR

Author/Year/Country	6MWT	OHS/OKS	WOMAC	HRQoL	FIM	Patient satisfaction	Clinical	Others
Tian et al. 2010 USA	NR	NR	NR	**[SF-12 physical component score]** Not significant across settings (IRF ± home ± outpatient & SNF ± home ± outpatient, in total of 6 models of care)	**[Motor]** IRF + Home significantly better than IRF + IRF/SNF, (MD = 8.20, $p < 0.01$ IRF + Home significantly worse than IRF + outpatient MD = 3.08, $p = 0.020$ 2.5% of variation counted	NR	NR	NR
Tribe et al. 2005 Australia	NR	NR	For THA, there was significant changes between pre- and 12 months post-op but not between inpatients and home groups	**[SF-36]** Not significant at 12 months for both TKA and THA.	NR	NR	NR	NR

Author/Year/Country	6MWT	OHS/OKS	WOMAC	HRQoL	FIM	Patient satisfaction	Clinical	Others
Walsh et al. 2006 USA	**[Ambulation distance (feet)]** p = 0.004, MD not reported, [IRF] n = 85, mean = 289, SD = 212 [SNF] n = 85, mean = 380, SD = 168	NR	NR	NR	**[Locomotion FIM score]** p < 0.001, MD not reported	NR	Discharge destinations (no. & %), proportion differences not reported, p = 0.029 (McNemar test)	Required home care services, significantly higher in SNF (p < 0.001); Required walker significantly higher in SNF (p< 0.01)
Yildirim et al. 2015 Turkey	NR	NR	NR	**[SF-36 physical component score]** 6 weeks score from baseline, p < 0.001 [I] n = 123, diff = 40.2, SD = 5.7; [C] n = 251, diff = 10.2, SD = 3.7 **[SF-36 mental component score]** not significant	NR	NR	**[Pain VAS]** 6 weeks from baseline in %, not significant [I] n = 123, diff = 56.7, SD = 8; [C] n = 251, diff = 65.4, SD = 9.1	**[Knee Society Clinical Rating System]** 6 weeks from baseline in %, not significant [I] n = 123, diff = 43.2, SD = 4.8; [C] n = 251, diff = 38, SD = 5.1

Abbreviations: 6MWT = 6-Minute Walk Test; **AKSCRS** = American Knee Society Clinical Rating System; **COOP** = Cooperative Functional Assessment Charts; **EQ-5D**; EquroQol-5 Dimension; **FIM** = Functional Independence Measure; **HRQoL** = Health-related quality of life; **IRF** = inpatient rehabilitation facility; **ITT** = intention to treat; **MD** = mean difference; **NR** = not reported; **OHS** = Oxford Hip Score; **OKS** = Oxford Knee Score; **SD** = standard deviation; **SF-36** = Short Form 36; **SNF** = skilled nursing facility; **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty; **VAS** = visual analogue scale; **WOMAC** = Western Ontario and McMaster University Osteoarthritis Index; **[I]** = intervention; **[C]** = comparator.

Table. Ap. 12 Quality appraisal of the included randomised and non-randomised comparative stuides

Author	Year	Hypothesis /Aim /Objective	Main Outcomes In Intro/Method	Patients Characteristics	Interventions	Confounders Distribution	Main Findings	Random Variability Assessment	Important Adverse Events	Patients Lost	P-Value Reported In Actual Values	Reporting	Recruited Sample Representativeness	Participated Sample Representativeness	Staff, Facility And Patients Representativeness	External Validity	Blinding Of The Subjects	Blinding Of The Measurer	Data Dredging	Adjustment For Lengths Of Follow-Up	Statistical Tests	Intervention Compliance	Outcome Described	Internal Validity - Bias	Source Of Arms - Same Population	Timing Of The Recruitment	Randomisation	Allocation Concealment	Confounding Adjustment	Loss Of Follow-Up	Internal Validity - Confounding (Selection Bias)	Power
Randomised Controlled Trials																																
Buhagiar et al.	2016	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10	⊘	⊘	✓	1	⊘	✓	✓	✓	✓	⊘	✓	5	✓	✓	✓	✓	✓	✓	6	1
Palmer Hill et al.	2000	✓	✓	⊘	✓	✓	✓	✓	✓	✓	⊘	9	⊘	✓	✓	2	⊘	⊘	✓	⊘	⊘	⊘	✓	2	✓	✓	✓	⊘	⊘	✓	4	0
Mahomed et al.	2008	✓	✓	⊘	✓	✓	✓	✓	✓	✓	✓	9	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	✓	⊘	✓	✓	5	1
Shepperd et al.	1998	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	⊘	✓	✓	2	⊘	⊘	✓	✓	✓	⊘	✓	4	⊘	✓	✓	✓	⊘	⊘	3	1
Observational studies																																
Benz et al.	2015	✓	✓	✓	✓	✓	✓	⊘	⊘	✓	✓	8	⊘	✓	✓	2	⊘	⊘	✓	✓	0	⊘	✓	3	✓	✓	⊘	⊘	⊘	✓	3	1
Bozic et al.	2006	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	1
Dauty et al.	2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10	✓	⊘	✓	2	⊘	⊘	✓	✓	0	⊘	✓	3	✓	✓	⊘	⊘	⊘	✓	3	1
DeJong et al.	2009	✓	✓	✓	⊘	✓	✓	✓	✓	✓	✓	9	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
de Pablo et al	2004	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Freburger et al.	2011	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	✓	⊘	✓	1	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Fu et al.	2017	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Inneh et al.	2016	✓	✓	✓	⊘	✓	✓	✓	⊘	✓	✓	8	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Halawi et al.	2015	✓	✓	✓	⊘	✓	✓	✓	✓	✓	✓	9	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	1
Hansen et al.	2015	✓	✓	⊘	⊘	⊘	✓	⊘	⊘	✓	✓	5	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Keswani et al.	2016	✓	✓	✓	⊘	✓	✓	✓	✓	✓	✓	9	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Mallinson et al.	2011	✓	✓	✓	✓	✓	✓	✓	⊘	✓	✓	9	⊘	✓	⊘	1	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Naylor et al.	2017	✓	✓	✓	⊘	✓	✓	✓	⊘	⊘	✓	7	⊘	⊘	✓	1	⊘	⊘	✓	✓	✓	⊘	✓	4	⊘	✓	⊘	⊘	✓	⊘	2	1
Oldmeadow et al.	2003	✓	✓	✓	⊘	⊘	✓	✓	⊘	✓	✓	7	⊘	⊘	⊘	0	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	0	⊘	⊘	⊘	✓	2	0
Rissman et al.	2016	✓	✓	✓	⊘	✓	✓	✓	✓	✓	✓	9	⊘	✓	⊘	1	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	0	2	0
Schwarzkopf et al.	2016	✓	✓	✓	⊘	0	✓	✓	⊘	✓	✓	7	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Tian et al.	2010	✓	✓	✓	⊘	✓	✓	✓	✓	✓	✓	9	✓	✓	✓	3	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	✓	✓	4	0
Tribe et al.	2005	✓	✓	✓	⊘	✓	✓	⊘	⊘	✓	✓	7	⊘	⊘	⊘	0	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0
Walsh et al.	2006	✓	✓	✓	⊘	⊘	✓	⊘	⊘	✓	✓	6	⊘	⊘	⊘	0	⊘	⊘	✓	✓	✓	⊘	✓	4	0	✓	⊘	⊘	✓	✓	3	0
Yildirim et al.	2015	✓	✓	✓	✓	✓	✓	⊘	⊘	✓	✓	8	⊘	✓	✓	2	⊘	⊘	✓	✓	✓	⊘	✓	4	✓	✓	⊘	⊘	⊘	✓	3	0

Table. Ap. 13 GRADE of the evidence base for question 5

Quality assessment								Effect direction	Quality
Study design	№ of studies	Specific outcomes	Risk of bias	Inconsistency	Indirectness	Imprecision	Other consideration		
Walking Test									
Randomised trials	1	6MWT	not serious	not applicable	not serious	not serious	none	No significant difference	⊕⊕⊕⊕ HIGH
Observational studies	1	Ambulation distance	not serious	not applicable	not serious [a]	not serious	none	*Favouring Inpatient*	⊕⊕◯◯ LOW
Oxford Hip/Knee Scores									
Randomised trials	1	OHS, OKS	not serious	serious [b]	not serious	not serious	none	No significant difference	⊕⊕⊕◯ MODERATE
Pseudo-randomised	1	OKS	not serious	not applicable	serious	not serious	none	No significant difference	⊕⊕◯◯ LOW
WOMAC									
Randomised trials	1	N/A	not serious	not applicable	not serious	not serious	none	No significant difference	⊕⊕⊕⊕ HIGH
Observational studies	2	N/A	serious [c]	serious [b]	not serious	not serious	plausible confounding	Not pooled; varied results in literature	⊕◯◯◯ VERY LOW
Health related quality of life									
Randomised trials	3	EQ5D, SF-36 and COOP	not serious	serious [b]	not serious	not serious	none	No significant difference	⊕⊕⊕◯ MODERATE
Pseudo-randomised	1	EQ-VAS	not serious	not applicable	serious	not serious	none	No significant difference@ 12 mo	⊕⊕◯◯ LOW
Observational studies	4	SF-36 and SF-12	not serious	serious [b]	not serious	not serious	plausible confounding	Not pooled; varied results in literature	⊕⊕◯◯ LOW
FIM									
Observational studies	3	Primarily on motor FIM	serious [c]	serious [b]	not serious	not serious	plausible confounding	Not pooled; varied results in literature	⊕◯◯◯ VERY LOW
Patient satisfaction									
Randomised trials	2	SF-36	not serious	serious [b]	not serious	not serious	none	Not pooled; varied results in literature	⊕⊕⊕◯ MODERATE

Appendix 7 Data from research question 6

Table. Ap. 14 Expert consensus on best practices for post–acute rehabilitation after total hip and knee arthroplasty

- *Patients be offered structured post-acute rehabilitation for THA (91%) and TKA (95%).*
- *For THA, patients be screened pre-operatively to assess their needs for structured post–acute rehabilitation (82%).*
- *Personal (THA [94%], TKA [97%]) and external (THA [85%], TKA [90%]) factors be identified and considered for their influence on need for post-acute rehabilitation.*
- *It is important to distinguish between an early and late phase of post–acute rehabilitation, based on stages of tissue healing and recovery of muscle function after THA (94%) and TKA (97%).*
- *Patient-specific needs and preferences be considered when applying rehabilitation best practice recommendations for THA (94%) and TKA (97%).*
- *Post-acute rehabilitation be provided by trained professionals with knowledge and clinical experience in arthritis and THA (97%) and TKA (97%) surgery.*
- *Standardised, evidence-based training be available to health professionals to ensure they have the knowledge and skills to provide safe and effective rehabilitation care to individuals undergoing THA (88%) and TKA (95%).*
- *For TKA, post-acute rehabilitation be provided through direct health professional supervision (87%); self-directed rehabilitation is not recommended (82%).*
- *Timing of post-acute rehabilitation is important for optimal patient outcomes after THA (88%) and TKA (97%).*
- *Personal (THA [100%], TKA [95%]) and external (THA [85%], TKA [90%]) factors be identified and considered for their influence on setting for post-acute rehabilitation.*
- *Appropriate rehabilitation interventions be provided for optimal patient outcomes after THA (88%) and TKA (92%)†.*
- *For TKA, overall dose of post-acute rehabilitation is important for optimal patient outcomes (84%).*
- *Personal (THA [97%], TKA [92%]) and external (THA [91%], TKA [95%]) factors be identified and considered for their influence on overall dose of post-acute rehabilitation.*
- *Body structure and function outcomes be routinely assessed after THA (94%) and TKA (95%).*
- *Activity and participation outcomes be routinely assessed after THA (94%) and TKA (97%).*
- *Personal (THA [94%], TKA [100%]) and external (THA [94%], TKA [97%]) factors be identified and considered for their influence on patient outcomes.*
- *Appropriate tools or methods be used to measure body structure and function outcomes after THA (97%) and TKA (97%).*
- *Appropriate tools or methods be used to measure activity and participation outcomes after THA (94%) and TKA (97%).*
- *Patients be monitored on a short-term follow up basis (for a 2-year period) after THA (88%) and TKA (95%) and on a long-term basis after TKA (84%).*
- *Patients have access to appropriate follow up services to address their needs in the initial 2-year period after THA (94%) and TKA (97%).*

* Percentages show key statements achieving 80% agreement in round 3.

† "Appropriate" refers to rehabilitation interventions that are judged suitable for primary THA and TKA patients during the post–acute rehabilitation period and were not further defined for panellists.

Table Source: Westby et al. (2014).[85]

Abbreviations: **THA** = total hip arthroplasty; **TKA** = total knee arthroplasty; **OA** = osteoarthritis.

Appendix 8 Review Working Group and Authors

Review Working Group

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- Dr Alun Cameron, Research Manager, RACS Research & Evaluation, incorporating ASERNIP-S

Appendix 9 Studies excluded at full-text review

Wrong population (e.g. not joint arthroplasty, mixed populations)

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Wrong intervention (e.g. not inpatient rehabilitation, mixed interventions)

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Wrong comparator (e.g. no comparator, incorrect comparator)

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Wrong outcomes (e.g. outcomes not relevant, cannot be extracted)

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Wrong study type (e.g. systematic review protocol)

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Full-text unavailable

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