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CADTH RAPID RESPONSE REPORT: SUMMARY WITH CRITICAL APPRAISAL

Outpatient or Short Stay Total Hip or Knee Arthroplasty versus Conventional Total Hip or Knee Arthroplasty: A Review of Clinical Effectiveness, Cost-Effectiveness and Guidelines

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Abbreviations

ASA	American Society of Anesthesiologists
BMI	body mass index
CI	confidence interval
ICER	incremental cost effectiveness ratio
PROs	patient reported outcomes
QALY	quality adjusted life year
RD	risk difference
RR	risk ratio
THA	total hip arthroplasty
TKA	total knee arthroplasty

Context and Policy Issues

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are proven procedures for treatment of advanced osteoarthritis.[1] These procedures (THA and TKA) are also referred to as total hip replacement and total knee replacement, respectively. Traditionally these procedures were performed and managed post-operatively in an inpatient setting. Demand for these procedures continue to increase due to the aging population and greater awareness of the usefulness of these procedures. It has been reported that currently one million hip and knee arthroplasty procedures are performed annually in Canada and the USA and this is estimated to exceed four million procedures by 2030.[2] In the light of this and considering the substantial burden on the health care system, efforts are being made to reduce length of hospital stay and minimize use of health care resources.[2] There is growing interest in outpatient or short stay (i.e., not overnight stay, or 24 hours or less [can include a one-night stay]) THA or TKA. However there appears to be no consensus regarding the safety and efficacy of these outpatient procedures.[3] One publication reported that some studies showed that outpatient THA or TKA have been associated with increased complications and readmissions whereas other studies have shown that, outpatient THA or TKA have been found to have outcomes comparable to inpatient THA or TKA.[3]

The aim of this report is to summarize the evidence regarding the clinical effectiveness and cost effectiveness of outpatient or short stay THA compared with conventional (also referred to as inpatient) THA; as well as to summarize the evidence regarding the clinical effectiveness and cost effectiveness of outpatient or short stay TKA compared with conventional TKA. An additional aim is to summarize the evidence-based guidelines regarding the outpatient or short-stay THA and TKA.

Research Questions

1. What is the clinical effectiveness of outpatient or short stay total hip arthroplasty compared with conventional total hip arthroplasty?

2. What is the clinical effectiveness of outpatient or short stay total knee arthroplasty compared with conventional total knee arthroplasty?
3. What is the cost effectiveness of outpatient or short stay total hip arthroplasty compared with conventional total hip arthroplasty?
4. What is the cost effectiveness of outpatient or short stay total knee arthroplasty compared with conventional total knee arthroplasty?
5. What are the evidence-based guidelines regarding outpatient or short-stay total hip arthroplasty and total knee arthroplasty?

Key Findings

Three relevant systematic reviews and one relevant economic evaluation were identified.

Generally, rates of complication, readmission, and reoperation were not statistically different or appeared numerically comparable between the outpatient and inpatient total hip arthroplasty (THA) groups. Mortality rates were low and appeared to be numerically comparable between the outpatient and inpatient THA groups.

Generally, rates of complication, readmission, and reoperation were not statistically different or appeared numerically comparable between the outpatient and inpatient total knee arthroplasty (TKA) groups. There were inconsistencies with respect to mortality rates in the outpatient and inpatient TKA groups; this finding was based on two studies included in one systematic review.

Inpatient THA was considered not to be cost-effective compared to outpatient THA at a willingness to pay threshold of US$50,000 as the incremental cost effectiveness ratio (ICER) for inpatient THA was US$81,116 per quality adjusted life year (QALY) for Medicare and US$140,917 per QALY for private payer insurance.

Findings need to be interpreted in the light of limitations such as evidence of limited quantity and low quality; and lack of long-term data.

No evidence was identified regarding the cost effectiveness of outpatient or short stay TKA.

No evidence-based guidelines regarding the outpatient or short stay THA or TKA were identified.

Methods

Literature Search Methods

A limited literature search was conducted by an information specialist on key resources including MEDLINE, the Cochrane Library, the University of York Centre for Reviews and Dissemination (CRD) databases, the websites of Canadian and major international health technology agencies, as well as a focused internet search. The search strategy was comprised of both controlled vocabulary, such as the National Library of Medicine’s MeSH (Medical Subject Headings), and keywords. The main search concepts were patients undergoing total knee or hip arthroplasty and outpatient or short stay surgeries. Search filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses, or network meta-analyses, randomized controlled trials or controlled clinical trials, economic studies, and guidelines. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2015 and September 26, 2020.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

Population	Patients requiring a total knee or hip arthroplasty (e.g., due to osteoarthritis)
Intervention	Q1,3: Total hip arthroplasty (i.e., total hip replacement) done with an outpatient or with a short-stay protocol (i.e., not overnight stay, or 24 hours or less [can include a one-night stay]) Q2,4: Total knee arthroplasty (i.e., total knee replacement) done with an outpatient or with a short-stay protocol (i.e., not overnight stay, or 24 hours or less [can include a one-night stay]) Q5: Total hip or knee arthroplasty done with an outpatient or with a short-stay protocol (i.e., not overnight stay, or 24 hours or less [can include a one-night stay])
Comparator	Q1,3: Total hip arthroplasty (i.e., total hip replacement) done with a conventional protocol (i.e., not outpatient or short-stay – longer than 24 hours or 'usual/standard care') Q2,4: Total knee arthroplasty (i.e., total knee replacement) done with a conventional protocol (i.e., not outpatient or short-stay – longer than 24 hours or 'usual/standard care') Q5: Not applicable
Outcomes	Q1-2: Clinical effectiveness (e.g., length of stay, rehospitalization, reoperations, emergency department visits, time to up and go, blood loss, functional outcomes, safety [adverse events or complications]) Q3-4: Cost-effectiveness outcomes (e.g., cost per quality of life years gained, incremental cost effectiveness ratios) Q5: Recommendations regarding patient selection for outpatient or short-stay total knee or hip arthroplasty, recommendations regarding implementation of outpatient or short-stay total knee or hip arthroplasty, recommendations regarding the use of outpatient or short-stay total knee or hip arthroplasty, recommendations regarding anesthetic protocol, recommendations regarding surgical techniques in the use of outpatient or short-stay total knee or hip arthroplasty
Study Designs	Health technology assessment, systematic review, randomized controlled trial, economic evaluation and evidence-based guideline

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2015. Systematic reviews in which all relevant studies were captured in other more recent or more comprehensive systematic reviews were excluded. Primary studies retrieved by the search were excluded if they were captured in one or more included systematic reviews. Guidelines with unclear methodology were also excluded.

Critical Appraisal of Individual Studies

The included publications were critically appraised by one reviewer using the following tools as a guide: A MeaSurement Tool to Assess systematic Reviews 2 (AMSTAR 2)[4] for systematic reviews, and the Drummond checklist[5] for economic evaluations. Summary scores were not calculated for the included studies; rather, the strengths and limitations of each included publication were described narratively.

Summary of Evidence

Quantity of Research Available

A total of 482 citations were identified in the literature search. Following screening of titles and abstracts, 451 citations were excluded and 31 potentially relevant reports from the electronic search were retrieved for full-text review. One potentially relevant publication was retrieved from the grey literature search for full-text review. Of these 32 potentially relevant articles, 28 publications were excluded for various reasons, and four publications met the inclusion criteria and were included in this report. These comprised three systematic reviews,[1,3,6] and one economic evaluation.[7] No evidence-based guidelines were identified. Appendix 1 presents the PRISMA[8] flowchart of the study selection.

Summary of Study Characteristics

Three systematic reviews,[1,3,6] and one economic evaluation[7] were identified. The primary studies included in the selected systematic reviews and relevant for this report are listed in Appendix 5. In two systematic reviews[3,6] all the included studies were relevant for this report and in the third systematic review[1] a subset of studies were relevant for this report. There was some overlap in the studies included in the systematic reviews hence it should be noted there is double counting of studies and findings from the systematic reviews are not exclusive. Additional details regarding the characteristics of included publications are provided in Appendix 2, Table 2 (systematic reviews) and Table 3 (economic evaluation).

Study Design

Of the three included systematic reviews,[1,3,6] one systematic review[6] included eight studies (one randomized controlled trial [RCT] and seven non-randomized studies [NRSs]) published between 2014 and 2019. The second systematic review[3] included seven studies (one RCT and six NRSs) published between 2009 and 2018. The third systematic review[1] included 17 studies (both comparative and non-comparative studies); only the four comparative studies (study design not specified further) were relevant for this report; these studies were published between 2005 and 2014. Two systematic reviews[3,6] included meta-analyses and the third systematic review[1] described each included primary study individually.

The selected economic evaluation[7] was a cost-utility analysis using a Markov model and conducted using a societal perspective over a lifetime horizon. Data sources included clinical data from published literature and, and cost data from the Blue Cross Blue Shield. All patients could potentially transition to revision THA, and potentially re-revision THA. After the first year, the THA-specific complication rates and revision rates were assumed to be the same in both the outpatient and inpatient THA groups due to lack of long-term data. Sensitivity analyses were conducted, using various parameters such as cost of inpatient THA, cost of outpatient THA, and complications (deep vein thrombosis, myocardial infarction, pulmonary embolism).

Country of Origin

The first author of one systematic review[6] was from Switzerland; the countries where the included primary studies were conducted were not reported by the authors. The second systematic review[3] was from Australia, and all the included studies were conducted in the USA. The third systematic review[1] was from Canada; the countries where the included primary studies were conducted were not reported by the authors.

The selected economic evaluation[7] was from the USA.

Patient Population

Two systematic reviews[1,3] included patients undergoing THA or TKA, and reported results separately for each of the interventions (THA or TKA). The third systematic review[6] involved patients undergoing THA. The total number of THA patients was 66,971 in one systematic review;[6] 64,484 in the second systematic review;[3] and 217 in the third systematic review.[1] The total number of TKA patients was 113,216 in one systematic review;[3] and 71,923 in another systematic review.[1] Measures of central tendencies and variances for age and bone mineral density (BMI) were not always specified. In one systematic review[6] the age of the THA patients was less than 80 years in two studies and not reported in six studies, proportion of females was 55%; and BMI in kg/m^2 was ≤ 40 in three studies and not reported in five studies. In the second systematic review[1] for the two included studies on THA patients, the mean age was 60 and 63 years, BMI in kg/m^2 was 30, and proportion of females was 51% in one study and not reported in the other study; the BMI in kg/m^2 was 37 in one study and not reported in the other study. In this systematic review[1] for the two included studies on TKA patients, the age ranged from 42 to 84 years, proportion of females was 37% in one study and not reported in the other study, BMI in (kg/m^2) was 31 in one study and not reported in the other study. In the third systematic review[3] patient demographics were presented for total joint arthroplasty (i.e., THA and TKA combined), age ranged from 54 years to 64 years; proportion of females was 60%; and BMI in kg/m^2 ranged from 26 to 34.

In the selected economic evaluation[7] the mean age of the patients undergoing THA was assumed to be 65 years.

Interventions and Comparators

In one systematic review[6] outpatient THA was compared to inpatient THA. In this systematic review[6] the surgical approach was anterior (in three studies), posterolateral (in one study), anterior or posterolateral (one study) and not reported (in three studies). In the second systematic review[3] outpatient THA was compared to inpatient THA, and outpatient TKA was compared to inpatient TKA; the surgical approach was not presented. In the third systematic review[1] outpatient THA was compared to inpatient THA, and outpatient TKA was compared to inpatient TKA. In this systematic review[1] for the two included studies on THA patients the surgical approach was direct anterior in one study and posterolateral in one study; and for the two included studies on TKA patients the surgical approach was medial paratella in one study and not reported in one study.

The economic evaluation[7] compared outpatient THA with inpatient THA.

Outcomes

The outcomes reported were rates of complications,[1,3,6] readmission,[3,6] reoperation,[3] and death.[6]

The economic evaluation[7] reported on the incremental cost-effectiveness ratio (ICER) expressed as incremental cost per quality of life year gained (QALY).

Summary of Critical Appraisal

An overview of the critical appraisal of the included publications is summarized below. Additional details regarding the strengths and limitations of included publications are provided in Appendix 3, Table 4 (systematic reviews) and Table 5 (economic evaluation).

In the three included systematic reviews[1,3,6] the objective was stated, multiple databases were searched, article selection was described and was conducted independently by two reviewers, lists of included articles were presented and study characteristics were described; however, a list of excluded articles was not presented. In two systematic reviews[1,3] the data extraction was done in duplicate; whereas in one systematic review[6] it was unclear if data extraction was done in duplicate hence potential for error in data extraction cannot be ruled out. Quality assessment was conducted; in two systematic reviews[1,6] the evidence was reported by the authors to be of low quality, and in one systematic review[3] the included studies were judged to be of low or unclear quality with respect to factors such as selective loss of patients during follow-up and the impact of confounders, hence there is possibility of differences in unmeasured characteristics between the two groups that could impact outcomes. In two systematic reviews[1,6] it was unclear if publication bias had been investigated, and in one systematic review[3] publication was investigated and the authors reported that there were no issues with respect to the outcome: complications. In the three systematic reviews[1,3,6] the authors declared their conflicts of interest; in one systematic review[3] there were no issues, and in two systematic reviews[1,6] some of the authors had association with industry; however they mentioned that their conflicts of interest were outside of this submitted work, hence the potential for bias may be less concerning.

In the economic evaluation[7] the objective, strategies compared, perspective taken, time horizon, sources for clinical and cost data were stated. The sources of clinical and cost data used seemed appropriate. The model used was described, and assumptions were reported and generally appeared to be reasonable. Sensitivity analyses were conducted by varying different model parameters to ensure the validity of the model and it appeared to be robust. Incremental analyses were reported. Conclusions were consistent with the results reported. Conflicts of interest of the authors were declared and some of the authors had association with industry or organizations involved in the development of innovative products for arthroplasty hence potential for bias cannot be ruled out.

Summary of Findings

The main findings are summarized below. Details of the study findings and authors' conclusions are presented in Appendix 4, Table 6 and Table 7 (economic evaluation). It is worth noting that there was some overlap in the studies included in the systematic reviews hence findings from the systematic reviews are not exclusive.

Clinical Effectiveness of outpatient total hip arthroplasty (THA) compared with inpatient THA

Three systematic reviews[1,3,6] reported on THA; of these systematic reviews, two systematic reviews[3,6] included meta-analyses and one systematic review[1] did not.

Complications

The systematic review by Bordoni et al.[6] reported that there was no statistically significant difference in rates of complication (overall, major and minor) between the outpatient THA and inpatient THA groups; the risk differences (RDs) varied between -0.02 to 0.1 and the 95% confidence intervals (CIs) encompassed zero, indicating not statistically significant. The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of complication (overall, major, and specific complications such as wound complication, transfusion, and urinary tract infection) for outpatient THA compared with inpatient THA; the risk ratios (RRs) varied between 0.59 and 0.99 and the 95% CIs encompassed one, indicating not statistically significant. The systematic review by Pollock et al.[1] reported that acute complication rates were 3.4% for outpatient THA and 0% for inpatient THA in one study; and 0% in outpatient THA and 40% in inpatient THA in another study; statistical significance level was not reported by the authors; post-discharge complication rates were 0% in both groups. It is possible that the large differences in complication rates between outpatients and inpatients in this systematic review may be due to systematic differences between the outpatients and inpatients, as the authors indicated that there was high risk of selection bias and high to moderate risks with respect to confounding factors.

Readmission

The systematic review by Bordoni et al.[6] reported that there was no statistically significant difference in rates of readmission between the outpatient THA and inpatient THA groups; risk difference (RD), -0.01; 95% confidence interval (CI), -0.03 to 0.00. The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of readmission for outpatient THA compared with inpatient THA; risk ratio (RR), 0.72; the 95% CI encompassed one, indicating not statistically significant.

Reoperation or revision

The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of reoperation for outpatient THA compared with inpatient THA; risk ratio (RR), 1.38; the 95% CI encompassed one, indicating not statistically significant.

Mortality

The systematic review by Bordoni et al.[6] reported that and the mortality ranged from 0% to 0.01% in all patients (outpatients and inpatients).

Clinical Effectiveness of outpatient total knee arthroplasty (TKA) compared with inpatient TKA

Two systematic reviews[1,3] reported on TKA; of these systematic reviews, one systematic review[3] included meta-analyses and one systematic review[1] did not.

Complications

The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of complication (overall, major, and wound complication) for outpatient TKA compared with inpatient TKA; the risk ratios (RRs) varied between 0.85 and 1.11 and the 95% CIs encompassed one, indicating not statistically significant; but transfusion rates were statistically significantly less for outpatient TKA compared with inpatient TKA; RR, 0.62; 95% CI, 0.46 to 0.84. The systematic review by Pollock et al.[1] reported that wound discharge and infection rates were 0% in outpatient TKA and 3.1% in inpatient TKA in one study, and 5.8% in outpatient TKA and 5.6% inpatient TKA in another study; statistical significance level was not reported by the authors.

Readmission

The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of readmission for outpatient TKA compared with inpatient TKA; RR, 1.03; the 95% CI encompassed one, indicating not statistically significant. The systematic review by Pollock et al.[1] reported that that readmission rates were 0% in both outpatient and inpatient TKA in one study, and 1.9% in outpatient TKA and 1.6% in inpatient TKA in another study; statistical significance level was not reported by the authors.

Reoperation or revision

The systematic review by Xu et al.[3] reported that there was no statistically significant difference in rates of reoperation for outpatient TKA compared with inpatient TKA; RR, 1.76; the 95% CI encompassed one, indicating not statistically significant. The systematic review by Pollock et al.[1] reported that that revision rates were 3.1% in outpatient TKA and 0% in inpatient TKA, and 1.9% in outpatient TKA and 2.1% in inpatient TKA; statistical significance level was not reported by the authors.

Mortality

The systematic review by Pollock et al.[1] reported that that mortality rates were 0% in both the outpatient and inpatient TKA in one study, and 3.1% in outpatient TKA and 2.4% in inpatient TKA in another study; statistical significance level was not reported by the authors.

Cost-Effectiveness of outpatient total hip arthroplasty (THA) compared with inpatient THA

In the economic evaluation[7] for the base case analysis, the ICER for inpatient THA was US$ 81,116 per QALY for Medicare; and the ICER for inpatient THA was US$ 140, 917 per QALY for private payer insurance. As both the ICERs were above the willingness to pay (WTP) threshold of US$50,000 per QALY, inpatient THA was not considered to be cost-effective compared to outpatient THA. However, the probabilistic sensitivity analysis (ICER scatter plot) showed there was uncertainty in the results. The authors reported that the initial age of the patient did not significantly impact the cost-effectiveness conclusion (i.e., for all age groups, the ICER was above US$50,000 for inpatient THA compared to outpatient THA). One-way sensitivity analysis (Tornado diagram) showed that with varying the complication rates, the ICER remained above US$50,000 for inpatient THA compared to outpatient THA. The Tornado diagram showed that ICER values were sensitive to variation in costs of outpatient and inpatient THA.

Cost-Effectiveness of outpatient total knee arthroplasty (TKA) compared with inpatient TKA

No evidence regarding the cost-effectiveness of outpatient TKA compared with inpatient TKA was identified, hence a summary cannot be provided.

Evidence-based guidelines regarding outpatient THA or TKA

No evidence-based guidelines regarding the outpatient THA or TKA were identified, hence a summary cannot be provided.

Limitations

There was overlap in the studies included in the selected systematic reviews hence the findings are not exclusive.

There were some limitations related to study reporting. For example, outpatient stay was not always defined hence the number of hours of stay at the hospital was unclear. Details of the surgical approach or procedure were not always presented; variations in surgical procedures could impact the findings. Long-term data were not available, hence long-term effects were unclear.

The evidence base is of limited quality. Most of the studies were non-randomized retrospective studies which have inherent limitations. There may be differences between patients who are assigned to outpatient THA or TKA and those who are assigned to inpatient THA or TKA, which could affect their outcomes. Though in some studies, the reported characteristics did not appear to be different between the groups, there may be confounding due to unmeasured parameters as the studies were not randomized studies. These quality appraisal issues were also raised by the authors of the included systematic reviews.

Generalizability of the findings to the Canadian setting is unclear as in two systematic reviews[1,6] the countries where the studies were conducted were not mentioned.

In the economic evaluation, it was assumed that after the first year, THA-related complications were the same in the outpatient and inpatient THA as long-term data were not available, hence it is unclear how findings would be impacted in case of a difference. Also, probabilities of complications were obtained from studies based on registry data, hence there may be some degree of uncertainty in the reliability of these data. Issues with registry data include misclassification, and not all data relevant for this report being recorded. Of note, for this economic evaluation a societal perspective was considered, hence the findings may not be applicable to a healthcare payer perspective.

No evidence was identified regarding the cost effectiveness of outpatient TKA. Furthermore, no evidence-based guidelines regarding patient selection for or provision of outpatient THA or TKA were identified.

Conclusions and Implications for Decision or Policy Making

Three systematic reviews,[1,3,6] and one economic evaluation[7] were identified. All three systematic reviews[1,3,6] reported on outpatient and inpatient THA, however not all systematic reviews reported on all outcomes that were of interest for this report. Generally, rates of complication, readmission, and reoperation were not statistically different or appeared numerically comparable between the outpatient and inpatient THA groups. Mortality rates were low and appeared to be comparable between the outpatient and inpatient THA groups. The authors of the systematic reviews cautioned that well designed, rigorous studies are needed to confirm results.

Of the three selected systematic reviews, two systematic reviews[1,3] reported on outpatient and inpatient TKA; however, not all outcomes that were of interest for this report were reported in both systematic reviews. Generally, rates of complication, readmission, and reoperation were not statistically different or appeared numerically comparable between the outpatient and inpatient TKA groups. There were inconsistencies with respect to mortality rates in the outpatient and inpatient TKA groups; this finding was based on two studies included in one systematic review.[1] The authors of the systematic reviews cautioned that well designed, rigorous studies are needed to confirm results.

The selected economic evaluation[7] was a cost-utility analysis. ICER for inpatient THA was US$ 81,116 per QALY for Medicare; and US$ 140, 917 per QALY for private payer insurance hence at a WTP of US$ 50,000 inpatient THA does not appear to be cost-effective compared to outpatient THA. However, there was uncertainty in the results as indicated by the probabilistic sensitivity analysis (ICER scatter plot).

Findings need to be interpreted in the light of limitations such as evidence of limited quantity and low quality; and lack of long-term data.

No evidence was identified regarding the cost effectiveness of outpatient TKA. Furthermore, no evidence-based guidelines regarding the outpatient THA or TKA were identified.

Six observational studies [2,9-13] did not satisfy our inclusion criteria due to irrelevant study design and were not included in the report. However, they may provide some useful insights, so are discussed here. Of note, these studies have not been critically appraised. The majority of these studies were retrospective studies. Of the six observational studies, four studies,[2,11-13] were conducted in Canada and two studies[9,10] were conducted in the USA. Findings from these studies showed complication rates[2,11] and readmission rates[2,10,13] for THA or TKA were either not statistically different or appeared to be numerically similar between inpatients and outpatients. These findings are in agreement with the findings in this report. Additionally, three studies[9,10,12] reported on patient reported outcomes (PROs) for THA or TKA in outpatients and inpatients, using various measures; generally for most measures the PROs were not statistically different between the inpatient and outpatient groups. The authors of these studies generally concluded that larger, prospective, and long-term studies are need for definitive conclusions.

There are several factors that may impact success with outpatient or same day discharge; these include multidisciplinary care team coordination, standardized perioperative protocols, discharge planning, and careful patient selection.[9] Well-designed studies are needed to investigate the safety and clinical effectiveness of outpatient THA or TKA compared to inpatient procedures, and to determine which subgroups of patients are likely to achieve the best outcomes with outpatient THA or TKA. Also, studies investigating the cost-effectiveness of outpatient THA are needed.

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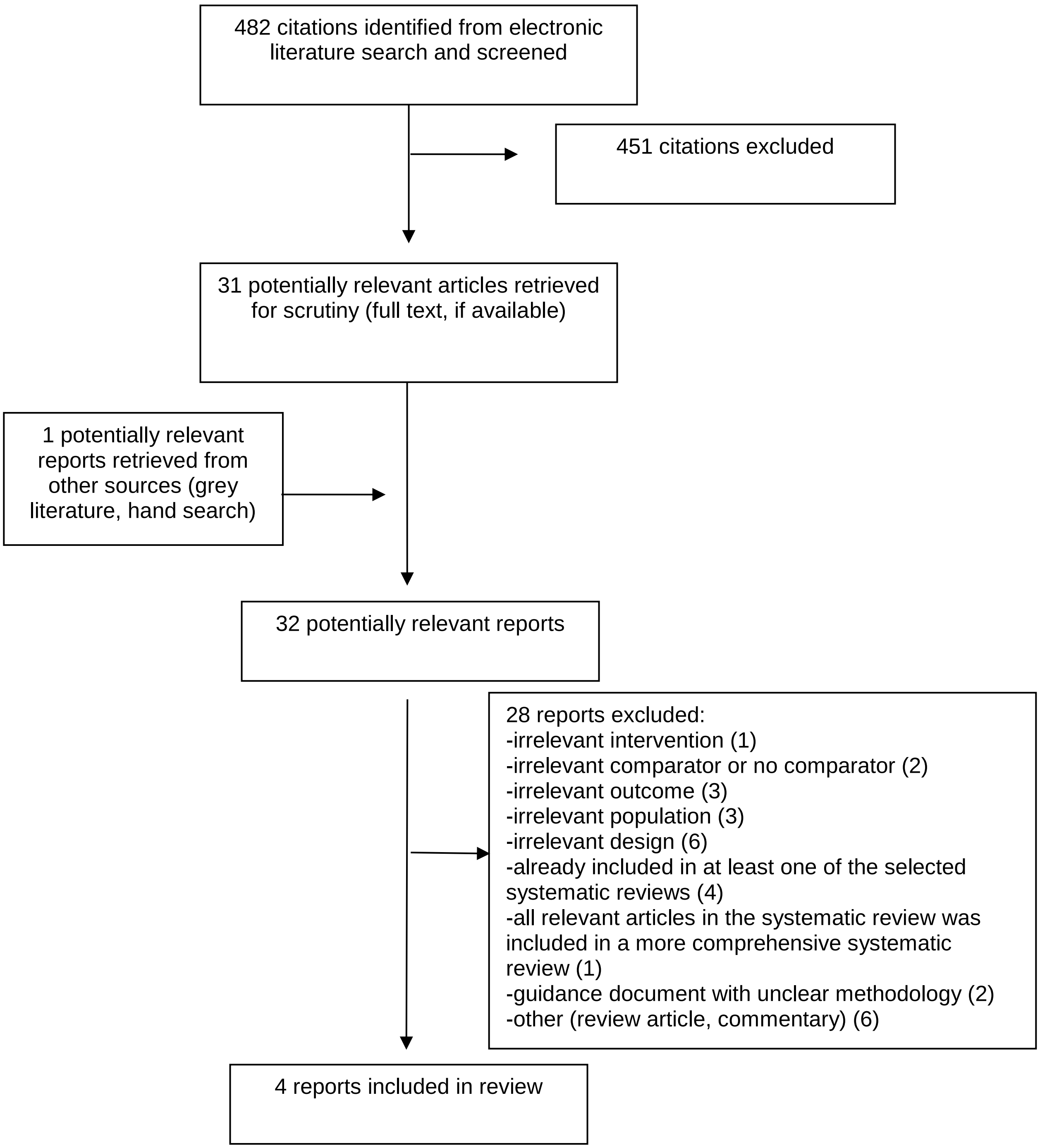
Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Publications

Table 2: Characteristics of Included Systematic Reviews

Study citation, country, funding source	Study designs and numbers of primary studies included	Population characteristics	Intervention and comparator(s)	Clinical outcomes, length of follow-up
Bordoni,[6] 2020, Switzerland. Funding; Authors reported that they received no funding	Systematic review with meta-analyses. Literature search conducted on 26 July 2019. Databases (PubMed, Web of Science, Cochrane library) and grey literature searched. It included 8 studies (1 RCT and 7 NRS) published between 2014 and 2019 (countries of origin NR). Inclusion criteria: studies that compared outpatient and inpatient THA and reported on complication and readmission Exclusion criteria: Non-English articles. Aim: To compare outpatient and inpatient THA in terms of complication and readmission rates	Patients undergoing THA N = 66,971 (1428 outpatients and 65,543 inpatients. Age: <75 years (1 study), <80 years (1 study), and NR (in 6 studies) % Female: 55% BMI (kg/m^2): < 40 (2 studies), 40 (1 study), and NR (5 studies)	Outpatient THA versus inpatient THA. Surgical approach: anterior (3 studies), posterolateral (1 study), anterior or posterolateral (1 study, and NR (3 studies)	Complication, readmission rates, and death Length of follow-up (months): 1 to 3
Xu,[3] 2020, Australia. Funding: NR	Systematic review with meta-analyses. Multiple database (PubMed, OVID Medline, CDSR, DARE, CCTR) were searched from inception to October 2018. Also, the reference list of the retrieved articles were reviewed. It included 7 studies (1 RCT and 6 NRS [i.e., retrospective studies]) published between 2009 and 2018, all	Patients undergoing TJA (TKA and/or THA) N (for TKA & THA) 177,792 (1613 outpatients and 176,179 inpatients). N (for TKA) = 113,216 N (for THA) = 64,484 Range for age, % female and BMI were reported for patients undergoing TJA (i.e., TKA & THA combined, TKA, and THA).	Outpatient (same day discharge or discharge within 23 hours) THA or TKA versus inpatient THA or TKA. Surgical approach: NR	Complication, readmission, and reoperation rates. (Complications reported include total complications, major complications, wound complication blood transfusion, UTI) Follow-up: 28 days to 90 days

CADTH

Study citation, country, funding source	Study designs and numbers of primary studies included	Population characteristics	Intervention and comparator(s)	Clinical outcomes, length of follow-up
	studies were from the USA. Of the 7 studies, 2 studies reported on both TKA and THA, 3 studies reported on THA and 2 studies reported on TKA Inclusion criteria: Studies comparing inpatient and outpatients undergoing TKA and/or THA and reporting on post-operative complications. Exclusion criteria: Studies including patients undergoing UKR or hip resurfacing were excluded. Non-English articles were excluded. Aim: To compare the post-operative complications in outpatients and inpatients undergoing TJA (subgroups: THA & TKA)	Age (years) (mean) ranged from 54 to 59.8 for outpatients and from 53.75 to 64 for inpatients. Difference in mean age was not significant (P =0.10) % Female: 48.9% in the outpatients and 59.9% in the inpatients (P = 0.007) BMI (kg/m^2): ranged from 27.6 to 33.8 in the outpatients, and from 25.8 to 33.2 in the inpatients, (P = 0.77)		
Pollock,[1] 2016, Canada. Funding: No external funding	Systematic Review with each included study described individually. Multiple databases (MEDLINE, Embase , and HealthSTAR) were searched from inception to November 2014. Also, the reference list of the relevant articles were reviewed. This systematic review included 17 studies of which 4 were comparative studies and relevant for this	Patients undergoing THA (2 NRS:1 case-control study [Aynardi et al.], 1 cohort study [Bertin]) TKA (2 NRS: 1 cohort study [Kolisek et al.], 1 retrospective cohort study [Lovald et al.]) and THA N = 217 (197 in Aynardi et al., & 20 in Bertin) Age (years): 60 in Aynardi et al. & 63 in Bertin	THA et al. Outpatient THA versus inpatient THA. Surgical approach: direct anterior, Smith-Peterson (Aynardi et al.); posterolateral (Bertin) TKA Outpatient TKA versus inpatient TKA Surgical approach: medial paratella (Kolisek et al.), NR (Lovald et al.)	THA Complications (acute, post-discharge) Follow-up: 1 year TKA Complications (acute, post-discharge) Follow-up: 2 year

Study citation, country, funding source	Study designs and numbers of primary studies included	Population characteristics	Intervention and comparator(s)	Clinical outcomes, length of follow-up
	report; and the remaining studies were non-comparative studies and were not relevant for this report, hence are not described here. The 4 studies were published between 2005 and 2014 Inclusion criteria: No specifics presented Exclusion criteria: Non-English articles were excluded. Aim: to assess the safety and feasibility of outpatient THA, TKA and UKA	% Females:51% in Aynardi et al 55% in Bertin BMI (kg/m^2): 30 in both Aynardi et al and in Bertin <u>TKA</u> N = 71923 (128 in Kolisek et al. & 71795 in Lovald et al.) Age (years) =42 to 64 in Kolisek et al. & 65 to 84 (with less than 4% being above 84) in Lovald et al. % Females: 37% in Koliset et al., and NR in Lovald et al. BMI (kg/m^2): 30.8 in Koliset et al., and NR in Lovald et al.		

BMI = body mass index; CCTR = Cochrane Central register of Controlled trials; CDSR = Cochrane Database of Systematic Reviews; DARE = Database of Abstracts of Review of Effectiveness; NR = not reported; NRS = non-randomized study; RCT = randomized controlled trial; THA = total hip arthroplasty; TJA = total joint arthroscopy; TKA = total knee arthroscopy; UKA = unicompartmental knee arthroplasty; UKR = unicompartmental knee replacement, UTI = urinary tract infection.

Table 3: Characteristics of Included Economic Evaluation

Study citation country, funding source	Type of analysis, time horizon, perspective	Population characteristics	Intervention and comparator(s)	Approach	Source of clinical, cost, and utility data used in analysis	Main assumptions
Rosinsky,[7] 2020, USA. Funding: The authors reported that they received no financial support for the research	Cost-utility analysis. Time horizon: lifetime. Perspective: societal.	Patients undergoing THA	Outpatient THA versus inpatient THA (Outpatient THA is defined as patients who were discharged on the same day as their surgery)	Markov model (using TreeAge software). Results presented as ICER expressed as	Sources of inputs in the model were presented. Clinical data and utilities were obtained from the literature.	The reference case was a theoretical individual of age 65 years, diagnosed with unilateral hip osteoarthritis and undergoing THA (65 years was

Study citation country, funding source	Type of analysis, time horizon, perspective	Population characteristics	Intervention and comparator(s)	Approach	Source of clinical, cost, and utility data used in analysis	Main assumptions
and/or publication of the article	Discounting: 3% annually. Costs were adjusted to 2019 US dollars.			incremental cost per QALY. One-way sensitivity analyses and probabilistic sensitivity analysis WTP threshold was set at US$50,000 per QALY	Cost data were from the literature, Blue Cross Blue Shield, and the World Bank	considered as average age of patients undergoing THA). All patients could potentially transition to revision THA, and potentially re-revision THA. Patients who deteriorated after re-revision entered the chronic failed hip state. During the first year complications (post-operative and THA specific) rates and revisions varied between the two treatment arms. After the first year THA-specific complication rates and revision rates were assumed to be the same in both treatment arms due to lack of long term data in the literature.

ICER = incremental cost-effectiveness ratio; QALY = quality adjusted life year; THA = total hip arthroplasty; WTP = willingness to pay.

Appendix 3: Critical Appraisal of Included Publications

Table 4: Strengths and Limitations of Systematic Reviews Using AMSTAR 2[4]

Strengths	Limitations
Bordoni,[6] 2020, Switzerland	
• The objective was clearly stated • Study selection was described, and a flow chart was presented • Three databases (PubMed, Web of Science, and Cochrane library) and grey literature was searched on 26 July 2019. • Study selection was described, and a flow chart was presented • A list of included studies was provided • Article selection was done independently by two reviewers • Quality assessment was done independently by two reviewers using quality assessment tools (RoB 2.0 for RCTs) and ROBINS-I for NRS) and judged by the authors to have moderate risk of bias. Using GRADE, the authors reported that the level of evidence was very low with respect to the outcomes: complications and readmission. • Characteristics of the included studies were presented • Meta-analysis was conducted. A random effects model was used • Conflicts of interest were declared. Two of the six authors had association with industry that was reported by them to be outside the submitted work. The remaining authors had no conflicts of interest	• A list of excluded studies was not presented • Unclear if data extraction was done by two reviewers • Unclear if publication bias was explored.
Xu,[3] 2020, Australia	
• The objective was clearly stated • Study selection was described, and a flow chart was presented • Three databases (PubMed, OVID Medline, CDSR, DARE, CCTR) was searched from inception to October 2018. Reference list of retrieved articles were also reviewed. • Study selection was described, and a flow chart was presented • A list of included studies was provided • Article selection was done independently by two reviewers • Data extraction was done independently by two reviewers • Quality assessment was done using the MOOSE criteria (Most of the included studies satisfied 5 of the 6 criteria reported. For most of the studies it was unclear if the 6th criterion [no selective loss during follow-up] was satisfied.) • Characteristics of the included studies were presented. • Meta-analysis was conducted. A random effects model was used • Publication bias was assessed using Funnel plot (for the outcome: total complication rates for TJA) and there appeared to none • The authors mentioned that there were no conflicts of interest.	• A list of excluded studies was not presented • Unclear if quality assessment was done independently by two reviewers • Details of the characteristics of the outpatients and inpatients were reported for TJA (i.e., TKA & THA combined). As characteristics of the outpatients and inpatients undergoing TKA and THA, were not reported separately, hence it was unclear if the outpatient and inpatient groups were comparable and its impact if any on the outcomes.

Strengths	Limitations
Pollock,[1] 2016, Canada.	
• The objective was clearly stated • Study selection was described, and a flow chart was presented • Multiple databases (MEDLINE, Embase, and HealthSTAR) were searched from inception to November 2014. Also, the reference list of the relevant articles was reviewed • Study selection was described, and a flow chart was presented • A list of included studies was provided • Article section was done independently by two reviewers • Data extraction was done independently by two reviewers • Quality assessment was done using the risk of bias tool and in 2 of the 4 included studies there was high risk of selection bias, and in 3 of the 4 included there was high risk of bias due to confounding factors. • Characteristics of the included studies were presented. • Meta-analysis was not conducted. The included studies were described individually, which seemed appropriate as they were two studies for each intervention and the results were variable.	• A list of excluded studies was not provided • Unclear if quality assessment was done independently by two reviewers, however it was mentioned that disagreements were resolved through consensus. • Conflicts of interest were declared and some of the authors had relevant financial relationship in the biomedical arena outside the submitted work.

AMSTAR 2 = A MeaSurement Tool to Assess systematic Reviews 2; CCTR = Cochrane Central register of Controlled trials; CDSR = Cochrane Database of Systematic Reviews; DARE = Database of Abstracts of Review of Effectiveness; GRADE = Grading of Recommendations Assessments, Development, and Evaluation; MOOSE = Meta-analysis of Observational Studies in Epidemiology; NRS = non-randomized study; RCT = randomized controlled trial; RoB = Risk of Bias; ROBINS-I = Risk of Bias In Non-randomized Studies of Interventions; TJA = total joint arthroplasty; TKA = total knee arthroplasty.

Table 5: Strengths and Limitations of Economic Evaluation Using the Drummond Checklist[5]

Strengths	Limitations
Rosinsky,[7] 2020, USA	
• Objectives were stated • The strategies compared were stated (outpatient and inpatient) • Time horizon (lifetime) and perspective (societal) were stated • Clinical data sources and transition probabilities were stated (literature) • Cost data sources were stated (literature, and Blue Cross Blue Shield) Indirect costs were obtained the World Bank • Discounting was reported • Model description was presented • Incremental analyses were conducted • Sensitivity analyses (one-way and probabilistic) were conducted • Conclusions were consistent with the findings	• Conflicts of interest were declared. Majority of the authors had association with industry and the potential for bias cannot be ruled out

Appendix 4: Main Study Findings and Authors' Conclusions

Table 6: Summary of Findings Included Systematic Reviews

<table>
<tr><th>Main study findings</th><th>Authors' conclusion</th></tr>
<tr><td colspan="2">Bordoni2020,[6] Switzerland</td></tr>
<tr><td>
Comparison of outpatient THA versus inpatient THA (meta-analyses results)
<table>
<tr><th>Outcome</th><th>No of studies</th><th>No of patients</th><th>RD (95% CI)</th><th>Heterogeneity I^2</th></tr>
<tr><td>Overall complication rate</td><td>7</td><td>65272</td><td>0.0 (-0.02 to 0.02)</td><td>62%</td></tr>
<tr><td>Major complication rate</td><td>3</td><td>1154</td><td>0.01 (-0.01 to 0.03)</td><td>0%</td></tr>
<tr><td>Minor complication rate</td><td>3</td><td>1154</td><td>-0.02 (-0.05 to 0.01)</td><td>0%</td></tr>
<tr><td>Readmission rate</td><td>6</td><td>66038</td><td>-0.01 (-0.03 to 0.00)</td><td>53%</td></tr>
</table>
Six studies (total number of patients = 66714) reported the number of deaths which ranged between 0.0% and 0.01%, and appeared to be comparable between the outpatient and inpatient groups.
</td><td>"This meta-analysis documented that outpatient THA is a feasible approach since it does not increase complications or readmissions with respect to inpatient THA, but the available studies present a moderate risk of bias and the quality of evidence of these findings is very low. Future high-level studies are needed to confirm results and indications for outpatient THA. (p. 1)"[6]</td></tr>
<tr><td colspan="2">Xu,[3] 2020, Australia</td></tr>
<tr><td>
Comparison of outpatient THA versus inpatient THA (meta-analyses results)
<table>
<tr><th>Outcome</th><th>No of studies</th><th>No of patients</th><th>RR (95% CI)</th><th>Heterogeneity I^2</th></tr>
<tr><td>Total complications</td><td>4</td><td>64481</td><td>0.82 (0.53 to 1.28)</td><td>81%</td></tr>
<tr><td>Major complications</td><td>NR</td><td>NR</td><td>0.99 (0.60 to 1.63)</td><td>0%</td></tr>
<tr><td>Wound complication</td><td>NR</td><td>NR</td><td>0.64 (0.22 to 1.84)</td><td>0%</td></tr>
<tr><td>Transfusion</td><td>NR</td><td>NR</td><td>0.59 (0.19 to 1.80)</td><td>95%</td></tr>
<tr><td>UTI</td><td>NR</td><td>NR</td><td>0.73 (0.25 to 2.12)</td><td>0%</td></tr>
<tr><td>Readmissions</td><td>NR</td><td>NR</td><td>0.72 (0.26 to 1.95)</td><td>32%</td></tr>
<tr><td>Reoperation</td><td>NR</td><td>NR</td><td>1.38 (0.74 to 2.56)</td><td>0%</td></tr>
</table>
Comparison of outpatient TKA versus inpatient TKA (meta-analyses results)
<table>
<tr><th>Outcome</th><th>No of studies</th><th>No of patients</th><th>RR (95% CI)</th><th>Heterogeneity I^2</th></tr>
<tr><td>Total complications</td><td>4</td><td>113308</td><td>0.86 (0.68 to 1.11)</td><td>10%</td></tr>
<tr><td>Major complications</td><td>NR</td><td>NR</td><td>1.11 (0.81 to 1.54)</td><td>0%</td></tr>
<tr><td>Wound complication</td><td>NR</td><td>NR</td><td>0.85 (0.39 to 1.860</td><td>0%</td></tr>
<tr><td>Transfusion</td><td>NR</td><td>NR</td><td>0.62 (0.46 to 0.84)</td><td>0%</td></tr>
<tr><td>Readmissions</td><td>NR</td><td>NR</td><td>1.03 (0.61 to 1.75)</td><td>23%</td></tr>
<tr><td>Reoperation</td><td>NR</td><td>NR</td><td>1.76 (1.07 to 2.92)</td><td>0%</td></tr>
</table>
Comparison of outpatient TJA versus inpatient TJA (meta-analyses results)
<table>
<tr><th>Outcome</th><th>No of studies</th><th>No of patients</th><th>RR (95% CI)</th><th>Heterogeneity I^2</th></tr>
<tr><td>Total complications</td><td>7</td><td>177792</td><td>0.82 (0.67 to 1.01)</td><td>57%</td></tr>
</table>
</td><td>"This meta-analysis found that outpatient TJA had comparable complication rates to inpatient TJA. Using current surgical techniques and pain control modalities, outpatient TKA and THA can be performed safely in select patients while significantly reducing costs to the healthcare systems. Quality randomized controlled trials with longer follow-up periods are needed to add to this body of evidence." (P. 43)"[3]</td></tr>
</table>

Main study findings	Authors' conclusion

Major complications	NR	NR	1.11 (0.81 to 1.54)	0%
Wound complication	NR	NR	0.85 (0.39 to 1.86)	0%
Transfusion	NR	NR	0.62 (0.46 to 0.84)	0%
UTI	NR	NR	0.79 (0.41 to 1.55)	0%
Readmissions	NR	NR	1.03 (0.61 to 1.75)	23%
Reoperation	NR	NR	1.76 (1.07 to 2.92)	0%

Pollock,[1] 2016, Canada.

Comparison of outpatient THA versus inpatient THA(Number of patients: 197 for Ayanardi et al; 57,793 for Bertin)

Outcome	Study	Outpatient group	Inpatient group
Acute complications	Ayanardi et al.	3.4%	0%
	Bertin	0%	40%
Post-discharge complications	Ayanardi et al.	0%	0%
	Bertin	0%	0%

Comparison of outpatient TKA versus inpatient TKA (Number of patients: 128 for Kolisek et al; 57,793 for Lovald et al.)

Post-discharge complications	Study	Outpatient group	Inpatient group
Complication	Kolisek et al.	9.4%	9.4%
	Lovald et al.	NR	NR
Pain	Kolisek et al.	0%	0%
	Lovald et al.	46.3%	57.5%
Wound discharge or infection	Kolisek et al.	0%	3.1%
	Lovald et al.	5.8%	5.6%
Readmission	Kolisek et al.	0%	0%
	Lovald et al.	1.9%	1.6%
Revision	Kolisek et al.	3.1%	0%
	Lovald et al.	1.9%	2.1%
Mortality	Kolisek et al.	0%	0%
	Lovald et al.	3.1%	2.4%

Acute complications were 0% in both groups by Koliset et al. and was not reported by Lovald et al.

Authors' conclusion: "In selected patients, outpatient THA, TKA, and UKA can be performed safely and effectively. However, studies lacked sufficient internal validity, sample size, methodological consistency, and standardization of protocols and outcomes. There is a need for more rigorous and adequately powered randomized trials to definitively conclude the safety and feasibility of outpatient THA, TKA, or UKA. (P. 14)"[1]

CI = confidence interval; RD = risk difference; RR = Risk Ratio; THA = total hip arthroplasty; TJA = total joint arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; UTI = urinary tract infection.

Table 7: Summary of Findings of Included Economic Evaluations

<table>
<tr><th>Main study findings</th><th>Authors' conclusion</th></tr>
<tr><td colspan="2">Rosinsky,[7] 2020, USA.</td></tr>
<tr><td>Cost-effectiveness over a lifetime from a societal perspective for patients undergoing THA (outpatients compared with inpatients)

The effectiveness (mean ± SD) expressed as QALY was 10.30±1.53 for outpatient and 10.36 ±1.27 for inpatient.
Lifetime Medicare cost (mean ± SD) expressed as US$ was 43,288 ± 1,606 for outpatient, and 48,155 ± 1,673 for inpatient.
Lifetime cost (private payer insurance) (mean ± SD) expressed as US$ was 49,972 ± 1,411 for outpatient, and 58,427 ± 1,534 for inpatient.

For the base case:
ICER for inpatient THA was US$ 81,116 per QALY for Medicare.
ICER for inpatient THA was US$ 140, 917 per QALY for private payer insurance
As both the ICERs are above the WTP threshold of US$50,000 per QALY, inpatient THA was considered to be not cost-effective compared to outpatient THA.

One way sensitivity analyses showed that factors that affected whether inpatient THA was cost-effective or not compared to outpatient THA were the effectiveness of the outpatient procedure, the effectiveness of the inpatient procedure, the cost of outpatient THA and cost of inpatient THA. The difference in complication rates (medical and orthopedic) did not appear to have a significant impact.

The authors reported that at a willingness to pay threshold of US$50,000 outpatient THA was determined to be more cost-effective than inpatient. However, the probabilistic sensitivity analysis (ICER scatter plot) showed there was uncertainty in the results.
The authors reported that the initial age of the patient did not significantly impact the cost-effectiveness conclusion (i.e. for all age groups, the ICER was above US$50,000 for inpatient THA compared to outpatient THA).</td><td>"In conclusion, this cost-effectiveness analysis suggests that for an ICER set at $50,000/QALY, outpatient THA is more cost effective than inpatient THA. The higher costs of the index procedure in the inpatient setting outweigh the minimal difference in outcomes between the interventions. Despite this conclusion, surgeons must weigh clinical factors first and foremost in determining if an individual patient can be safely operated on in the outpatient setting. (p.5)"[7]</td></tr>
</table>

SD = standard deviation

Appendix 5: Overlap between Included Systematic Reviews

Primary study citation	Systematic review citation		
	Bordoni et al.[6]	Xu et al.[3]	Pollock et al.[1]
Aynardi et al., HSS J 2014; 10: 252-255.	x	x	x
Basques et al., J Bone Joint Surg Am 2017; 9: 1969-1977	x		
Bertin et al., Clin Orthop Relat Res 2005 ; 435: 154-163			x
Bonvonratwet et al., J Arthroplasty 2017; 32: 1773-1778		x	
Darrith et al., J Arthroplasty 2019; 34: 221-227	x	x	
Goyal et al.; Clin Orthop Relat Res 2017; 475: 364-372	x	x	
Kolisek et al., Clin Orthop Relat Res 2009; 467: 1438-1442		x	x
Lovald et al., J Arthroplasty 2014; 31:510-515			x
Nelson et al., J Arthroplasty 2017; 3 : 1439-1442	x	x	
Richards et al., J Arthroplasy 2018; 33: 3206-3210	x		
Springer et al., Orthop Clin North Am 2019; 48: 15-23	x	x	
Weiser et al., J Arthroplasty 2018; 33: 3502-3507	x		

X = included