WASHINGTON STATE HEALTH CARE AUTHORITY

APPENDICES

Total Knee Arthroplasty

Health Technology Assessment

Date: September 22nd, 2010

APPENDIX A. FDA APPROVED DEVICES

FDA approved prostheses for use in UKA.

Navigation system	Manufacturer	Decision Date	Procedures
TGS Unilateral Knee Arthroplasty Modular Tibia System	Alexandria Research Technologies, LLC (Plymouth, MN, USA)	07/23/2010	• UKA (either condyle of the knee) • To be used with the TGS UKA System
TGS Unilateral Knee Arthroplasty System (TGS UKA System)	Alexandria Research Technologies, LLC (Plymouth, MN, USA)	05/04/2009	• UKA (either condyle of the knee)
Preservation Unicondylar Tibia	DePuy Orthopaedics, Inc. (Warsaw, IN, USA)	05/05/2004	• Cemented UKA
Oxford Meniscal Unicompartmental Knee System	Biomet Orthopedics, Inc. (Warsaw, IN, USA)	04/21/2004	• Cemented UKA, medial compartment only
Oxford Unicompartmental Knee Femoral Component	Biomet Orthopedics, Inc. (Warsaw, IN, USA)	07/10/2001	• UKA for primary or post-traumatic degenerative disease, deformity, or revision
Miller/Galante Precoat Unicompartmental Knee System	Zimmer, Inc (Warsaw, IN, USA)	07/11/1995 Modification (line extension, 8 mm articular surface) approved: 04/02/2001	• UKA
Duracon Unicompartmental Femoral Component	Howmedica Corporation (Rutherford, NJ, USA)	03/06/1995	• UKA
Duracon Unicompartmental Knee System	Howmedica Corporation (Rutherford, NJ, USA)	03/30/1993	• UKA
Duracon All Plastic Tibial Component	Howmedica Corporation (Rutherford, NJ, USA)	03/30/1993	• UKA
PFC Unicondylar Knee System	Johnson & Johnson Orthopaedics, Inc. (Raynham, MA, USA)	8/26/1991	• UKA
PFC Unicondylar Knee System, Porous Coated Femoral Component	Johnson & Johnson Orthopaedics, Inc. (Raynham, MA, USA)	10/23/1991	• UKA
Genesis Unicompartmental Knee System	Smith & Nephew Richards, Inc. (Memphis, TN, USA)	12/27/1991	• UKA
Kirschner (R) Unicondylar-II Knee System	Kirschner Medcal Corporation (Timonium, MD, USA)	06/26/1988	• UKA
Kirschner Unicondylar Knee System	Kirschner Medcal Corporation (Timonium, MD, USA)	12/31/1987	• UKA
Tricon Unicompartmental Knee System	Richards Medical Co., Inc. (Memphis, TN, USA)	12/09/1985	• UKA

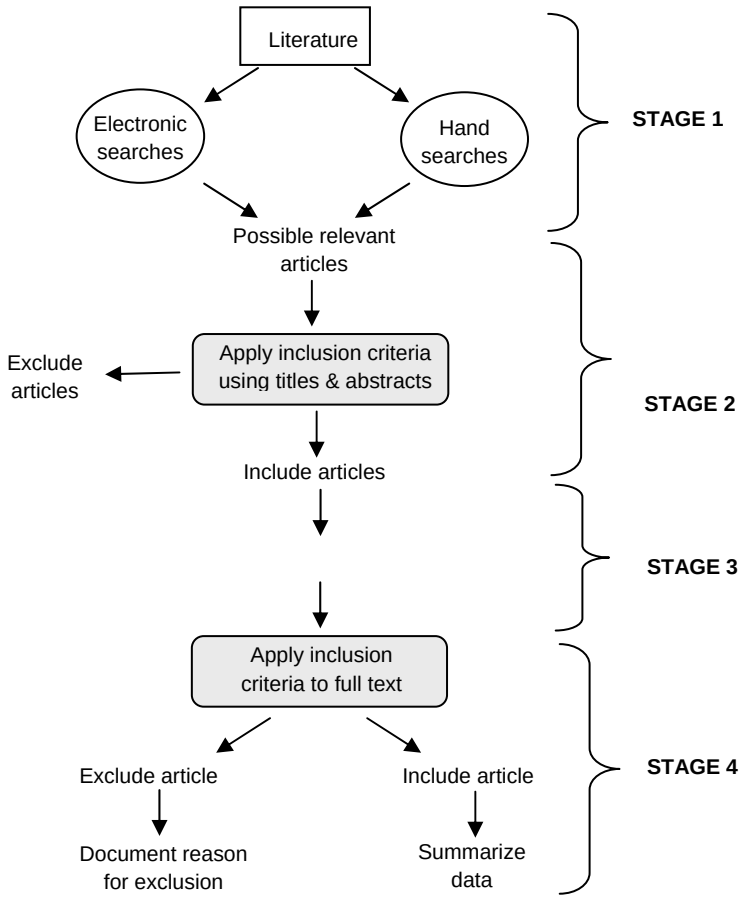
Tricon-P Tibial Component	Richards Medical Co., Inc. (Memphis, TN, USA)	09/26/1984	• UKA
Tricon-M Tibial Component	Richards Medical Co., Inc. (Memphis, TN, USA)	09/26/1984	• UKA
ICLH Tibial Plateau	DePuy Orthopedics, Inc (Warsaw, IN, USA)	01/08/1981	• UKA

ROM: range of motion; THA: total hip arthroplasty; TKA: total knee arthroplasty; UKA: unilateral knee arthroplasty.

FDA approved prostheses for use in bicompartmental knee arthroplasty.

Prosthesis	Manufacturer	Decision Date	Procedures
JOURNEY Select Knee System	Smith & Nephew, Inc. (Memphis, TN, USA)	12/15/2009	• Existing unicompartmental tibial and femoral components and patellofemoral implant components may be combined to create a bicompartmental knee replacement prosthesis
Restoris MultiCompartmental Knee (MCK) System	MAKO Surgical Corp (Ft. Lauderdale, FL, USA)	06/17/2009	• Patellofemorotibial replacement for the medial side of the knee
DePuy Graduated Compartmental Knee (GCK) Femoral and Tibial Components	DePuy Orthopaedics, Inc. (Warsaw, IN , USA)	6/26/2007	• Bicompartmental or tricompartmental patellofemorotibial replacement for the medial or lateral side of the knee
DePuy Graduated Compartmental Knee (GCK)	DePuy Orthopaedics, Inc. (Warsaw, IN , USA)	09/11/2006	• unicompartmental tibial and femoral components and patellofemoral trochlear components and patellar components that may be combined to create a bicompartmental knee replacement prosthesis
Conformis Bicompartmental Knee Repair System	Conformis, Inc. (Foster City, CA, USA)	03/09/2006	• Medial or lateral condyle and the patellofemoral areas

Appendix B. ALGORITHM FOR ARTICLE SELECTION



Appendix C. SEARCH STRATEGIES

Database: MEDLINE

Partial Knee Arthroplasty

1	"Arthroplasty, Replacement, Knee"[Mesh] OR total knee OR TKR OR TKA
2	(arthroplasty OR total joint OR REPLACEMENT) AND KNEE
3	Unicompart* OR Bicompart* OR Bilateral Unicompart* OR Moncompart* OR Unicondyl*
4	"Biomechanics"[Mesh] OR "In Vitro "[Publication Type] OR "Cadaver"[Mesh] OR "Case Reports "[Publication Type]
5	#1 OR #2
6	#3 AND #5
7	#6 NOT #4
8	LIMIT ENGLISH

Navigated TKA

9	"Surgery, Computer-Assisted"[Mesh] OR COMPUTER ASSIST* OR COMPUTER NAVIGAT*
10	#9 AND #5
11	#10 NOT #4
12	LIMIT ENGLISH
13	#12 NOT #8

Special Populations TKA

14	(Prognosis/Narrow[filter])
15	total knee [TI] OR TKR [TI] OR TKA[TI]
16	#15 NOT #4
17	LIMIT ENGLISH
18	#17 NOT (#8 OR #13)

Special Populations Partial Knee Arthroplasty

19	#14 AND #7
20	LIMIT ENGLISH
21	#21 NOT (#8 OR #13 OR 18)

Cost Effectiveness

22	"Cost-Benefit Analysis"[Mesh]
23	#8 AND #24

Bibliographies

Identified from bibliographies

Total Screened: 1313

Parallel strategies were used to search the Cochrane Library, Embase and others listed below. Keyword searches were conducted in the other listed resources.

Electronic Database Searches

The following databases have been searched for relevant information:
Agency for Healthcare Research and Quality (AHRQ)
Cumulative Index to Nursing and Allied Health (CINAHL)
Cochrane Database of Systematic Reviews (through 2009, Issue 2)
Cochrane Registry of Clinical Trials (CENTRAL) (through 2009, Issue 2)
Cochrane Review Methodology Database (through 2009, Issue 2)
Computer Retrieval of Information on Scientific Projects (CRISP)
Database of Reviews of Effectiveness (Cochrane Library) (through 2009, Issue 2)
EMBASE (1985 through July 23, 2009)
PubMed (1975 through July 23, 2009)
Informational Network of Agencies for Health Technology Assessment (INAHTA)
NHS Economic Evaluation Database (Cochrane Library through 2009, Issue 2)
HSTAT (Health Services/Technology Assessment Text)
EconLIT

Additional Economics, Clinical Guideline and Gray Literature Databases

AHRQ- Healthcare Cost and Utilization Project
Canadian Agency for Drugs and Technologies in Health
Centers for Medicare and Medicaid Services (CMS)
Food and Drug Administration (FDA)
Google
Institute for Clinical Systems Improvement (ICSI)
National Guideline Clearinghouse

Appendix D. EXCLUDED ARTICLES

Exclude at full-text review

CN-TKA vs. CONV-TKA

Author	Reason for exclusion
1. Anderson	Radiographic alignment only; no function, no perioperative complications
2. Bäthis 2004	Radiographic alignment only; no function, no perioperative complications
3. Bertsch 2007	Article in German
4. Browne 2010	Administrative database
5. Carter 2008	Historical control
6. Chin 2005	Radiographic alignment only; unlcear whether all perioperative complications were
7. Clemens 2003	Historical control
8. Confalonieri 2007	Radiographic alignment only; no function, no perioperative complications
9. Daubresse 2005	Focus is on alignment; no function, no perioperative complications
10. Deo 2010	Focus is post-op cognitive dysfunction; no function, no other perioperative complications
11. Haaker 2005	Radiographic alignment only; no function, no perioperative complications
12. Han 2006	Radiographic alignment only; no function, no perioperative complications
13. Hart 2003	Radiographic alignment only; no function, no perioperative complications
14. Hernandez-Vaquero 2010	Radiographic alignment only; no function, no perioperative complications
15. Jenny 2005	Historical control
16. Jenny 2001	Radiographic alignment only; no function, no perioperative complications
17. Jung 2009	Comparison between fluoroscopy-assisted and navigation-guided TKA
18. Kim 2005	Radiographic alignment only; no function, no perioperative complications
19. Kinzl 2004	Article in German/Review
20. Leng 2007	Article in Chinese
21. Maculé-Beneyto 2006	Radiographic alignment only; no function, no perioperative complications
22. Malik 2007	Radiographic alignment only; no function, no perioperative complications
23. Matsumoto 2004	Radiographic alignment only; no function, no perioperative complications
24. Mielke 2001	Article in German
25. Mombert 2007	Radiographic alignment only; no function, no perioperative complications
26. Novicoff 2010	Systematic review focused on alignment
27. Oberst 2008	CT parameters/radiographic alignment only; no function, no perioperative complications
28. Perlick 2004	Article in German
29. Restrepo 2008	Femoral rotational alignment only; no function, no perioperative complications
30. Rosenberger 2008	Historical control
31. Saragaglia 2001	Article in French
32. Seon 2006	Focus is on less-invasive (LIS) surgical technique
33. Skowronski 2005	Radiographic alignment only; no function, no perioperative complications
34. Song 2007	Knee stability
35. Stöckl 2004	Radiographic alignment only; no function, no perioperative complications
36. Tingart 2008	Focus is radiographic alignment/precision of placement; no data given for complications
37. Weinrauch 2006	Focus on rehabilitation of quadricep muscle; no function, no perioperative complications
38. Yau 2008	Historical control

39. Zigo 2009	Radiographic alignment only; no function, no perioperative complications
40. Zorman 2005	Historical control

UKA vs. TKA

Study	Reason for exclusion
41. Fuchs 2003	control group = healthy subjects
42. Fuchs 2002	control group = healthy subjects

UKA vs. HTO

Study	Reason for exclusion
43. Borjesson 2007	Groups not compared by surgery
44. Ivarsson 1991	Groups not assessed at similar time periods
45. Fisher 2003	Radiographic alignment, not function

Bicompartmental or bi-unicompartmental vs. TKA

Study	Reason for exclusion
46. Parratte 2010	Case series
47. Callahan 1995	Metaanalysis of case series

Special Populations

Study	Reason for exclusion
48. Yau 2008	Alignment outcome only
49. Hopper (2008)	No subpopulations compared
50. Gulati (2008)	Alignment outcome only
51. Servien (2009)	Historical control
52. Radke (2005)	No subpopulations compared
53. Kort (2007)	No subpopulations compared
54. Berend (2005)	No subpopulations compared
55. Pennington (2003)	No subpopulations compared
56. Swienckowski (2004)	No subpopulations compared
57. Vorlat (2000)	No subpopulations compared
58. Robertsson (1999)	No subpopulations compared
59. Riddle (2008)	No subpopulations compared
60. Stern (1993)	TKA performed on all patients. Intaoperative evaluation for UKA selection.
61. Swank (1993)	No subpopulations compared
62. Tabor (1998)	No subpopulations compared
63. Deshmukh (2002)	Review
64. Thiengwittayaporn (2009)	Alignment outcome only
65. Choong (2009)	Alignment outcome only
66. Eck (2008)	Alignment outcome only
67. Restrepo (2007)	Metaanalyses of simultaneous vs. unilateral (not staged)

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Appendix E. LEVEL OF EVIDENCE DETERMINATION

Each study was rated against pre-set criteria that resulted in an evidence rating (Level of Evidence I, II, III, or IV) and presented in a table. For therapeutic and prognostic articles, the criteria are listed in the Table below.

Definition of the different levels of evidence for articles on therapy and prognosis

	Studies of Therapy		Studies of Prognosis	
Level	**Study design**	**Criteria**	**Study design**	**Criteria**
I	Good quality RCT	• Concealment • Blind or independent assessment for important outcomes • Co-interventions applied equally • F/U rate of 80%+ • Adequate sample size	Good quality cohort	• Prospective design • Patients at similar point in the course of their disease or treatment • F/U rate of 80%+ • Patients followed long enough for outcomes to occur • Controlling for extraneous prognostic factors*
II	Moderate or poor quality RCT	• Violation of any of the criteria for good quality RCT	Moderate quality cohort	• Prospective design, with violation of one of the other criteria for good quality cohort study • Retrospective design, meeting all the rest of the criteria in level I
	Good quality cohort	• Blind or independent assessment in a prospective study, or use of reliable data* in a retrospective study • Co-interventions applied equally • F/U rate of 80%+ • Adequate sample size • Controlling for possible confounding†		
III	Moderate or poor quality cohort	• Violation of any of the criteria for good quality cohort	Poor quality cohort	• Prospective design with violation of 2 or more criteria for good quality cohort, or • Retrospective design with violation of 1 or more criteria for good quality cohort
	Case-control	• Any case-control design	Case-control	• Any case-control design
IV	Case series	• Any case series design	Case series	• Any case series design

* Authors must provide a description of robust baseline characteristics, and control for those that are unequally distributed between treatment groups.

Studies from Registries	
Study design	**Criteria**
Good quality registry	• Designed specifically for conditions evaluated • Includes prospective data only • Validation of completeness and quality of data • Patients followed long enough for outcomes to occur • Independent outcome assessment* • Complete follow-up of ≥ 85% • Controlling for possible confounding† • Accounting for time at risk‡
Moderate quality cohort	• Prospective data from registry designed specifically for conditions evaluated with violation of 2 of the rest of the criteria in level I
Poor quality cohort	• Prospective data from registry designed specifically for conditions evaluated with violation of 3 or more of the rest of the criteria in level I • Retrospective data or data from a registry not designed specifically for conditions evaluated

* Outcome assessment is independent of healthcare personnel judgment. Some examples include patient reported outcomes, death, and reoperation.
† Authors must provide a description of robust baseline characteristics, and control for those that are unequally distributed between treatment groups.
‡ Equal follow-up times or for unequal follow-up times, accounting for time at risk.

Determination of Overall Strength of Evidence

Following the assessment of the quality of each individual study included in the report, an overall "strength of evidence for the relevant question or topic is determined. Methods for determining the overall strength of evidence for diagnostic studies are variable across the literature and are most applicable to evaluation of therapeutic studies.

SRI's method incorporates the primary domains of quality (LoE), quantity of studies and consistency of results across studies as described by AHRQ.[63]

The following definitions are used by SRI to determine whether or not the body of evidence meets the criteria for each domain:

Domain	Definition/Criterion
Quality	• At least 80% of the studies are LoE I or II
Quantity	• There are at least three studies which are adequately powered to answer the study question
Consistency	• Study results would lead to a similar conclusion (similar values, in the same direction) in at least 70% of the studies

Based on the criteria described above, the possible scenarios that would be encountered are described below. Each scenario is ranked according to the impact that future research is likely to have on both the overall estimates of an effect and the confidence in the estimate. This ranking describes the overall "Strength of Evidence" (SoE) for the body of literature on a specific topic. The method and descriptions

of overall strength are adapted for diagnostic studies from system described by the GRADE Working Group[62] for the development of clinical guidelines.

SoE	Description	Further Research Impact	Domain Criterion Met		
			Quality	Quantity	Consistency
1	**High**	Very unlikely to change confidence in effect estimate	+	+	+
2	**Moderate**	Likely to have an important impact on confidence in estimate and *may* change the estimate	+	-	+
			+	+	-
3	**Low**	Very likely to have an important impact on confidence in estimate and *likely* to change the estimate	+	-	-
			-	+	+
4	**Very Low**	Any effect estimate is uncertain	-	+	-
			-	-	+
			-	-	-

Assessment of Economic Studies

Full formal economic analyses evaluate both costs and clinical outcomes of two or more alternative interventions. The four primary types are cost minimization analysis (CMA), cost-utility analysis (CUA), cost-effectiveness analysis (CEA), and cost-benefit analyses (CBA). Each employs different methodologies, potentially complicating critical appraisal, but some common criteria can be assessed across studies.

No standard, universally accepted method of critical appraisal of economic analyses is currently in use. A number of checklists [Canadian, BMJ, AMA] are available to facilitate critique of such studies. The Quality of Health Economic Studies (QHES) instrument developed by Ofman, et al.[131] QHES embodies the primary components relevant for critical appraisal of economic studies.[131, 132] It also incorporates a weighted scoring process and which was used as one factor to assess included economic studies. This tool has not yet undergone extensive evaluation for broader use but provides a valuable starting point for critique.

In addition to assessment of criteria in the QHES, other factors are important in critical appraisal of studies from an epidemiologic perspective to assist in evaluation of generalizability and potential sources of study bias.

Such factors include:

- Are the interventions applied to similar populations (eg, with respect to age, gender, medical conditions, etc)? To what extent are the populations for each intervention comparable and are

differences considered or accounted for? To what extent are population characteristics consistent with "real world" applications of the comparators?

- Are the sample sizes adequate so as to provide a reasonable representation of individuals to whom the technology would be applied?
- What types of studies form the basis for the data used in the analyses? Data (eg, complication rates) from randomized controlled trials or well-conducted, methodologically rigorous cohort studies for data collection are generally of highest quality compared with case series or studies with historical cohorts.
- Were the interventions applied in a comparable manner (eg, similar protocols, follow-up procedures, evaluation of outcomes, etc)?
- How were the data and/or patients selected or sampled (eg, a random selection of claims for the intervention from a given year/source or all claims)? What specific inclusion/exclusion criteria or processes were used?
- Were the outcomes and consequences of the interventions being compared comparable for each? (eg, were all of the relevant consequences/complications for each intervention considered or do they primarily reflect those for one intervention?)

Assessment of the overall strength of evidence for formal economic analyses does not appear to be documented in the literature. For the purposes of this HTA, overall strength was determined by:

- Quality of the individual studies: Where the majority of quality indicators described in the QHES met and were the methods related to patient/claim selection, patient population considerations and other factors listed above consistent with a high quality design?
- Number of formal analyses (3 or more)
- Consistency of findings and conclusions from analyses across studies.

QHES Instrument[131] **Study** _____

Questions	Points	Yes	No
1. Was the study objective presented in a clear, specific, and measurable manner?	7		
2. Were the perspective of the analysis (societal, third-party payer, etc.) and reasons for its selection stated?	4		
3. Were variable estimates used in the analysis from the best available source (ie, randomized controlled trial - best, expert opinion - worst)?	8		
4. If estimates came from a subgroup analysis, were the groups prespecified at the beginning of the study?	1		
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions?	9		
6. Was incremental analysis performed between alternatives for resources and costs?	6		
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated?	5		
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate?	7		
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described?	8		
10. Were the primary outcome measure(s) for the economic evaluation clearly stated and did they include the major short-term, long-term and negative outcomes included?	6		
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for the measures/scales used?	7		
12. Were the economic model (including structure), study methods and analysis, and the components of the numerator and denominator displayed in a clear, transparent manner?	8		
13. Were the choice of economic model, main assumptions, and limitations of the study stated and justified?	7		
14. Did the author(s) explicitly discuss direction and magnitude of potential biases?	6		
15. Were the conclusions/recommendations of the study justified and based on the study results?	8		
16. Was there a statement disclosing the source of funding for the study?	3		
TOTAL POINTS	**100**		

Appendix F. LEVEL OF EVIDENCE FOR COMPARATIVE STUDIES.

CN-TKA versus CONV-TKA

Methodological quality of RCTs evaluating CN-TKA and CONV-TKA

Methodological Principle	Bejek (2007)	Bohling (2005)	Choong (2009)	Chontanaphuti (2008)	Church (2007)	Conteduca (2009)	Decking (2005, 2007)	Dutton (2008)	Ensini (2007)
Study design									
Randomized controlled trial	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pseudo-randomized trial									
Cohort Study									
Prospective									
Retrospective									
Statement of concealed allocation*			✓		✓		✓		
Intent-to-treat*			✓						
Independent or blind assessment			✓	✓	✓		✓	✓	✓
Complete follow-up of ≥85%			✓	✓	✓	✓	✓	✓	
Adequate sample size	✓	✓	✓			✓		✓	✓
Controlling for possible confounding		✓	✓	✓	✓	✓	✓	✓	✓
Evidence Class	II	II	I	II	II	II	II	II	II

Methodological Principle	Hinarejos (2009)	Kalairajah (2005)	Kalairajah (2006)	Kim (2007)	Kim (2008)	Lüring (2008)	Lützner (2008, 2010)	Martin (2007)	Martin (2009)
Study design									
Randomized controlled trial	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pseudo-randomized trial									
Cohort Study									
Prospective									
Retrospective									
Statement of concealed allocation*	✓	✓		✓	✓	✓	✓	✓	
Intent-to-treat*							✓		
Independent or blind assessment				✓				✓	

Complete follow-up of ≥85%	✓	✓	✓	✓	✓	✓	✓	✓	
Adequate sample size	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controlling for possible confounding	✓		✓	✓	✓	✓	✓	✓	✓
Evidence Class	II	II	II	II	II	II	II	II	II

Methodological Principle	Matziolis (2007)	Ooi (2008)	Perlick (2004)	Seon (2009)	Sparmann (2003)	Chauhan(2004)/ Spencer (2007)	van Strien (2009)	Weng (2009)
Study design								
Randomized controlled trial	✓	✓		✓		✓	✓	✓
Pseudo-randomized trial			✓		✓			
Cohort Study								
Prospective								
Retrospective								
Statement of concealed allocation*	✓			✓		✓	✓	
Intent-to-treat*								
Independent or blind assessment		✓	✓	✓		✓	✓	✓
Complete follow-up of ≥85%	✓	✓	✓	✓		✓	✓	
Adequate sample size	✓	✓	✓	✓	✓	✓		✓
Controlling for possible confounding	✓	✓		✓		✓	✓	✓
Evidence Class	II	II	II	II	II	II	II	II

Methodological quality of nonrandomized studies comparing CN-TKA and CONV-TKA

Methodological Principle	Bolognesi (2005)	Bonutti (2008)	Chaiyakit (2009)	Chang (2010)	Chang (2006)	Cheung (2009)	Czurda (2010)	Ek (2008)	Haytmanek (2010)	Kamat (2009)
Study design										
Randomized controlled trial										
Cohort Study										
Prospective		✓		✓	✓	✓			✓	
Retrospective	✓		✓				✓	✓		✓
Statement of concealed allocation*										
Intent-to-treat*										
Independent or blind assessment			✓		✓			✓		
Complete follow-up of ≥85%	✓	✓		✓		✓				

Adequate sample size	✓	✓		✓		✓	✓	✓	✓	✓
Controlling for possible confounding	✓	✓		✓	✓	✓	✓	✓	✓	✓
Evidence Class	III	III	III	III	III	III	III	III	III	III

Methodological Principle	Kim (2009)	Lüring (2009)	Matsumoto (2006)	Molfetta (2008)	Pang (2009)	Schnurr (2010)	Seon (2005)	Stulberg (2006)	Shen (2009)	Zumstein (2006)
Study design										
Randomized controlled trial										
Cohort Study										
Prospective	✓				✓		✓		✓	✓
Retrospective		✓	✓	✓		✓		✓		
Statement of concealed allocation*										
Intent-to-treat*										
Independent or blind assessment	✓				✓			✓		✓
Complete follow-up of ≥85%	✓		✓	✓	✓	✓	✓		✓	✓
Adequate sample size	✓		✓	✓	✓	✓	✓	✓		✓
Controlling for possible confounding	✓	✓	✓	✓	✓	✓	✓	✓		✓
Evidence Class	II	III	III	III	II	III	III	III	III	II

UKA versus TKA

Methodological quality of studies evaluating UKA versus TKA.

Methodological principle	Newman (2009)	Newman (1998)	Ackroyd (2002)	Amin (2006)	Cameron (1988)	Dalury (2009)	Foote (2010)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓	✓	✓	✓
Statement of concealed allocation*							
Intention to treat*							
Independent or blind assessment				✓			
Cointerventions applied equally	✓	✓	✓	✓		✓	
Complete follow-up of ≥ 85%		✓	✓	✓*	✓		
Adequate sample size	✓	✓	✓	✓			
Controlling for possible confounding†	✓	✓		✓	✓	✓	✓
Evidence class	II	II	III	III	III	III	III

*92% at 6 months, 90% at 18 months, 87% at 36 monts, 81% at 60 months

Methodological principle	Furnes (2007)	Gioe (2003)	Hassaballa (2007)	Hopper (2008)	Isaac (2007)	Koskinen (2008)	Laurencin (1991)	Lombardi (2009)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓	✓	✓	✓	✓
Statement of concealed allocation*								
Intention to treat*								
Independent or blind assessment								
Cointerventions applied equally					✓		✓	
Complete follow-up of ≥ 85%	✓			✓	✓		✓	
Adequate sample size	✓	✓	✓	✓		✓		✓
Controlling for possible confounding†	✓					✓	✓	✓
Evidence class	III	III	III	III	III	III	III	III

Methodological principle	McAllister (2008)	Robertsson (1999)	Rougraff (1991)	Walton (2006)	Weale (2001)	Willis-Owen (2009)	Wylde (2008)	Yang (2003)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓	✓	✓	✓	✓
Statement of concealed allocation*								
Intention to treat*								
Independent or blind assessment						✓		
Cointerventions applied equally				✓	✓			✓
Complete follow-up of ≥ 85%			✓		✓			

Adequate sample size		✓	✓	✓			✓	✓
Controlling for possible confounding†		✓	✓					✓
Evidence class	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**

Methodological quality of studies evaluating HTO versus UKA.

Methodological principle	Weidenhielm (1993) Borjesson (2005)	Stukenborg-Colsman (2001)	Broughton (1986) Weale (1994)	Ivarsson (1991)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓
Statement of concealed allocation*				
Intention to treat*				
Independent or blind assessment			✓	
Cointerventions applied equally				✓
Complete follow-up of ≥ 85%				
Adequate sample size			✓	
Controlling for possible confounding†	✓	✓		
Evidence class	**II**	**II**	**III**	**III**

Special Populations (KQ 4)

Level of evidence for registry studies evaluating UKA in special populations.

METHODOLOGICAL PRINCIPLE	Koskinen (2007)	W-Dahl (2009)	Harrysson (2004)	Gioe (2003 2007)	Robertsson (2000)	No author
Source	Finland	Australian Sweden	Sweden	Minnesota community	Sweden	England/ Wales
Designed specifically for conditions evaluated	✓	✓	✓	✓	✓	✓
Includes prospective data only	✓	✓	✓		✓	✓
Validation of completeness and quality of data		✓	✓		✓	✓
Patients followed long enough for outcomes to occur	✓	✓	✓	✓	✓	✓
Independent outcome assessment*	✓	✓	✓	✓	✓	✓
Complete follow-up of ≥ 85%	✓	✓	✓	✓	✓	✓
Controlling for possible confounding†	✓	✓	✓			
Accounting for time at risk‡	✓	✓	✓	✓	✓	✓
Level of Evidence	**II**	**II**	**II**	**IV**	**II**	**II**

* Outcome assessment is independent of healthcare personnel judgment. Some examples include patient reported outcomes, death, and reoperation.

† Authors must provide a description of robust baseline characteristics, and control for those that are unequally distributed between treatment groups.

‡ Equal follow-up times or for unequal follow-up times, accounting for time at risk.

Note: Robertsson and Harrysson may have overlapping data

Level of evidence for non-registry studies evaluating TKA in special populations.

Methodological principle	Bourne 2007	Dowsey 2009	Singh 2008	Gandhi 2010	Parsley 2010
Study design Prospective cohort study Retrospective cohort study Case-control study Case series	✓	✓	✓	✓	✓
Patients at similar point in the course of their disease or treatment	✓	✓	✓	✓	✓
Patients followed long enough for outcomes to occur	✓	✓	✓	✓	✓
Complete follow-up of ≥ 80%	✓	✓			
Controlling for extraneous prognostic factors*		✓	✓	✓	✓
Evidence class	**II**	**I**	**III**	**III**	**III**

* Authors must provide a description of robust baseline characteristics, and control for those that are unequally distributed between treatment groups.

Special Populations (KQ 4 continued)

Level of evidence for non-registry studies evaluating UKA in special populations.

Methodological Principle	Kuipers (2009)	Tabor (2005)	Heck (1993)	Price (2005)
Study Design				
Prospective cohort design				
Retrospective cohort design	✓	✓	✓	✓
Case-control design				
Case-series				
Patients at similar point in the course of their treatment	✓	✓	✓	✓
Complete follow-up of ≥85% *	✓	✓		✓
Patients followed long enough for outcomes to occur	✓		✓	✓
Controlling for extraneous prognostic factors	✓			
Level of Evidence	**II**	**III**	**III**	**III**

Level of evidence for non-registry studies evaluating CN-TKA in special populations.

Methodological Principle	Millar (2009)
Study Design	
Prospective cohort design	
Retrospective cohort design	✓
Case-control design	
Case-series	
Patients at similar point in the course of their treatment	✓
Complete follow-up of ≥85% *	✓
Patients followed long enough for outcomes to occur	✓
Controlling for extraneous prognostic factors	
Level of Evidence	**III**

Level of evidence for studies evaluating simultaneous vs. bilateral knee arthroplasty.

Methodological quality of studies evaluating Simultaneous and Staged Bilateral TKA

Methodological principle	Yoon (2010)	Stefansdottir (2008)	Barrett (2006)	Forster (2006)	Walmsley (2006)	Stubbs (2005)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓	✓	✓
Statement of concealed allocation*						
Intention to treat*						
Independent or blind assessment	✓					
Cointerventions applied equally	✓			✓		
Complete follow-up of ≥ 85%				✓		
Adequate sample size	✓	✓	✓	✓		✓
Controlling for possible confounding†	✓	✓	✓			
Evidence class	**III**	**III**	**III**	**III**	**III**	**III**

Methodological principle	Macario (2003)	Ritter (2003)	Mangaleshkar (2001)	Liu (1998)	Ritter (1997)
Study design Randomized controlled trial Cohort study Case-series	✓	✓	✓	✓	✓
Statement of concealed allocation*					
Intention to treat*					
Independent or blind assessment					
Cointerventions applied equally				✓	
Complete follow-up of ≥ 85%	✓	✓	✓	✓	
Adequate sample size	✓	✓	✓		✓
Controlling for possible confounding†	✓				
Evidence class	**III**	**III**	**III**	**III**	**III**

* Applies to RCTs only.

† Authors must provide a description of robust baseline characteristics, and control for those that are unequally distributed between treatment groups.

Question		possible points	Soohoo 2006	Slover 200
1	Was the study **objective** presented in a clear, specific, and measurable manner?	7	7	7
2	Were the **perspective** of the analysis (societal, third-party payer, etc.) and reasons for its selection stated?	4	0	4
3	Were **variable estimates** used in the analysis from the best available source (ie, randomized controlled trial - best, expert opinion - worst)?	8	0	8
4	If estimates came from a **subgroup analysis**, were the groups prespecified at the beginning of the study?	1	1	1
5	Was **uncertainty** handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions?	9	9	9
6	Was **incremental analysis** performed between alternatives for resources and costs?	6	6	6
7	Was the methodology for **data abstraction** (including the value of health states and other benefits) stated?	5	5	5
8	Did the **analytic horizon allow time** for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate?	7	7	7
9	Was the **measurement of costs** appropriate and the methodology for the estimation of quantities and unit costs clearly described?	8	8	8
10	Were the primary **outcome measure(s**) for the economic evaluation clearly stated and did they include the major short-term, long-term and negative outcomes included?	6	6	6
11	Were the health outcomes **measures/scales valid** and reliable? If previously tested valid and reliable measures were not available, was justification given for the measures/scales used?	7	7	0
12	Were the **economic model** (including structure), study methods and analysis, and the components of the numerator and denominator displayed in a clear, transparent manner?	8	0	0
13	Were the choice of economic model, main **assumptions, and limitations** of the study stated and justified?	7	7	7
14	Did the author(s) explicitly discuss direction and magnitude of potential **biases?**	6	6	6
15	Were the **conclusions/recommendations** of the study justified and based on the study results?	8	8	8
16	Was there a statement disclosing the **source of funding** for the study?	3	3	3

TOTAL	100	**80**	**85**

Appendix G. Study Characteristics of Included Studies

Population characteristics of RCTs comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
Lützner (2010/2008)	n = 40 male: 32% age: 68 years (63–74) BMI: 30 kg/m^2 (27–33)	n = 40 male: 34% age: 69 years (59–76) BMI: 30 kg/m^2 (27–33)	Included: • Primary or secondary OA of the knee • Mechanical axis between 20º varus and 5º valgus Excluded: • Previous hemiarthroplasty or total arthroplasty • Severe instability that could not be treated with an unconstrained, cruciate- retaining TKA
Choong (2009)	n = 59 male: 30% age: 70 years (45–89) BMI: 30 kg/m^2 (19–48)	n = 55 male: 50% age: 69 years (49–88) BMI: 30 kg/m^2 (17–45)	Included: • OA (n = 103) or RA (n = 8) of the knee • All patients scheduled for elective primary TKA by the three participating surgeons
Conteduca (2009)	n = 50 male: 32% age: 70 years (53–81) BMI: 30 kg/m^2 (42–20)	n = 50 male: 32% age: 74 years (54–85) BMI: 29 kg/m^2 (38–20)	Included: • Primary gonarthrosis • Unilateral TKA Excluded: • History of bleeding diathesis • Contraindications to NSAIDs
Hinarejos (2009)	n = 43 male: 14% age: 73 years (± 7.3) BMI: NR	n = 44 male: 23% age: 74 years (± 7.3) BMI: NR	Included: • Primary unilateral TKA • Diagnosis of OA (any other indication excluded) Excluded: • Previous surgery requiring removal of implants • Varus or valgus deformities of 10º or greater or flexion contractures of 10º or greater • Revision surgery to TKA
Martin (2009)	n = 50 male: 44% age: 71 years (53–86) BMI: 29 kg/m^2 (23–48)	n = 50 male: 40% age: 71 years (56–87) BMI: 29 kg/m^2 (21–45)	Included: • Planned primary TKA • Diagnosis of primary OA Excluded: • Preoperative valgus deformity > 15º • Revision surgery to TKA • TKA due to trauma or injury during last 12 months • Immobile hip • Active infection • Severe untreated bleeding abnormalities • Pregnancy • Known metal allergies • Neurologic deficit • Any routine contraindication to surgery

Population characteristics of RCTs comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
Seon (2009)	n = 43 male: 5% age: 67 years (56–84) BMI: NR	n = 42 male: 10% age: 68 years (52–83) BMI: NR	Included: • Unilateral primary TKA Excluded: • Prior open knee surgery • Severe deformity (> 20º varus or > 30º flexion contracture)
van Strien (2009)	n = 21 male: %NR* age: 71 years* BMI: 28 kg/m^2*	n = 19	• NR
Weng (2009)	n = 60 male: 32% age: 70 years (57–82) BMI: 28 kg/m^2 (17–39)	n = 60 male: 32% age: 70 years (57–82) BMI: 28 kg/m^2 (17–39)	Included: • Staged bilateral TKAs within a period of 3 months
Chotanaphuti (2008)	n = 86 male: 7% age: 67 years (53–80) BMI: NR	n = 94 male: 12% age: 68 years (47–81) BMI: NR	Included: • OA (n = 168) or RA (n = 12) Excluded: • Previous bony procedures on the knee • Incomplete or unsatisfactory radiographs for accurate measurements
Dutton (2008)	n = 52 male: 15% age: 68 years BMI: 28 kg/m^2	n = 56 male: 21% age: 67 years BMI: 27 kg/m^2	Included: • Substantial pain and loss of function due to OA of the knee • Any degree of genu varum deformity • < 15º of genu valgum deformity Excluded: • Genu valgum deformity of > 15º • Previous knee surgery that required the removal of metallic implants • Revision TKA • Active knee joint infection • Need for bilateral TKA
Kim (2008)	n = 160 male: NR age: NR BMI: NR	n = 160 male: NR age: NR BMI: NR	Included: • OA (98%) or RA (1%) or Osteonecrosis (1%) • Primary TKA
Luring (2008)	n = 30 male: NR age: 70 years BMI: 31 kg/m^2	n = 60† male: NR age: 69 years BMI: 32 kg/m^2	Included: • Primary TKA • Age < 75 years Excluded:

Population characteristics of RCTs comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
			• Previous operations (e.g. HTO) • Trauma • Deformity > 20º varus/valgus/extension • BMI > 35
Ooi (2008)	n = 10 male: 50% age: 67 years BMI: NR	n = 20‡ male: 20% age: 66 years BMI: NR	Excluded: • History of previous VTE or PE • Patients on prophylaxis or treatment for VTE • Previous procedure of the esophagus
Bejek (2007)	n = 69 male: 32% age: 69 years (49–83) BMI: NR	n = 63 male: 26% age: 68 years (50–85) BMI: NR	• NR
Church (2007)	n = 14 male: 71% age: 62 years (52–75) BMI: 32 kg/m^2	n = 12 male: 33% age: 67 years (54–80) BMI: 30 kg/m^2	Included: • Primary TKA for OA Excluded: • History of inflammatory arthritis • Previous femoral instrumentation • Thromboembolic disease • Esophageal disorder
Decking (2007, 2005)	n = 27 male: 33% age: 65 years BMI: 28 kg/m^2	n = 25 male: 32% age: 67 years BMI: 30 kg/m^2	Included: • Primary (n = 39) or secondary (n = 8) knee OA • RA (n = 5)
Ensini (2007)	n = 60 male: 50% age: 69 ± 6.3 BMI: NR	n = 60 male: 33% age: 71 ± 7.8 BMI: NR	Included: • Arthritis either primary or secondary to articular or extraarticular fractures • Avascular necrosis Excluded: • Infection • Revision surgery • Severe knee instability
Kim (2007)	n = 50§ male: 15% age: 68 years (54–83) BMI: 27 kg/m^2	n = 50§ male: 15% age: 68 years (54–83) BMI: 27 kg/m^2	Included: • OA • Bilateral sequential primary TKA Excluded: • Varus deformity > 20º • Flexion contracture of > 30º
Martin (2007)	n = 100 male: 32% age: 70 years (48–85) BMI: 30 kg/m^2	n = 100 male: 27% age: 71 years (49–84) BMI: 28 kg/m^2	Included: • Primary TKA • OA • After high tibial osteotomy Excluded: • Revision surgery to TKA • TKA due to trauma or injury in last 12 months • Immobile hip • Active infection

Population characteristics of RCTs comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
			• Severe untreated bleeding abnormalities • Malignancy • Pregnancy • Known metal allergies • Neurological deficit
Matziolis (2007)	n = 32 male: %NR age: 71 years (54–84) BMI: 31 kg/m^2	n = 28 male: %NR age: 70 years (52–83) BMI: 32 kg/m^2	Included: • Primary arthritis of the knee Excluded: • Previous surgery on the joint • Patients who could not be treated with an unconstrained TKA with a short stem
Spencer (2007)/ Chauhan (2004)	n = 35 male: NR age: NR BMI: NR	n = 36 male: NR age: NR BMI: NR	Included: • Primary TKA for OA
Kalairajah (2006)	n = 10 male: 64% age: 64 years (48–81) BMI: NR	n = 14 male: 30% age: 63 years (45–78) BMI: NR	Included: • OA • Unilateral TKA Excluded: • History of stenosis of the carotid artery • A likely source of arterial emboli such as atrial fibrillation or a prosthetic valve
Böhling (2005)	n = 50 male: 28% age: 69 years (40–83) BMI: NR	n = 50 male: 22% age: 72 years (49–91) BMI: NR	Included: • Primary TKA
Kalairajah (2005)	n = 30 male: 37% age: 66 years (35–85) BMI: NR	n = 30 male: 40% age: 66 years (41–88) BMI: NR	Included: • Unilateral TKA for OA Excluded: • History of bleeding diathesis • Contraindication to non-steroid anti-inflammatory medication • Currently taking warfarin
Perlick (2004)	n = 50 male: 20% age: 66 years (30–80) BMI: NR	n = 50 male: 16% age: 72 years (50–85) BMI: NR	Included: • NR Excluded: • No exclusion criteria were used
Sparmann (2003)	n = 120 male:27%	n = 120 male: 34%	Included: • Primary TKA • Patients suitable to a condylar prosthesis

Population characteristics of RCTs comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
	age: 67 years BMI: NR	age: 66 years BMI: NR	Excluded: • No exclusion criteria were used

BMI = body mass index. CN-TKA = computer-navigated total knee arthroplasty; CONV-TKA = conventional total knee athroplasty; NR = not reported; OA = osteoarthritis; RA = rheumatoid arthritis.
*Demographics were given for total population only, which also includes a CT-based CN-TKA group (n = 17) which was not included in the data abstraction and analysis since this report's focus is on image-free computer-navigated TKA. The article states that no significant differences between the three groups were present preoperatively
†The "conventional TKA" group (n = 30) and the "free-hand MIS TKA" group (n = 30) were combined to form the CONV-TKA group.
‡Groups A (n = 10, TKA with an intramedullary femur guide and an extramedullary tibia guide) and B (n = 10, TKA with intramedullary guides for both the tibia and the femur) were combined to form the CONV-TKA group.
§Bilateral sequential TKA was performed in 50 patients for a total of 100 knees; thus the demographics for both groups are identical.

Population characteristics of nonrandomized studies comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
Prospective cohorts			
Chang (2010)	n = 50 male: 16% age: 70 years (55–85) BMI: 28 kg/m^2 (19–36)	n = 50 male: 22% age: 71 years (51–81) BMI: 28 kg/m^2 (21–35)	Included: • OA • Undergoing primary MIS-TKA Excluded: • Abnormal coagulation status, including abnormal laboratory data • Known medical conditions affecting hemostasis (liver cirrhosis and end-stage renal disease) • Long-term anticoagulant use • Incomplete medical records
Haytmanek (2010)	n = 47 male: 40% age: 66 years (40–87) BMI: 32 kg/m^2 (22–44)	n = 48 male: 27% age: 66 years (41–82) BMI: 30 kg/m^2 (22–46)	Excluded: • < 12 years of education • Inability to read and write in English • History of mental illness • Parkinson's disease • Depression • Dementia • Current use of an antidepressant and/or antipsychotic medication
Cheung (2009)	n = 47 male: 13% age: 67 years (50–79) BMI: NR	n = 47 male: 13% age: 67 years (52–78) BMI: NR	Included: • Primary OA Excluded: • Previous osteotomy, UKA, or fractures around the knee • Varus or valgus deformity > 20º • Flexion contractures of > 20º • Bone defects treated with bone grafts or metal augmentation
Kim (2009)	n = 160 male: 12% age: 69 years (56–81) BMI: 27 kg/m^2 (22–45)	n = 160 male: 12% age: 69 years (56–81) BMI: 27 kg/m^2 (22–45)	Included: • Primary OA • Bilateral sequential TKA • Varus deformity of 8º–20º
Pang (2009)	n = 35 knees male: 6% age: 66 years (49–79) BMI: NR	n = 35 knees male: 14% age: 66 years (54–78) BMI: NR	Included: • Primary OA with varus deformity Excluded: • Valgus knees which were associated with inflammatory arthritis
Shen (2009)*	n = 16 male: 38%	n = 36 male: 33%	• NR

Population characteristics of nonrandomized studies comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
	age: 69 years	age: 71 years	
Bonutti (2008)	n = 55 male: 40% age: 64 years (39–90) BMI: 34 kg/m^2	n = 55 male: 33% age: 71 years (47–88) BMI: 32 kg/m^2	Included: • OA • Failed conservative treatment
Chang (2006)	n = 43 male:19% age: 68 years (49–79) BMI: NR	n = 29 male:14% age: 70 years (55–79) BMI: NR	Included: • OA • RA • Primary TKA
Zumstein (2006)†	n = 30 male: 28%‡ age: 73 years‡ BMI: NR‡	n = 30 male: 21%‡ age: 74 years‡ BMI: NR‡	Included: • Primary TKA Excluded: • RA or other inflammatory arthritis
Seon (2005)	n = 47 knees§ male: NR age: 67 years (41–85)	n = 50 knees§ male: NR age: 65 years (48–82)	Included: • Primary TKA Excluded: • Prior open-knee surgery
Retrospective cohorts			
Czurda (2010)	n = 146 male: 24% age: 76 years (52–87) BMI: 29 kg/m^2 (17–60)	n = 265 male: 24% age: 75 years (45–96) BMI: 30 kg/m^2 (18–47)	Included: • Primary TKA for degenerative OA • Follow-up of at least 1.5 years • Operation was performed by an experienced surgeon Excluded: • RA • Postoperative infection and/or if the pain suffered from at the time of follow-up appeared after falling or another traumatic experience
Schnurr (2010)	n = 260 male: 36% age: 69 years (41–92)	n = 187 male: 37% age 70 years (40–86)	Included: • Primary TKA Excluded: • Revision TKA
Chaiyakit (2009)	n = 44 male: 7% age: 64 years (± 7.3) BMI: 26 kg/m^2	n = 23 male: 30% age: 69 years (± 9.8) BMI: 27 kg/m^2	• NR

Population characteristics of nonrandomized studies comparing computer-navigated TKA with conventional TKA.

Study (year)	Treatment Group		Inclusion/Exclusion Criteria
	CN-TKA	CONV-TKA	
Kamat (2009)	n = 263 male: 44% age: 73 years BMI: NR	n = 302 male: 44% age: 72 years BMI: NR	Included: • Primary OA • TKA using the TC Plus SB type of knee prosthesis Excluded: • TKA for any etiology other than OA (ie, RA, osteonecrosis) • Other implant types
Luring (2009)	n = 25 male%: NR age: 69 years (52–78) BMI: 30 kg/m^2	n = 25 male%: NR age: 69 years (53–82) BMI: 29 kg/m^2	Included: • Primary and varus OA Excluded: • Other etiologies (ie, RA, trauma, valgus deformity)
Ek (2008)	n = 50 male: 36% age: 69 years (49–85) BMI: 30 kg/m^2	n = 50 male: 34% age: 71 years (55–85) BMI: 32 kg/m^2	• NR
Molfetta (2008)	n = 30 male: 26% age: 68 years (65–81) BMI: NR	n = 30 male: 13% age: 67 years (62–80) BMI: NR	Included: • OA with varus knee • Implanted using the Search-evolution prosthesis • Operated on by same surgeon • Underwent same surgical parapatellar medial access Excluded: • Preoperative varus lower limb alignment of > 15º • Flexion deformities of > 10º
Matsumoto (2006)	n = 30 male: 17% age: 75 years (50–91) BMI: NR	n = 30 male: 17% age: 73 years (45–90) BMI: NR	Included: • OA • Primary TKA Excluded: • Valgus deformity • Severe bony defects • RA
Stulberg (2006)	n = 38 male: 37% age: 66 years (48–86) BMI: 34 kg/m^2 (24–44)	n = 40 male: 43% age: 64 years (25–88) BMI: 32 kg/m^2 (20–55)	• NA
Bolognesi (2005)	n = 50 male: 48 age: NR BMI: NR	n = 48 male: 44 age: NR BMI: NR	Included: • Primary TKA • Varus or valgus knees

BMI = body mass index; CN-TKA = computer-navigated total knee arthroplasty; CONV-TKA = conventional total knee athroplasty; MIS-TKA = minimally-invasive total knee arthroplasty; NR = not reported; OA = osteoarthritis; RA = rheumatoid arthritis; UKA = unilateral knee arthroplasty.
*Shen 2009 also analyzed patients who underwent metal-on-metal hip resurfacing (n = 19) and primary total hip arthroplasty (n = 31) but only TKA patients are reported for the purposes of this report.
†Zumstein 2006 also analyzed patient who underwent image-based navigation (n = 30) for a total of 90 knees; these patients were excluded from our analysis.

‡Demographic reported for the 29 patients in each group after loss-to-follow-up.

§Reflects number of knees after loss to follow-up. Originally, 105 knees in 92 patients were included. Three knees in the CN-TKA group were excluded due to conversion to a CONV-TKA, and two knees in the CN-TKA groups and three knees in the CONV-TKA group were lost to follow-up, leaving 97 knees in 84 patients with the minimum 1-year follow-up. We were unable to determine the number of patients in each group with the information given since some patients underwent bilateral TKA.

Study and Patient Characteristics for Simultaneous versus Staged Bilateral TKA in 11 Retrospective Cohort Studies

Study (year)	Simultaneous Bilateral TKA	Staged Bilateral TKA*	Diagnosis	Prosthesis/Type of Surgery	Outcomes	Follow-up (% followed)	Funding
Yoon (2010)	n = 119 (238 knees) male%: 5.9 age: 70 yrs (34 – 83)	n = 119 (238 knees) male%: 5.9 age: 70 yrs (34 – 83)	OA or RA	LCS prosthesis with mobile-bearing platform NexGen prosthesis with fixed-bearing system	• Systemic and local complications • Total blood loss • Mortality • Length of hospital stay	NR (% NR)	No funds provided for the study.
Stefansdottir (2008)	n = 1,139 (2,278 knees) male%: 40.8 age: 70.4 yrs (SD 8.0, 41–92)	n = 3,432 (6,864 knees) male%: 37.5 age: 71.2 yrs (SD 7.9, 40 – 93)	OA	NR	• Mortality • Causes of mortality • Survival	NR (% NR)	Funding received from Stiftelsen vanföra i Skåne, Medical Faculty, Lund University, the Swedish Association of Local Authorities and Regions, and the Swedish Research Council.
Barrett (2006)	n = 8324 (16648 knees) male%: 42.2 age: 57.4% 66-74 yrs 39.0% 75-84 yrs 3.6% ≥ 85 yrs	n = 13039 (26078 knees) male%: 37.1 age: 57.6% 66-74 yrs 38.4% 75-84 yrs 4.0% ≥ 85 yrs	NR	NR	• Pulmonary embolism	NR (% NR)	Funding received from the National Institute of Arthritis and Musculoskeletal and Skin Diseases, and the National Institutes of Health.

Study and Patient Characteristics for Simultaneous versus Staged Bilateral TKA in 11 Retrospective Cohort Studies

Study (year)	Simultaneous Bilateral TKA	Staged Bilateral TKA*	Diagnosis	Prosthesis/Type of Surgery	Outcomes	Follow-up (% followed)	Funding
Forster (2006)	n = 28 (56 knees) male %: 53.6 age: 66 (51 – 70)	*Staged within 1 week:* n = 36 (72 knees) male %: 50 age: 68 (48 – 77) *Staged within ave. 29 mos:* n = 38 (76 knees) male %: 42.1 age: 64 (41 – 79)	OA, RA, psoriatic arthritis, other forms of arthritis	Uncemented low contact stress TKS using anteroposterior glide tibial component	• ROM • AKS score • HSS score • Complications • Blood loss • Mortality • Hospital stay	*Simultaneous*: 4.8 yrs (1.0 – 6.7) (% NR) *Staged within 1 wk*: 4.1 yrs (1.0 – 7.2) (% NR) *Staged within ave. 29 mon*: 3.9 yrs (1.0 – 7.2) (% NR)	Authors received no benefits from a commercial entity.
Walmsley (2006)	n = 826 (1652 knees) male %: NR age: NR	n = 1796 (3592 knees) male %: NR age: NR	NR	NR	• Mortality	NR (%NR)	NR
Stubbs (2005)†	n = 61 (122 knees) male %: NR age: median 65 (42 – 81)	n = 38 (76 knees) male %: NR age: median 68 (40 – 81)	OA	NR	• Complications • Blood loss • KSS • SF-12 • Revision • Mortality • Hospital stay	*Simultaneous*: 3.86 yrs (% NR) *Staged*: 2.75 yrs (% NR)	NR
Macario (2003)	n = 91 (182 knees) male %: NR age: NR	n = 32 (64 knees) male %: NR age: NR	OA, RA	NR	• Complications • Economics/cost • Mortality • Hospital stay	NR (% NR)	Funding was received from the Stanford Medical Scholars Program.
Ritter (2003)	n = 2050 (4100 knees) male %: 44.2 age: 69.9	n = 152 (304 knees) male %: 23.0 age: 69.2	OA, RA	Anatomic graduated components with a universal trochlear groove	• Survival (revision and death) • KSS • Complications • Mortality	Simultaneous: 6 mo (%NR) 12 mo (93%) 3 yrs (67.6%) 5 yrs (46.4%) 7 yrs (27.3%) 10 yrs (11.8%) 12 yrs (6.1%) 15 yrs (1.3%) Ave f/u: 4.8 yrs Staged: 6 mo (%NR) 12 mo (97.4%) 3 yrs (78.3%) 5 yrs (66.4%) 7 yrs (27.6%) 10 yrs (4.6%) 12 yrs (3.3%) 15 yrs (0.6%) Ave. f/u: 4.4 yrs	No funding provided for the study.
Mangaleshkar (2001)	n = 54 (108 knees) male %: 38.9 age: 73 (36 – 90)	n = 34 (68 knees) male %: 38.3 71.7 (58 – 84)	NR	NR	• Mortality	30 days (100%)	NR

Study and Patient Characteristics for Simultaneous versus Staged Bilateral TKA in 11 Retrospective Cohort Studies

Study (year)	Simultaneous Bilateral TKA	Staged Bilateral TKA*	Diagnosis	Prosthesis/Type of Surgery	Outcomes	Follow-up (% followed)	Funding
Liu (1998)	n = 64 (128 knees) male %: 4.7 age: 66.7 (44 – 78)	n = 24 (48 knees) male %: 0 age: 68.6 (54 – 79)	OA, RA	PCA, Miller-Galante II, Osteonics, or Whiteside prosthesis	• HSS knee score • Blood loss • Complications • Range of motion • Mortality • Hospital stay	31 months (18 – 44 months) (100 %)	NR
Ritter (1997)	n = 12922 (25844 knees) male %:38.6 age: 73.4	n = 50108 (100216 knees) male %: 33.1 age: 72.9	OA, RA	NR	• Complications • Mortality • Hospital stay	30 days (% NR) 3 months (% NR) 6 months (% NR) 12 months (% NR) 24 months (% NR)	Funding was received from the U.S. Agency for Health Care Policy and Research.

TKA: total knee arthroplasty; RA: rheumatoid arthritis; ROM: range of motion; OA: osteoarthritis; NR: not reported

*Time between first and second operation for staged patients: 12 months (1 – 48 months) [Yoon]; within 12 months [Stefansdottir, Walmsley, Barrett, Stubbs, Ritter (1997)]; 1 week(Forster et al 2006); 29 months (5 – 68 months)(Forster et al 2006); 184 days (SD 94 days, 36 – 364 days) [Macario]; 1.4 years (SD 0.8 yrs, 10 days – 3 years) [Ritter (2003)]; 15 days – 6 months [Mangaleshkar]; 7.4 days (5 – 11 days) [Liu].

†Age estimated from graph.

Summary of risk factors associated with revision after TKA

Risk Factor	Reference	Study Type	LoE	Outcomes
Age	AHRQ	SR/HTA	n/a	**WOMAC**: No relationship between age and scores (4 studies; f/u = 6 months for 3 studies, f/u = NR for 1 study) **SF-36:** Older age: better SF-36 physical health scores (1 study; f/u = 2 years) **KSS:** No relationship between age and scores (KSS knee pain, KSS knee) (1 study; f/u = 2 years)
	Bourne (2007)	Prospective cohort	II	**WOMAC**: Age > 80 years: greater improvement in change in scores from baseline (versus other age groups) (mean change: 19 ± 2; *P* = .01); mean f/u = 9.5 years). **SF-12:** Age > 80 years: greater improvement in change in scores from baseline (versus other age groups) (mean change: 7 ± 1; *P* = .01). **KSS:** Age < 50 years: greater improvement in change in scores from baseline (versus other age groups) (KSS Clinical Rating scores) (mean change: 29 ± 5; *P* = .03).
	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: Older age: less sustained improvement by multivariable longitudinal regression modeling (*P* < .001); mean f/u = 3.0 years). **SF-36:** Older age: less sustained improvement in the physical function and role physical scores by multivariable longitudinal regression modeling (*P* = .002, *P* = .001; respectively); mean f/u = 3.0 years).
	Dowsey (2009)	Prospective cohort	I	**Periprosthetic infection:** No relationship between age group and periprosthetic infection rate (f/u = 12 months).
	Singh (2008)	Retrospective cohort	III	**Moderate/severe postoperative pain:** ***2 years:*** Age >60 to 70 years: lower rate of pain they would describe as moderate to severe (versus age ≤ 60 years) (6.3% versus 10.3%; multivariate analysis: OR = 0.49 (95% CI, 0.31, 0.77); *P* = .002). No significant relationship in outcome for patients >70 to 80 years (rate = 11.4%) or > 80 years (rate = 11.4%). Five ***5 years***: No significant differences between age groups (age ≤ 60 years versus others, as described above).
Sex	AHRQ	SR/HTA	n/a	**WOMAC**: No relationship between patient sex and scores (4 studies; f/u = 6 months to 7 years) **KSS:** No relationship (KSS knee pain, KSS knee) (1 study; f/u = 2 years)
	Bourne (2007)	Prospective cohort	II	**WOMAC**: No relationship between patient sex and change in scores from baseline (mean f/u = 9.5 years) (males had significantly better preoperative scores). **SF-12:** No relationship between patient sex and change in SF-12 physical or mental health scores from baseline (males had significantly better preoperative scores). **KSS:** Female sex: lower improvement in change in KSS Clinical Rating score (versus males) (21 ± 24 versus 25 ± 22; *P* = .01) (males had significantly better preoperative scores). Male sex: no relationship in change in KSS knee subscale score (versus females)
	Parsley (2010)	Retrospective cohort	III	**KSS:** No relationship between patient sex and change in KSS knee or function scores (males had significantly better preoperative scores) (mean f/u: 1.56 years, minimum 1 year)
	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: Female sex: less sustained improvement by multivariable longitudinal regression modeling (*P* = .006); mean f/u = 3.0 years). **SF-36:** No relationship between patient sex and physical function or role physical scores by multivariable longitudinal regression modeling (*P* = .40, *P* = .59; respectively); mean f/u = 3.0 years).
	Dowsey	Prospective	I	**Periprosthetic infection:** Female sex: lower risk of developing periprosthetic infection (versus males) (OR = 5.93

Summary of risk factors associated with revision after TKA

Risk Factor	Reference	Study Type	LoE	Outcomes
	(2009)	cohort		(95% CI, 1.95, 18.04); *P* = .002) (f/u = 12 months).
Sex	Singh (2008)	Retrospective cohort	III	**Moderate/severe postoperative pain:** ***2 years***: Female sex: higher rate of pain they would describe as moderate to severe (versus males) (9.0% versus 6.6%; multivariate analysis: OR = 1.45 (95% CI, 1.01, 2.08); *P* = .04). ***5 years***: No significant differences between sexes in rate of moderate to severe pain (7.9% versus 6.5%; multivariate analysis: OR = 1.23 (95% CI, 0.74, 2.02); *P* = .42).
Obesity/ BMI	AHRQ	SR/HTA	n/a	**WOMAC**: Mixed results (3 studies). Improvements in WOMAC scores correlate with increasing body max, difference between pts with BMI < 25 versus > 40 was not significant (1 study; f/u = 1 year); no relationship between BMI and WOMAC (1 study, f/u = 6 months); improvements in WOMAC scores associated with lower BMI (1 study, data and f/u = NR) **HSS:** BMI > 30: significantly better HS scores versus BMI < 30 (1 study, f/u = 10 years) **KSS:** Mixed results (2 studies) BMI correlated with function (1 study, no details give, f/u = 2 years); no relationship between age and KSS knee pain or knee scores (1 study; f/u = 1 year)
	Bourne (2007)	Prospective cohort	II	**WOMAC**: Class III (BMI not defined) and Class IV (BMI >40) obesity: Greater improvement in WOMAC scores from baseline compared with the other groups (Normal: 20 ± 2 versus Class III: 25 ± 3 and Class IV: 26 ± 7; *P* < .05 for both), but Class IV sample size was very small (n = 15) (mean f/u = 9.5 years). **SF-12:** No relationship between obesity/BMI and change in SF-12 physical or mental health scores from baseline. **KSS:** No relationship between increasing obesity/BMI and change in KSS Clinical Rating Function scores from baseline.
	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: No relationship between BMI and WOMAC scores by multivariable longitudinal regression modeling (*P* = .64); mean f/u = 3.0 years). **SF-36:** No relationship between BMI and physical function or role physical scores by multivariable longitudinal regression modeling (*P* = .73, *P* = .95; respectively); mean f/u = 3.0 years).
	Dowsey (2009)	Prospective cohort	I	**Periprosthetic infection:** BMI ≥ 40: higher risk of developing periprosthetic infection (versus BMI < 30) (multivariate analysis: OR = 8.96 (95% CI, 1.59, 50.63); *P* = .013) (f/u = 12 months); BMI 30–39: similar risk in developing infection (versus BMI < 30) (multivariate analysis: OR = 2.2 (95% CI, 0.64, 8.14); *P*= .201).
Type of arthritis	AHRQ	SR/HTA	n/a	**KSS:** RA patients: greater % improvement versus OA patients (KSS knee, KSS function) (2 studies; mean f/u = 4.5 – 9.8 years) **HSS:** RA patients: greater % improvement versus OA patients (1 study; mean f/u = 6.7 years).
	Bourne (2007)	Prospective cohort	II	**WOMAC**: No relationship between diagnosis (OA versus other) and change in WOMAC scores (mean f/u = 9.5 years). **SF-12:** No relationship between diagnosis (OA versus other) and change in SF-12 physical health scores. **KSS:** No relationship between between diagnosis (OA versus other) and change in KSS Clinical Rating Function scores from baseline.

Summary of risk factors associated with revision after TKA

Risk Factor	Reference	Study Type	LoE	Outcomes
	Dowsey (2009)	Prospective cohort	I	**Periprosthetic infection:** No relationship between diagnosis (OA versus RA) and risk of developing periprosthetic infection (f/u = 12 months).
Comorbidities (Diabetes mellitus, others)	AHRQ	SR/HTA	n/a	**WOMAC:** Number of comorbid conditions: more comorbidities was associated with greater improvements in WOMAC function (but not pain) scores (*P* = .01; *P* = .31, respectively)(1 study; f/u = 6 months).
	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: No relationship between comorbidity and WOMAC scores by multivariable longitudinal regression modeling (*P* = .100); mean f/u = 3.0 years). **SF-36:** Greater comorbidity: less sustained improvement in physical function and role physical scores by multivariable longitudinal regression modeling (*P* = .013, *P* = .005; respectively); mean f/u = 3.0 years).
	Dowsey (2009)	Prospective cohort	I	**Periprosthetic infection:** Diabetes mellitus (DM): significantly higher risk of developing periprosthetic infection (vs no DM) (OR = 6.87 (95% CI, 2.42, 19.56); *P* < .001) (f/u = 12 months). Respiratory disease or smokers: no relationship to risk of developing infection.
Preoperative pain levels	AHRQ	SR/HTA	n/a	**WOMAC:** Greater bodily pain: associated with greater improvements in WOMAC pain and function scores (*P* < .001; *P* = .003, respectively)(1 study; f/u = 6 months); Greater joint pain: associated with greater improvements in WOMAC function scores (*P* < .001)(1 study; f/u = 6 months)
	Singh (2008)	Retrospective cohort	III	**Moderate/severe postoperative pain:** ***2 years and 5 years***: No relationship between preoperative pain levels (moderate to severe) and the risk of having moderate to severe postoperative pain (multivariate analysis: *P* = .53; *P* = .14 at 2 and 5 years, respectively).
Hospital volume	Marlow (2010)	SR	n/a	**Morbidity:** Lowest versus highest volume (definitions varied): Mixed results (7 studies total): 5 studies: increased hospital volume associated with decreased morbidity rates; 2 studies reported no relationship. **Mortality:** Lowest versus highest volume (definitions varied): Mixed results (6 studies total): 3 studies: increased hospital volume associated with decreased mortality rates; 3 studies reported no relationship. **Length of stay:** Lowest versus highest volume (definitions varied): Mixed results (4 studies total): 3 studies: increased hospital volume associated with decreased length of stay; 1 study reported no relationship.
Surgeon volume	Marlow (2010)	SR	n/a	**Morbidity:** Lowest versus highest volume (definitions varied): Mixed results (3 studies total): 2 studies: increased surgeon volume associated with decreased morbidity rates; 1 study reported no relationship. **Mortality:** Lowest versus highest volume (definitions varied): 2 studies reported no relationship. **Length of stay:** Lowest versus highest volume (definitions varied): 1 study: increased surgeon volume associated with decreased length of stay.
Length of	AHRQ	SR/HTA	n/a	**WOMAC:** Increased length of stay: associated with greater improvements in WOMAC function (but not pain)

Summary of risk factors associated with revision after TKA

Risk Factor	Reference	Study Type	LoE	Outcomes
hospital stay				scores (*P* = .03; *P* = .05, respectively)(1 study; f/u = 6 months).
Waiting time	AHRQ	SR/HTA	n/a	**WOMAC:** Increased waiting time: no relationship with improvements in WOMAC function or pain scores (*P* = .86; *P* = .40, respectively)(1 study; f/u = 6 months).
Year of follow-up	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: Greater year of follow-up: less sustained improvement by multivariable longitudinal regression modeling (*P* = .048); mean f/u = 3.0 years). **SF-36:** Greater year of follow-up: no relationship with physical function but less sustained improvement in role physical scores by multivariable longitudinal regression modeling (*P* = .37, *P* = .002; respectively); mean f/u = 3.0 years).
Education	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: No relationship by multivariable longitudinal regression modeling (*P* = .43); mean f/u = 3.0 years). **SF-36:** Lesser education: less sustained improvement in physical function but no relationship with role physical scores by multivariable longitudinal regression modeling (*P* < .001, *P* = .58; respectively); mean f/u = 3 yrs).
SF-36 mental health	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: Poorer mental health: less sustained improvement by multivariable longitudinal regression modeling (*P* < .001); mean f/u = 3.0 years). **SF-36:** Poorer mental health: less sustained improvement in physical function and role physical scores by multivariable longitudinal regression modeling (*P* = .031, *P* = .007; respectively); mean f/u = 3.0 years).
Ethnicity (white)	Gandhi (2010)	Retrospective cohort	III	**WOMAC**: No relationship between ethnicity (white or other) and WOMAC scores by multivariable longitudinal regression modeling (*P* = .074); mean f/u = 3.0 years). **SF-36:** No relationship between BMI and physical function or role physical scores by multivariable longitudinal regression modeling (*P* = .76, *P* = .16; respectively); mean f/u = 3.0 years).

AHRQ: Agency for Healthcare Research and Quality
BMI: body mass index
CI: confidence interval
HSS: Hospital for Special Surgery (outcome measure)
KSS: Knee Society Score (outcome measure)
n/a: not applicable
NR: not reported
OA: osteoarthritis
OR: odds ratio
RA: rheumatoid arthritis
SF-12: Short-Form 12 (outcome measure)
SF-36: Short-Form 36 (outcome measure)
SR/HTA: systematic review/health technology assessment
WOMAC: Western Ontario and McMaster Universities OA index (outcome measure)

Summary of risk factors associated with revision after UKA

Risk Factor	Reference	Study Type	Level of Evidence	Survival or Revision Rates	Relative Risk or *p*-values
Age	W-Dahl (2009)	Swedish Arthroplasty Registry	**II**	7-year revision rate: <55 years: 19% 55-64 years: 13% 65-74 years: 8.6% ≥75 years: 5.7%	• Patients <65 years had a significantly higher risk of revision than patients who were ≥65 years (cumulative revision rate at 7 years was 14% and 7.5%, respectively) • This difference increased with time after surgery Adj HR at 0-6 months = 1.23 (.95-1.6), p = 0.1; Adj HR at 6 months to 1.5 years = 1.8 (1.6-2.1), p< 0.001); Adj HR at ≥1.5 years = 1.96 (1.7-2.2), p< 0.001 • Male and female patients <55 years had a greater risk of revision than male and female patients 55-64 years for the entire follow-up period Adj HR = 1.52 (1.4-1.7), p< 0.001
	Harrysson (2004)	Swedish Arthroplasty Registry	**II**	9.2-year revision rate: <65 years: 22% ≥65 years: 14%	• When controlling for year of operation and gender, the risk of revision in the older group was lower (risk ratio, 0.55; 95% CI, 0.45-0.65; *p* <0.0001)
	Koskinen (2007)	Finnish Arthroplasty Registry	**II**	NR	• Cox regression analysis demonstrated that ≤65 year old patients were at higher risk of revision than patients >65 years of age, controlling for sex and brand of UKA (risk ratio, 1.5, 95% CI, 1.1-2.0; *p* = 0.04)
	No authors (2009)	National Joint Registry of England and Wales	**II**	3-year survival rate (CI) <65 years: 90.4% (89.3-91.3) ≥65 years: 95.3% (94.5-96.0)	NR
	Gioe (2003)	Community-based Implant Registry	**IV**	NR	• Age groups by category (<65 years, 65-74 years, and ≥75 years) had no effect on revision rate (*p* = 0.11)
	Kuipers (2009)	Retrospective Cohort	**II**	5-year survival rate: >60 years: 89.4% <60 years: 77.2%	• Hazard ratio for revision rates comparing younger age to older age was 2.2 (95% CI, 1.1-4.4; *p* = 0.03), controlling for presence of patellofemoral joint OA, body mass index, gender, clinic, individual surgeon, and surgical caseload
	Tabor (2005)	Retrospective Cohort	**III**	Survival rate: <60 years 5 year: 92% 10 year: 92% 15 year: 83% 20 year: 77% ≥60 years 5 year: 95%	NR

Summary of risk factors associated with revision after UKA

Risk Factor	Reference	Study Type	Level of Evidence	Survival or Revision Rates	Relative Risk or *p*-values
				10 year: 89% 15 year: 85% 20 year: 85%	
	Price (2005)	Retrospective Cohort	**III**	10-year survival rate: <60 years: 91% ≥60 years: 96%	• The 10-year survival was 96% and 91% for patients >60 years and <60 years of age, respectively (p = 0.6) • The mean Hospital for Special Surgery (HSS) score for the younger group at 10 years was higher (94 points) than the older group (86 points), p = 0.001) with mean pre-surgical scores of 52 and 57 in the younger and older groups, respectively
Obesity	Kuipers (2009)	Retrospective cohort	**II**	NR	• A body mass index >30 kg/m² did not predict implant survival after UKA in this population, controlling for age, presence of patellofemoral joint OA, gender, clinic, individual surgeon, and surgical caseload (p = 0.08)
	Tabor (2005)	Retrospective cohort	**III**	Survival rate: Obese: 5 year: 100% 10 year: 100% 15 year: 91 % 20 year: 91% Nonobese: 5 year: 93% 10 year: 87% 15 year: 82% 20 year: 77%	• Survival rates were superior for obese patients at all intervals, however statistical significance achieved for 20-year survival only (p = 0.02)
	Heck (1993)	Retrospective cohort	**III**	NR	• Mean weight of patients requiring revision was 90.4 kg and the mean weight of patient with successful arthroplasty was 67 kg (p = 0.0003) • The mean BMIs were 24.7 kg/m² and 32.6 kg/m² in the success and failure groups, respectively (no p-values reported) • Patients that were obese (defined by authors as ≥81 kg) were more likely to undergo revision han those <81 kg (p = 0.0001)

Summary of risk factors associated with revision after UKA

Risk Factor	Reference	Study Type	Level of Evidence	Survival or Revision Rates	Relative Risk or *p*-values
Sex	Harrysson (2004)	Swedish Arthroplasty Registry	**II**	NR	• After multivariate analysis the association between sex (male compared to female) and all-cause revision were not significant (risk ratio, 0.98, 95% CI, 0.85-1.1; *p* = 0.71), adjusting for age and year of operation • The association between sex and revision caused by loosening of components was also not significant (p = 0.23) • Rates by sex were not reported
Sex	Koskinen (2007)	Finnish Arthroplasty Registry	**II**	NR	• Cox regression analysis demonstrated no significant difference in revision risk between males and females, adjusting for age and type of UKA
	No authors (2009)	National Joint Registry of England and Wales	**II**	3-year survival rate (CI) Females: 93% (91.1-93.0) Males: 93.5% (92.6-94.3)	NR
	Gioe (2003)	Community-based Implant Registry	**IV**	NR	• There was no significant association between sex and survival (*p* = 0.9)
	Kuipers (2009)	Retrospective Cohort	**II**	NR	• Cox regression analysis showed that sex was not associated with survival (*p* = 0.11), controlling for age, presence of patellofemoral joint OA, body mass index, clinic, individual surgeon and surgical caseload
	Tabor (2005)	Retrospective Cohort	**III**	Survival rates (CI): Male 5 year: 87% (75-99) 10 year: 79% (64-94) 15 year: 65% (44-87) 20 year: 56% (31-81) Female 5 year: 97% (92-100) 10 year: 95% (89-100) 15 year: 92% (84-100)	• Females has significantly higher survival rates than males at 10 years (*p* = 0.03), 15 years (*p* = 0.04), and 20 years (*p* = 0.0007) • No adjustments made for other potential confounding factors such as age

Summary of risk factors associated with revision after UKA

Risk Factor	Reference	Study Type	Level of Evidence	Survival or Revision Rates	Relative Risk or *p*-values
				20 year: 90% (71-100)	
	Heck (1993)	Retrospective cohort	III	6 year revision rates: Male: 2.4% Female: 3.9%	• The revision rates between male and female were significant ($p = 0.02$) • No adjustments made for other potential confounding factors such as age
Multi-compart-ment	Robertsson (2000)	Swedish Arthroplasty Registry	II	NR	• Patients with a multicompartmental disease, such as rheumatoid arthritis, had much higher revision rates than those with a one compartment disease, osteoarthritis (see Figure in text)
Multi-compart-ment	Kuipers (2009)	Retrospective cohort	II	NR	• After multivariate analysis the presence of patellofemoral OA was associated with decreased risk of revision (Adj HR = 0.3, 95% CI, 0.11-0.89; $p = 0.03$), controlling for age, body mass index, gender, clinic, individual surgeon, and surgical caseload • This amounts to an almost 70% reduction in revision over time • Two or more radiological features of patellofemoral OA were present in 98 of 437 procedures (22.4%) • The agreement between the observers for determining these features was fair (mean kappa – 0.39, standard error = 0.048)
Provider and facility	Koskinen (2007)	Finnish Arthroplasty Registry	II	NR	• There was no association between caseload ($\leq$10 or >10) and revision rates
	Kuipers (2009)	Retrospective cohort	II	NR	• There were no associations between different surgeons ($p = 0.53$), surgical caseload of $\leq$10 or >10 UKA per year ($p = 0.17$), and different hospitals ($p = 0.78$)

Detailed summary of demographics and safety outcomes from Millar study evaluating computer assisted TKA.

Author (Year)	Study Type Years of study	Number of patients/knees Mean age (range) Sex	Diagnosis (%)	Follow up	Tourniquet time (min)	Mean hemoglobin loss (g/dl)	True blood volume loss (ml)
Millar (2010)	Prospective cohort January 2006-January 2007	Computer-assisted TKA N = 61 Mean age: 65 years 30% male Morbidly obese: BMI > 40 kg/m² n = 30 Mean age: 65 years 27% male Non-obese: BMI < 30 kg/m² N = 31 Mean age: 65 years 32% male	NR	100%	Morbidly obese: 92 ± 5 (60-125) Non-obese: 90 ± 6 (60-138) *p* = .16	Morbidly obese: 22 ± 10 (3-35) Non-obese: 17 ± 6 (2-26) *p* = .02	Morbidly obese: 1105 ± 321 (671-1942) Non-obese: 923 ± 276 (521-1642) *p* = .02

APPENDIX H. CLINICAL PEER REVIEWERS

Reviewer	Areas of expertise
Paul A. Manner, MD, FRCSC Assistant Professor University of Washington School of Medicine Department of Orthopaedics	• Orthopedic surgeon • Assistant Professor, University of Washington School of Medicine, Department of Orthopaedics and Sports • Adult reconstruction and arthroplasty
Jason S. Weisstein, MD, MPH, FACS Total joint reconstruction of the hip and knee, and orthopaedic oncology/tumor	• Orthopedic surgeon • Specializes in hip and knee surgery as well as musculoskeletal oncology. • He performs primary and complex revision hip and knee replacement using the latest techniques including minimally invasive knee surgery and total hip resurfacing arthroplasty. • From an oncology perspective, he is an expert at limb salvage, the surgical treatment of bone and soft tissue tumors, orthopaedic conditions arising in cancer patients (i.e., avascular necrosis), and metastatic disease. • Master of Public Health in Epidemiology

Anderson KC, Buehler KC, Markel DC. 2005. Computer assisted navigation in total knee arthroplasty: comparison with conventional methods. *J Arthroplasty* 20:132-8

Forster MC, Bauze AJ, Bailie AG, Falworth MS, Oakeshott RD. 2006. A retrospective comparative study of bilateral total knee replacement staged at a one-week interval. *J Bone Joint Surg Br* 88:1006-10

Reviewer Identification Information

Reviewer Name **Jason Weisstein, MD, MPH, FACS**

INTRODUCTION Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Overview of topic is adequate?
- Topic of assessment is important to address?
- Public policy and clinical relevance are well defined?

Overview of topic is adequate? Yes. This is a well balanced introduction of the topic. The only point that could be clarified is the concept of minimally invasive total knee replacement. Minimally invasive total knee replacement has been used to encompass both partial knee replacement (UKA) as well as knee replacement that is performed through a smaller incision and/or causes less soft tissue trauma. I do believe that to call UKA minimally invasive knee replacement is quite confusing. Unfortunately, not all orthopaedic surgeons agree on the definition of minimally invasive total knee replacement. Still, most experts joint reconstruction surgeons accept that minimally invasive does not merely refer to a smaller incision length than that used in conventional TKA, but also less soft tissue trauma (i.e., quadriceps muscle and tendon are not disrupted).

Topic of Assessment is Important to Address? Yes. Total knee replacement is the most commonly performed joint arthroplasty in the United States. Therefore, the importance of this assessment need not be underestimated. The field of total knee replacement is becoming increasingly confusing as more products and techniques are being unveiled without adequate expert scientific review to legitimize these products and techniques.

Public Policy and Clinical Relevance are well defined? Yes. Both are well defined. Please see answer to prior question.

Specific Comments:

Page 8 – Under Key Question 2), I believe the wording should be Including not Inlclude as in 3) and 4).

Page 15 – Under Key Question 5, second paragraph, line 4. The part after the semicolon (in the Singapore favoring total knee replacement) is confusing and seems to be grammatically incorrect.

BACKGROUND Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Content of literature review/background is sufficient?

Content of literature review/background is sufficient? Yes. This review is exceedingly thorough with regards to the comparisons and data. Table 2 is as detailed a literature review as I have seen in the orthopaedic literature.

Specific Minor Points:

Page 21 has an extra bullet at the bottom of the page

REPORT OBJECTIVES & KEY QUESTIONS Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Aims/objectives clearly address relevant policy and clinical issue?
  Yes. The relevant policy and clinical issues are addressed. The only topic that did not receive any attention is that of minimally invasive total knee replacement. As mentioned here, this does not refer to partial knee replacement, but rather to a procedure that results in less soft tissue trauma. This is a hot topic nowadays as minimally invasive techniques have become increasingly popular. The data to support the utility of this type of TKA is very controversial.

- Key questions clearly defined and adequate for achieving aims? Yes. Questions are excellent.

METHODS Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Method for identifying relevant studies is adequate? Yes. The system which was utilized for identifying relevant studies as well as for evaluating the strength of particular studies was very good.
- Criteria for the inclusion and exclusion of studies is appropriate? Yes, absolutely.
- Method for Level of Evidence (LoE) rating is appropriate and clearly explained? This is where the report excels. I cannot identify a report in the orthopaedic literature that systematically rates manuscripts as well as this review did.
- Data abstraction and analysis/review are adequate? Extremely thorough.

Specific Points:

Page 39, Outcomes. The last sentence is incomplete. Radiographic alignment for computer navigation…….?

Page 44, first sentence. The idea of a follow up period being postoperative is confusing. I would be more specific like 1 day, 1 week, or X number of days postoperative.

RESULTS Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Amount of detail presented in the results section appropriate? Yes.
- Key questions are answered? Yes.
- Figures, tables and appendices clear and easy to read? Yes.
- Implications of the major findings clearly stated? Yes.
- Have gaps in the literature been dealt with adequately? Yes.
- Recommendations address limitations of literature? Yes, definitely.

CONCLUSIONS Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Are the conclusions reached valid? Yes. The conclusions are succinct, well supported, and detail what policy makers should know about the salient issues surrounding TKA.

OVERALL PRESENTATION and RELEVANCY Comments

While reviewing this section please keep the following questions in mind, but please comment on any point:

- Is the review well structured and organized? Yes.
- Are the main points clearly presented? Yes.
- Is it relevant to clinical medicine? Yes, for the reasons stated in part 1.
- Is it important for public policy or public health? This review has very important implications for both public policy and public health. As TKA is multibillion dollar industry, there are direct conclusions that may affect decision making especially from an insurers perspective. Public

health decisions also are impacted by the conclusions especially in light of some of the newer technologies that have come to the forefront of orthopaedics (i.e., computer navigation). Conclusions made by this report may assist public health decisions especially when it comes down to choosing between particular procedures for the same diagnosis, knee osteoarthritis.