Unicompartmental Knee Arthroplasty (UKA): A Review of the Clinical and Cost-Effectiveness and Guidelines for Use

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Context and policy issues:

Unicompartmental knee arthroplasty (UKA) is a surgical procedure that replaces medial and/or lateral compartments of the knee. The most common use of this procedure is in the treatment of medial osteoarthritis (OA) of the knee, although the procedure can be used for other conditions that damage knee functions, such as avascular and aseptic necrosis, knee deformity and refractory osteomalacia. The main surgical alternatives to UKA for OA are total knee arthroplasty (TKA), arthroscopy and osteotomy. For medial osteoarthritis, the major surgical alternatives are TKA and high tibial osteotomy (HTO).

UKA is usually performed by making an approximate three-inch incision to the affected area to remove damaged bone and then the prosthesis is implanted to replace the damaged bone. This is in contrast with TKA that replaces all three (medial, lateral and patellofemoral) compartments of the knee. HTO is a surgical technique that breaks and re-aligns the tibia into a better position so that the force of the body to the knee is transmitted through undamaged cartilage.

In general, the proportion of arthritic knees that are suitable for UKA is approximately five to six percent of the total cases. In Canada, the proportion of UKA among all the knee surgery cases was around eight percent annually between 2002/2003 (fiscal year) and 2004/2005. However, there are interprovincial variations in the number of primary UKA: the proportion of primary UKA among all the knee surgeries in western provinces (British Columbia, Alberta, Saskatchewan and Manitoba) was between 11% (Alberta) and 14% (Manitoba), whereas the proportion for the eastern provinces (Ontario, Quebec, Nova Scotia, New Brunswick and Newfoundland & Labrador) was between one percent (Newfoundland & Labrador) and eight percent (New Brunswick).
During the past decade, UKA has become a more frequently used procedure. This is thanks to the improvement in the quality of implants and the introduction of minimally invasive surgery techniques.\textsuperscript{7,8} Therefore, it is important to understand indications as well as potential short- and long-term risks and benefits to achieve favorable prognosis of UKA. \textsuperscript{7,8,9} UKA is considered to be cheaper, require shorter hospital stay, surgical time and rehabilitation time.\textsuperscript{3,8,9} UKA is also considered to provide greater postoperative range of motion (ROM), fewer complications, lower infection rates and less postoperative pain.\textsuperscript{3,9} However, UKA may require more revisions (i.e. a replacement surgery to replace some or all of the components of a failed knee replacement joint\textsuperscript{10}) over time than TKA.\textsuperscript{9} In addition, indications for UKA have been controversial.\textsuperscript{9,11} UKA is considered to be suitable for those who are over 60 years old, physically inactive and/or do not have history of inflammatory arthritis who failed to respond to non-operative treatments.\textsuperscript{3,8} On the other hand, contraindications for UKA are obesity, heavy physical activities and significant ligament problems. However, others\textsuperscript{9} indicated that obesity should not be used as an exclusion criteria for UKA for elderly patients under certain circumstances. Yet, based on the Canadian Orthopaedic Association, age and weight for patients were not included as indications for UKA.\textsuperscript{8}

Given increasing interests in UKA as a surgical option, decisions may need to be made regarding appropriate and cost-effective implementation of various surgical options by considering trade-offs between advantages and disadvantages of these surgical options.\textsuperscript{12} Therefore, it is important to understand current evidence on clinical effectiveness and cost-effectiveness of these surgical alternatives. In this report, evidences on clinical effectiveness and safety as well as cost-effectiveness of UKA are reviewed. In addition, clinical guidelines of the use of UKA are reported.

**Research questions:**

1. What is the clinical effectiveness and safety of unicompartmental knee arthroplasty?

2. Is there evidence for patient groups that would most benefit from unicompartmental knee arthroplasty and situations where it should not be used?

3. What are the guidelines for use of unicompartmental knee arthroplasty?

4. What is the cost-effectiveness of unicompartmental knee arthroplasty?

**Methods:**

A limited literature search was conducted on key health technology assessment resources, including PubMed, The Cochrane Library (Issue 2, 2008), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international HTA agencies, and a focused Internet search. Results include articles published between 2003 and July 2008, and are limited to English language publications only. This search was supplemented by hand searching the bibliographies of selected papers. No filters were applied to limit the retrieval by study type.

HTIS reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews and meta-analyses are presented first. These are followed by economic evaluations, randomized controlled trials (RCTs), observational studies and evidence-based guidelines.
Summary of findings:

Three systematic reviews and six additional recent observational studies were identified. Two economic evaluation studies and one consensus guideline were also found. No health technology assessment reports or additional RCTs were identified.

Systematic reviews

Of the three systematic reviews retrieved,\textsuperscript{7,8,13} two reports were with respect to the use of UKA for osteoarthritis (OA)\textsuperscript{7,8} and one report was with respect to the use of UKA for osteonecrosis.\textsuperscript{13} These systematic reviews are further detailed in Appendix 1.

The objective of the systematic review by Griffin et al.\textsuperscript{7} was to assess the safety and efficacy of UKA compared with TKA and HTO based on studies published between 1988 and 2004. The study reviewed the use of primary UKA for patients diagnosed with medial or lateral unicompartmental OA of the knee, excluding patients with rheumatoid arthritis. Only primary TKA and HTO associated with unicompartmental OA were considered as comparisons. Outcomes of interests were: perioperative and postoperative morbidity, mortality and other factors (e.g. blood transfusion requirement, operation time), prosthesis survival, functional outcomes, patient recovery (e.g. length of hospital stay), patient satisfaction, and cost/resource use. A total of 14 studies were reviewed. Eight studies (one RCT and seven observational studies) compared UKA versus TKA, and five studies (two RCTs and three observational studies) compared UKA versus HTO. One observational study compared total clinical costs of UKA, TKA and HTO. The proportion of revision (up to 10 years) between UKA and TKA was comparable. However, the proportion was lower for HTO than for UKA. The three procedures showed equivalent post-operative knee function and pain. Postoperative ROM was better for UKA than for TKA. UKA required shorter hospital stay than TKA. The length of hospital stay was comparable between UKA and HTO. Several studies assessed the safety issue. Based on results from these studies, the incidence of deep vein thrombosis (DVT) was higher for UKA than for TKA and the incidence of DVT and wound complications was higher for HTO than for UKA. Pooled analyses were not conducted due to mixed study designs and little comparability of study results. The authors concluded that UKA was at least as safe and efficacious (with respect to knee functioning) as TKA and HTO. However, the author also concluded that evidence on knee survival among the three methods was still ambiguous.

Ontario Ministry of Health and Long-Term Care\textsuperscript{8} compared the effectiveness and safety of UKA and TKA based on studies published between 1998 and 2003. Studies were included for review if at least 80% of patients recruited in the study had osteoarthritis and if at least one of the outcomes of interest was included. The main outcomes of interests were pain and functional scores. Only four relevant studies were cited (one RCT, two observational studies, one retrospective review). Of these, three of them have been discussed in Griffin et al.\textsuperscript{7}. Consistent with findings in Griffin et al.\textsuperscript{7}, the authors concluded that UKA seemed to be as effective as TKA. In addition, UKA required shorter hospital stay and faster recovery than TKA.

Myers et al.\textsuperscript{13} provided a comprehensive review of the literature regarding TKA for the treatment of secondary or spontaneous osteonecrosis and UKA for the treatment of spontaneous osteonecrosis. Number of revisions and global functional outcomes were primary measures of interest. The following inclusion criteria was used for study selection: studies published on or after October 2005, contained primary UKA for spontaneous osteonecrosis with outcomes of interest and consisted of ≥ 90% of patients with primary TKA or UKA for either secondary osteonecrosis and/or spontaneous osteonecrosis. In total, three studies (two observational...
studies and one case study) assessed both UKA and TKA for spontaneous osteonecrosis of the knee, and another three studies (one observational study and two case studies) assessed TKA only. Two studies (one observational and case studies each) assessed UKA only. The review conducted pooled analyses (based on 148 knees for TKA and 64 knees for UKA). Comparisons of UKA and TKA for spontaneous osteonecrosis patients showed higher percentages of revision UKA (13%; range: 0%-50%) than for TKA (3%; range: 1%-33%). Overall outcome of TKA was also better than UKA: weighted averages of “good” and “poor” outcomes for TKA were 92% (range: 67%-100%) and 6% (range: 0%-33%), respectively, whereas they were 90% (range: 50%-100%) and 16% (range: 0%-50%) for UKA. The author concluded that postoperative outcomes for TKA were better than those for UKA for the treatment of spontaneous osteonecrosis with respect to functional scoring and revision. However, the author also noted that unfavorable results against UKA may be due to patient heterogeneity. Only one study in their review provided excellent outcomes after UKA and it was the only study that selected patients following established indications of UKA for spontaneous osteonecrosis.

Economic evaluations

The economic studies that were identified were conducted in the US and compared cost-effectiveness of UKA versus TKA.

Solver et al.\textsuperscript{12} assessed cost-effectiveness of UKA compared with TKA for elderly patients from the US Medicare payer’s perspective. A Markov model was constructed for a theoretical cohort of 78-year old patients with unicompartmental arthritis for whom medical management had failed. The model examined life-time cost-effectiveness of UKA. Health states considered were perioperative death, revisions (septic or aseptic), postoperative death and well states (well with UKA, TKA or revision). Appropriate utility score\textsuperscript{i} was assigned to each health state based on literature reviews. Costs of UKA, TKA and revision arthroplasties consisted of surgery and professional (surgeon and anaesthetist) fees, which were the national average of Medicare reimbursements for UKA and TKA (in 2005 US dollars). Both costs and outcomes were discounted at 3% annually. The model was based on a number of general assumptions:

- Revision costs and utilities are same for UKA and TKA
- All patients with infection were assumed to have a revision arthroplasty
- Mortality rates for those who survived UKA or TKA were same as age-adjusted mortality rates for general population
- Revision arthroplasty, if required, was conducted only once for each patient
- Due to lack of data, the annual septic revision were assumed to be 1% for TKA and 1.5% for UKA after 10 years
- Utility of initial postoperative period for patients who underwent UKA and TKA were the same

Based on the base-case scenario, on average, UKA was cheaper yet provided greater quality-adjusted life year (QALY) gain. The average cost was slightly lower for UKA (US$13,100) than

\textsuperscript{i} “Good” outcome was defined as knees that met all the following criteria: no revision, no ominous radiographic signs, high postoperative functional scores (average Knee Society score $\geq$ 70 points or Hospital for Special Surgery score $\geq$ 70 points or average Knee Society knee score $\geq$ 80 points); “Poor” outcome refers to knees that met one of the following criteria: revision required for any reasons, ominous radiographic signs, overall Knee Society score< 60.

\textsuperscript{ii} Utility scores describe the level of health states as indices generally ranging from 0.00 (dead) to 1.00 (perfect health). Utility score for each health state is used to calculate quality-adjusted life years (QALYs).
for TKA (US$13,300) and the QALY gain was slightly greater for UKA (5.66 QALYs) than for TKA (5.61 QALYs). One-way sensitivity analyses (based on a cost-effectiveness threshold of $50,000/QALY) indicated that the base-case results were sensitive to revision, costs, perioperative mortality and infection rates and utilities. In particular, TKA was cost-effective if one of the following conditions is met:

- Annual revision for UKA will be at least 4% (which the authors considered as quite high given current practices)
- Average total costs of UKA will be higher than US$13,500 or the costs of TKA will be lower than US$8,500
- Revision cost will be greater than US$116,000

On the other hand, TKA is not cost-effective even though annual revision of TKA becomes 0% (no failure). The author concluded that UKA and TKA showed similar cost-effectiveness for the elderly population. However, results are sensitive to changes in a number of factors incorporated in the decision models, particularly with respect to prosthesis survival and surgery costs.

Soohoo et al.\textsuperscript{14} compared cost-effectiveness of UKA as an alternative to TKA for patients with medial or lateral unicompartmental arthritis. A decision model was developed targeting 65-year old unicompartmental OA patients with a time horizon of 18 remaining life years. Health states considered were complication (infection and death), surgery and postoperative recovery, revision TKA and resection arthroplasty. Both costs (measured in 1998 US dollars) and outcomes were discounted at 3\% annually. The analyses were based on the societal perspective but restricted to those that directly affected the target population. Data on transition probabilities and utilities were obtained from a review of previous studies. Cost data (including surgery and physician’s costs) were obtained from Medicare- and Medicaid-based database reported in 1998. Base-case scenario was based on the following assumptions:

- The survival of UKA and TKA were 12 and 15 years, respectively
- Postoperative utility was 0.90 (on a scale of 0.00 to 1.00) for both UKA and TKA
- Revision TKA (after the failure of UKA or TKA) had utility of 0.60
- Utility for surgery and postoperative recovery was 0.50

Using the base-case scenario, UKA was slightly more cost-effective than TKA; the QALY gain for UKA was greater than that for TKA by approximately 0.02 QALYs (i.e. approximately 7 days of life with full health) with an additional cost of approximately US$5 (i.e. ICER = $277/QALY). One-way sensitivity analyses were conducted using $50,000/QALY as the cost-effectiveness threshold level. Results from sensitivity analyses indicated that the cost-effectiveness of UKA decreased as the survival of UKA became lower than that of TKA. In addition, UKA was more cost-effective as long as patients who underwent UKA experience higher postoperative utility than the TKA patients did. Finally, UKA was no longer cost-effective if the total cost of UKA was more expensive than that for TKA. In conclusion, UKA was found to be cost-effective as long as the prosthesis survival, postoperative functional outcomes and costs are comparable to those for TKA. On the other hand, UKA was no longer cost-effective if the procedure resulted in lower utilities compared with TKA or the prosthesis survival of UKA is shorter than 12 years.
Observational studies

Of the six observational studies, two were prospective studies\textsuperscript{15,16} and the remaining four were retrospective studies.\textsuperscript{17-20} Five studies compared UKA and TKA for patients with OA.\textsuperscript{15-18,20} One study compared UKA between patients with OA and those with osteonecrosis.\textsuperscript{19} Details of these studies are summarized in Appendix 2.

Furnes et al.\textsuperscript{16} compared the early failure rate and the failure mechanisms of primary cemented UKA with those of primary cemented TKA. The study utilized 11-year follow-up data from Norwegian Arthroplasty Registry for all Norwegian hospitals from January 1994 to December 2004. The study prospectively analyzed a total of 2,288 cases and 3,032 cases of UKA and TKA. Survival of prostheses and various causes of failure leading to prostheses revisions were assessed.

Ten-year prosthesis survival rate for TKA patients were significantly higher than for UKA patients of all ages (i.e. between 17 and 92 years old). Stratified analyses by age group also showed significantly higher prosthesis survival rate for TKA patients (p<0.05) aged between 61 and 69 years old. Eleven-year revision risks from all causes were also significantly higher for UKA for patients of all ages; patients who underwent UKA were twice as likely to require revisions compared with patients with TKA (relative risk (RR) = 2.0; p<0.05). In addition, relative risks of revision were greater for older age groups. The authors also assessed various reasons for revisions. In particular, UKA was associated with more revisions due to pain (RR = 11.3, p<0.001), aseptic loosening of the tibial component (RR = 1.9; p<0.001) or femoral component (RR = 4.8; p<0.001), and periprosthetic fracture (RR = 3.2; p=0.02). In contrast, risk of revisions due to infection was almost 70% lower for UKA than for TKA (p=0.01). In general, the authors found that UKA was inferior to TKA for all ages based on the 11-year follow-up data.

Issac et al.\textsuperscript{15} compared UKA and TKA with respect to changes in proprioceptive performance and functional outcomes for those who were diagnosed with primary end-stage osteoarthritis (OA). The study was based on 34 patients aged between 50 and 75 years old. Seventeen patients underwent medial UKA and another 17 underwent TKA. Proprioception was measured by joint position sense (in degrees), postural sway (in square millimeters), and postural path (in millimeters)\textsuperscript{iii}. The study also measured functional outcomes using previously validated Oxford Knee Score questionnaire (OKS)\textsuperscript{iv}. All the outcomes were measured at a day before surgery (baseline) and 6-months postoperatively for both operated and contralateral knees.

Both UKA and TKA patient groups showed significant improvements in proprioception. In particular, the percentage of improvement in sway area and sway path were significantly greater for the UKA group than for the TKA group (p=0.01 and p=0.03, respectively). With respect to functional outcomes, the two groups did not show any significant difference in the size of increase in average OKS scores (p=0.22). Therefore, patients who underwent UKA performed better regarding postural control (measured by postural sway); the magnitude of postoperative

\textsuperscript{iii} Joint position sense is measured as the magnitude of errors (in degrees) in reproducing the targeted joint angle. Postural sway area or postural sway path were measured as the total area (in square millimeters) or distance (in millimeters) of centre of mass or pressure displacement, respectively.

\textsuperscript{iv} OKS is a 12-item self-reporting questionnaire that assesses the ability to perform day-to-day activities. In the original OKS, each item is scored from 1 (highest functioning) to 5 (lowest functioning). Score from each item is then combined to produce a total function score ranging from 12 (highest functioning) to 60 (lowest functioning).\textsuperscript{21} However, in Issac et al.,\textsuperscript{15} a modified scoring of OKS was used: the total score ranged from 0 (lowest functioning) to 48 (highest functioning).
improvement in postural sway measures for UKA was more than twice of that for TKA. One study consideration was with respect to the accuracy of estimated effects. Although a formal sample size calculation was conducted *a priori*, reported estimates should be interpreted with caution. Due to small sample size, potential differences in patient characteristics other than outcomes of interest may impact the accuracy of the estimates.

Confalonieri *et al.* (2007)\(^{20}\) compared clinical and non-clinical outcomes for matched paired patients over 60 years old with isolated medial compartment knee arthritis with patients who were treated by UKA and computer-assisted TKA (CA-TKA). *A priori* hypothesis was that UKA would provide better mid-term outcomes than CA-TKA for these patients. Thirty-two patients who underwent a medial UKA between February 2001 and September 2001 were matched with those who underwent CA-TKA between August 1999 and September 2002. The average follow-up for UKA and CA-TKA groups were 48 months and 49 months, respectively. Clinical outcomes were measured using Knee Society Score (KSS; consisting of knee score and function score)\(^{v}\), the Italian Orthopaedic UKR Uses Group (GIUM) questionnaire\(^{vi}\), hip-knee-ankle (HKA) angle and frontal tibial component (FTC) angle.\(^{vii}\) The study also assessed the safety issues (frequency of revisions and complications). Non-clinical outcomes of interest were surgical time and hospital stay. All the outcomes were measured preoperatively and at the latest follow-up periods for each patient.

Patients who underwent UKA scored better than those who underwent CA-TKA in terms of average postoperative functional scores (p=0.02) and GIUM scores (p=0.01). However, results of HKA and FTC angles were significantly worse for UKA than for CA-TKA (p<0.001). The study did not observe revisions or complications for UKA group, whereas 11 CA-TKA patients required blood transfusions. UKA required shorter surgical time as well as shorter hospital stay compared with CA-TKA (p<0.001). Overall, UKA was found to be superior to CA-TKA in terms of functional outcomes, safety and resource use for this selected senior patient group.

Amin *et al.*\(^{18}\) assessed whether or not active ROM, Knee Society Score (KSS) and five-year survival rate for unilateral UKA were similar to those for unilateral TKA. The analyses included 54 patients who underwent primary UKA and 54 retrospectively matched patients who underwent primary TKA. All patients had osteoarthritis of the knee. Those who had bilateral procedures were excluded from the analyses to avoid dependence of knees that complicates statistical analyses. Patients were followed-up at six-, 18-, 36- and 60-months postoperatively.

On average, postoperative ROM was better for UKA patients than TKA patients. However, consistent with the finding from Furnes *et al.*,\(^{16}\) five-year survivorship (from any reason) was better for TKA (100%) than for UKA (86%) (p=0.01). No significant difference was found with respect to postoperative functional scores between the two groups. At five years postoperatively, a small percentage of patients who underwent UKA (11%) experienced complications such as pain, infection and recurrent dislocation of the mobile meniscal implant that required a revision surgery. The authors concluded that TKA generated better mid-term outcomes with respect to prostheses survival and rate of complications. However, UKA seemed to provide comparable functional outcomes and better ROM.

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\(^{v}\) Knee score measures pain, range of motion and stability. Function score measures walking and stair climbing capacities. Total scores range from 0 (lowest functioning) to 100 (highest functioning) for each score.\(^{22}\)

\(^{vi}\) GIUM is a 10-item condition-specific measure for assessing pre- and postoperative functional outcomes of UKA. Scores range between 0 (lowest functioning) to 100 (highest functioning).\(^{23}\)

\(^{vii}\) The ideal degrees for HKA and FTC angles were set at 180 and 90 degrees, respectively.
Walton et al.\textsuperscript{17} compared differences in patient-reported outcomes with respect to physical functioning as well as the ability to return to sports and work activities for those who underwent UKA or TKA. Patients with isolated medial compartment osteoarthritis of the knee were recruited retrospectively. UKA patients were recruited two years after the recruitment of the TKA patients due to the availability of UKA prostheses at the study site. The study assessed outcomes of 183 UKA and 142 TKA patients. Outcomes of interests were level of functioning (measured by Oxford 12-item knee score (OKS) and a modified Grimby score\textsuperscript{viii}) and postoperative sports activity. Patients were asked types of sport activity (e.g. walking, swimming, gym work) they participated in immediately prior to the surgery and at the time of follow-up assessment. The study also assessed the timing of return to sport activities. In addition, patients were asked about pre- and postoperative employment status.

Overall, UKA was found to provide better patient-reported outcomes with respect to functioning and the ability to resume sport activities. After the surgery, levels of functioning were significantly better for UKA than for TKA patients; both average OKS and modified Grimby scores indicated better functioning for patients following UKA compared with those following TKA (p<0.05 for both comparisons). Based on results from Grimby scores for the two groups, at the time of follow-up, on average, patients following UKA were able to conduct less than 2 hours of moderate exercise. In contrast, patients following TKA were only able to conduct occasional light exercise at the time of follow-up. Patients in the UKA group were more likely to increase or maintain their sport activities after the surgery compared with those in the TKA group. Moreover, patients in the TKA group were more likely to reduce their sport activities postoperatively. Regarding employment, patients in the UKA group were more likely to return to work after the surgery compared with those in the TKA group (p=0.044). However, this result should be interpreted with caution because more patients in the TKA group were retired (78\%) prior to the surgery compared with those in the UKA group (54\%). Therefore, this difference may have resulted in favorable results to the UKA group. In fact, after the analysis was restricted to those who were of working age (<65 years old), the study did not find significant difference for the same comparison (p=0.14).

Langdown et al.\textsuperscript{19} compared outcomes following mobile-bearing minimally invasive medial UKA between patients with end-stage focal spontaneous osteonecrosis of the knee and those with primary medial compartment osteoarthritis. The study compared functional outcomes for 28 prostheses for focal spontaneous knee osteonecrosis with those for 28 prostheses for primary medial compartment OA. Patients were matched based on four factors: age, sex, time since surgery, and the location where the data were collected. OKS questionnaire was administered prior to the surgery. Follow-up assessment was conducted at the latest available time point for each patient. Average length of follow-up was 5.2 years (range: 1 to 13) for patients with osteonecrosis and 4.8 years (range: 1 to 13) for patients with OA. For those who underwent bilateral implants, only one knee (with worse outcome) was subject to the analyses to avoid dependence of the outcomes on statistical analyses.

Postoperative functioning (measured by OKS) was slightly better for patients with osteonecrosis (38 points) than for patients with OA (40 points). However, the difference was not statistically significant (p>0.1). As well, during the follow-up period, no patient required a revision surgery for both patient groups. Therefore, the authors concluded that medial UKA was reliable for spontaneous focal osteonecrosis in the short to medium term. Small sample size was one of

\textsuperscript{viii} See footnote ii for details about OKS. The Grimby score measures the level of physical activity of the elderly patients. The Grimby scores used in Walton et al.\textsuperscript{17} ranged from 1 (barely any physical activity) to 6 (regular, hard exercise).
the study considerations. Therefore, the observed non-significant difference in functional outcomes may be due to small sample size. In addition, because of no incidence of prostheses failure (due to, in part, small sample size), the study was not able to compare prostheses survivals between the two groups.

Guidelines

One recently published international consensus guideline for the management of hip and knee osteoarthritis was identified. The guideline was developed by the Osteoarthritis Research Society International (OARSI) based on a systematic review of existing guidelines associated with the management of hip and knee osteoarthritis published between 1945 and 2006. The authors adopt Shekelle et al. to assess the level of evidence for each recommendation. In addition, the strength of recommendation (SOR) measure was developed to reflect clinical effectiveness of each recommendation. SOR was obtained by asking members of the guideline development group to rate the effectiveness (instead of efficacy) of each recommendation using a visual analogue scale (VAS: on a 0 to 100 scale). Each member scored SOR by considering factors such as efficacy, safety, cost-effectiveness, experience, patient tolerance and acceptability of each procedure. Average SOR was calculated for each recommendation. Higher SOR indicates stronger recommendation.

Of the 25 general, non-pharmacological, pharmacological and surgical treatment recommendations, two relevant recommendations are:

- Patients with hip or knee OA who are not obtaining adequate pain relief and functional improvement from a combination of non-pharmacological and pharmacological treatment should be considered for joint replacement surgery. Replacement arthroplasties are effective, and cost-effective interventions for patients with significant symptoms, and/or functional limitations associated with a reduced health-related quality of life, despite conservative therapy. [Level of evidence: III (At least one non-experimental descriptive study); SOR=96% (Confidence interval (CI): 94%, 98%)]

- Unicompartmental knee replacement is effective in patients with knee OA restricted to a single compartment. [Level of evidence: IIb (At least one well-designed quasi-experimental study); SOR=76 (CI: 64%, 88%)]

Limitations

It is important to recognize several potential limitations in systematic reviews and observational studies. General conclusions about the efficacy and safety of UKA compared with TKA and HTO were limited at least due to the following issues:

- Only a handful RCT and observational studies were found. In addition, the quality of most of these studies were moderate to low due to small sample size, poor randomization, failure in controlling for baseline patient heterogeneities, high loss to follow-up rate and short follow-up period

- Some studies included in the systematic reviews were also relatively old (e.g. conducted in the mid-1990s). Considering rapid changes in prosthesis technology, these earlier studies may not provide useful policy implications

- There were variations in types of devices with respect to manufacturers, bearing (fixed versus mobile) and flaxation (cemented versus uncemented) used across studies. For instance, Griffin et al. included studies based on 14 different types of UKA and 10 different types of TKA prostheses. Although the investigation of potential differences in

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clinical outcomes across different types of prostheses is beyond the scope of this report, such a difference may affect the overall findings

- A number of studies did not report detailed baseline patient characteristics, making it difficult to assess generalizability of studies and potential selection bias
- Some studies included a broader range of patient populations (e.g. with respect to age and other demographic and health risk characteristics), most of the analyses did not compare efficacy of UKA among patients with various indications. Therefore, implications regarding differential indications for UKA, TKA and HTO (e.g. with respect to age, gender) were not clear
- A handful studies assessing the effectiveness of UKA for osteonecrosis were also found. However, these studies were based on small sample size and short follow-ups

There are also several potential study considerations for the economic studies:

- Potential complications other than infection seemed not to be explored explicitly in both studies. For example, one of the major complications of TKA and UKA are deep vein thrombosis (DVT) and a higher incidence of DVT were reported in Griffin et al.\textsuperscript{7} Therefore, potential differences in the incidence of DVT may impact study results
- Potential cost savings from the use of UKA (e.g. shorter hospital stay and rehabilitation, lower prosthesis costs) were not considered due to data availability.\textsuperscript{14} Therefore, UKA may be more cost-effective compared to TKA had these factors have been considered in the analyses

Conclusions and implications for decision or policy making:

Based on results from systematic reviews and other observational studies, UKA appears to be superior to TKA for middle-aged to senior patients with knee osteoarthritis with respect to postoperative range of motion, incidence of complications and resource use (i.e. shorter surgical time, hospital stay and rehabilitation days). Postoperative physical functioning and pain level for patients who underwent UKA were found to be at least as good as those who underwent TKA. Short- to mid-term UKA prostheses survival was found to be worse than that for the TKA prostheses. In addition, based on results from one systematic review for osteonecrosis patients,\textsuperscript{13} TKA appeared to be superior to UKA for spontaneous osteonecrosis patients regarding overall postoperative outcomes, functional scores and revision.

However, these conclusions were limited by lack of evidence obtained from high quality studies. Based on clinical studies and a consensus guideline, little information was found with respect to indications for UKA. UKA seems to be efficacious in patients with single compartment OA based on a consensus guideline. Based on systematic reviews and observational studies, UKA also seems to be efficacious for the elderly population. However, evidences for other indicators such as gender, BMI or disease severity are not clear due to lack of studies reporting separate outcomes by indicators. As well, very few studies assessed UKA for patients with osteonecrosis. Based on a review of two economic studies, UKA was slightly more cost-effective than TKA for the elderly patient population as long as prostheses survival and costs are comparable between the two techniques for the targeted population. However, the result was sensitive to a number of factors. UKA was no longer cost-effective if postoperative utility, UKA prosthesis survival or the cost of UKA was greater than TKA, or the cost of revision surgery increased. Further well-designed clinical and cost-effectiveness studies for various indications would be useful in helping proper patient selection and devise use.
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## Appendices:

### Appendix 1: Summary of systematic reviews

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| To assess the safety and efficacy of UKA compared with TKA and HTO | Intervention  
  - UKA, TKA and HTO | UKA vs. TKA  
  Postoperative knee function and pain: comparable  
  Range of motion: UKA better  
  Hospital stay: UKA shorter  
  10-year survival: Comparable  
  Complications: UKA fewer |
|                          | Inclusion criteria  
  - Human studies  
  - Patients diagnosed with unicompartmental OA of the knee  
  - Excluding rheumatoid arthritis  
  - Primary UKA, TKA and HTO  
  - TKA and HTO associated with unicompartmental OA  
  - Studies published between 1988 and 2004 | |
|                          | Types of included studies  
  UKA vs. TKA  
  - 1 RCT; 7 observational studies | |
|                          | UKA vs. HTO  
  - 2 RCTs; 3 observational studies | |
|                          | Follow-up  
  UKA vs. TKA: 6 months to 12.8 years  
  UKA vs. HTO: 6 months to 17 years | |
| **Ontario Ministry of Health and Long-Term Care** | | |
| To assess the effectiveness and safety (with respect to revisions and complications) of UKA and TKA | Intervention  
  - UKA and TKA | |
|                          | Inclusion criteria  
  - At least 80% of the included patients in a study have diagnosed osteoarthritis  
  - At least one of the targeted outcomes are reported  
  - Abstract or full paper  
  - Systematic reviews, RCTs, non-RCTs and case series published since 1995  
  - English language articles only | |
|                          | Types of included studies | |

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*Unicompartmental Knee Arthroplasty* 15
<table>
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<tr>
<th>Author (Year) objectives</th>
<th>Design</th>
<th>Conclusions and study considerations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1 RCT; 2 observational studies; 1 retrospective review</td>
<td>interventions)</td>
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<tr>
<td></td>
<td>Follow-up Not reported</td>
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<tr>
<td>Myers et al.\textsuperscript{13}</td>
<td><strong>Intervention</strong></td>
<td>• Post-operative functional outcomes and revision rates were better for TKA than for UKA</td>
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<td></td>
<td>• UKA and TKA</td>
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<td></td>
<td><strong>Inclusion criteria</strong></td>
<td><strong>Study considerations</strong></td>
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<tr>
<td></td>
<td>• Studies regarding primary UKA for spontaneous osteonecrosis with outcomes of interest</td>
<td>• Lack of evidence</td>
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<td></td>
<td>• Studies published on or after October 2005 that consist of cohorts of ≥ 90% of patients with primary TKA or UKA for spontaneous osteonecrosis</td>
<td>• Lack of studies with long-term follow-up</td>
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<td></td>
<td><strong>Types of included studies</strong></td>
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<td></td>
<td>UKA vs. TKA</td>
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<tr>
<td></td>
<td>• 2 observational studies; 1 case study UKA only</td>
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<td></td>
<td>• 1 observational study; 1 case study TKA only</td>
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<td></td>
<td>• 1 observational study; 2 case studies</td>
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<tr>
<td></td>
<td><strong>Follow-up</strong></td>
<td>2.5 to 9 years</td>
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</table>

HTO: high tibial osteotomy; OA: osteoarthritis; RCT: randomized controlled trial; TKA: total knee arthroplasty; UKA: unicompartmental knee arthroplasty

Unicompartmental Knee Arthroplasty
### Appendix 2: Summary of observational studies

<table>
<thead>
<tr>
<th>Author (Year), Study design</th>
<th>Interventions</th>
<th>Results</th>
<th>Conclusions and study considerations</th>
</tr>
</thead>
</table>
| Furnes et al.\(^{16}\) Prospective | **UKA** (primary cemented UKA) (n = 2288) **TKA** (primary cemented TKA) (n = 3032) | 10-year survival rate (95% CI)  
All ages  
**UKA** = 80.1% (76.6, 84.2)  
**TKA** = 92.0% (90.4, 93.6)  
Age ≤ 60  
**UKA** = n/a\(^{†}\)  
**TKA** = 85.5% (81.0, 90.0)  
60 < Age < 70  
**UKA** = 78.8% (71.4, 86.2)  
**TKA** = 91.1% (88.0, 94.2)  
Age ≥ 70  
**UKA** = 89.6% (85.9, 93.3)  
**TKA** = 94.1% (92.5, 95.7) | Survival of UKA is inferior to that of TKA for all age groups  
Major reasons for revision UKA are due to femoral or tibial loosening, periprosthetic fracture and pain |
| | | 11-year revision risk from all causes\(^{‡}\)  
All ages: RR = 2.0 (1.6, 2.5)  
Age ≤ 60: RR = 1.7 (1.1, 2.6)  
60 < Age < 70: RR = 2.5 (1.6, 3.9)  
Age ≥ 70: RR = 1.9 (1.2, 2.7) | |
| Issac et al.\(^{15}\) Prospective | **UKA** (medial UKA) (n = 17) **TKA** (n = 17) | Joint position sense  
**Operated leg**  
**UKA** = 21% improvement (p<0.001)\(^{††}\)  
**TKA** = 17% improvement (p<0.001)  
**Contralateral leg**  
**UKA** = 7% improvement (p=0.013)  
**TKA** = 2% improvement (p=0.07)  
Sway area  
**Operated leg**  
**UKA** = 57% improvement (p<0.001)  
**TKA** = 8% improvement (p>0.05)  
**Contralateral leg**  
**UKA** = 16% improvement (p<0.01)  
**TKA** = 12% improvement (p>0.05)  
Sway path  
**Operated leg**  
**UKA** = 39% improvement (p<0.001)  
**TKA** = 18% improvement (p<0.01) | Both UKA and TKA showed significant improvement in static and dynamic proprioception  
Major difference in outcome between UKA and TKA is with respect to a better dynamic proprioception of UKA compared with TKA  
Only age was controlled for; |
<table>
<thead>
<tr>
<th>Author (Year), Study design</th>
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<tbody>
<tr>
<td><strong>Confalonieri et al.</strong>&lt;sup&gt;20&lt;/sup&gt;</td>
<td><strong>UKA</strong> (medial UKA) (n = 32) <strong>TKA</strong> (computer-assisted TKA) (n = 32)</td>
<td><strong>Contralateral leg</strong>&lt;br&gt;UKA = 12% improvement (p&lt;0.05)&lt;br&gt;TKA = 4% improvement (p=0.22) <strong>Results</strong>&lt;br&gt;Average OKS (lowest function = 0; highest function = 48)&lt;br&gt;UKA&lt;br&gt;Baseline = 23.3 (SD: 5.92)&lt;br&gt;6-month postoperative = 38.2 (SD: 2.63)&lt;br&gt;(Size of improvement = 14.9; p&lt;0.001)&lt;br&gt;TKA&lt;br&gt;Baseline&lt;sup&gt;‡‡&lt;/sup&gt; = 21.4 (SD: 5.58)&lt;br&gt;6-month postoperative = 35.5 (SD: 3.15)&lt;br&gt;(Size of improvement = 14.1; p&lt;0.001)</td>
<td>other potential confounders were not taken into account for the analyses Small sample size</td>
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<td><strong>Follow-up:</strong>&lt;br&gt;Minimum of 48 months for UKA [average follow-up = 54.7 months (48 to 67)]&lt;br&gt;Minimum of 49 months for TKA [average follow-up = 53.7 months (49 to 73)]</td>
<td><strong>Average KSS knee scores (lowest function=0; highest function =100)</strong>&lt;br&gt;UKA&lt;br&gt;Preoperative = 45.1 (SD: 3.1)&lt;br&gt;Postoperative&lt;sup&gt;§&lt;/sup&gt; = 80.5 (SD: 5.1)&lt;br&gt;(Size of improvement = 35.4)&lt;br&gt;TKA&lt;br&gt;Preoperative = 43.9 (SD: 3.1)&lt;br&gt;Postoperative = 78.4 (SD: 4.7)&lt;br&gt;(Size of improvement = 34.5)&lt;br&gt;Difference in the postoperative KSS knee scores between TKA and UKA = 2.1 (p=0.08)</td>
<td>UKA showed superior functioning than computer-assisted TKA for the treatment of isolated primary medial compartment knee arthritis for those aged 60 and older Computer-assisted TKA requires longer surgical time and hospital stay than UKA</td>
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<td><strong>Age range:</strong>&lt;br&gt;60 to 83 years old</td>
<td><strong>Average KSS functional scores (lowest function=0; highest function =100)</strong>&lt;br&gt;UKA&lt;br&gt;Preoperative = 49.7 (SD:3.59)&lt;br&gt;Postoperative = 83.5 (SD:9.3)&lt;br&gt;(Size of improvement=33.8)&lt;br&gt;TKA&lt;br&gt;Preoperative = 48.5 (SD:3.2)&lt;br&gt;Postoperative = 78.8 (SD:7.8)&lt;br&gt;(Size of improvement=30.3)&lt;br&gt;Difference in the postoperative KSS functional scores between TKA and UKA = 4.7 (p=0.02)</td>
<td>Differential length of follow-up across patients were not taken into account in analyses</td>
<td></td>
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<tr>
<td>Author (Year), Study design</td>
<td>Interventions</td>
<td>Results</td>
<td>Conclusions and study considerations</td>
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<td>Amin <em>et al.</em>(^{18}) Retrospective matched (matching factors = age, sex, BMI, preoperative active ROM, preoperative KSS scores)</td>
<td><strong>UKA</strong> (unilateral UKA) (n = 54) <strong>TKA</strong> (unilateral TKA) (n = 54) <strong>Follow-up:</strong> Average follow-up</td>
<td>Average GIUM score (postoperative scores only) (lowest function =0; highest function =100) <strong>UKA</strong> = 76.00 (SD: 4.9) <strong>TKA</strong> = 73.03 (SD: 4.8) (p=0.01)(^{\ddagger\ddagger}) Deformity <em>Average HKA (in degree varus)</em> <strong>UKA</strong> = 176.8 (range: 174-182) <strong>TKA</strong> = 179.3 (range: 177-182) (p&lt;0.001) <em>Average (FTC) (in degree)</em> <strong>UKA</strong> = 86.9 (range: 84-90) <strong>TKA</strong> = 89.4 (range: 87-92) (p&lt;0.001) Average surgical time <strong>UKA</strong> = 51.5 minutes (SD: 9.5) <strong>TKA</strong> = 108.8 minutes (SD: 13.5) (p&lt;0.001) Average hospital stay <strong>UK</strong> = 5.1 days (SD: 1.08) <strong>TKA</strong> = 8.2 days (SD: 2.85) (p&lt;0.001) Safety (number of cases) • Revisions (0) • Complications associated with implant selection (0) • Patients required blood transfusion (for THA group) (11) • Signs of radiological loosening (0)</td>
<td>[Five assessment periods: preoperative, postoperative (6, 18, 36 and 60 months)] *Postoperative average ROM Significantly better for UKA (p=0.001) *Postoperative average KSS knee scores No difference (p&gt;0.05) *Postoperative average KSS functional scores No difference (p&gt;0.05) Mid-term (5-year) survivorship of UKA was inferior to that of TKA Active ROM was greater for UKA No difference in overall knee and functional</td>
</tr>
<tr>
<td>Author (Year), Study design</td>
<td>Interventions</td>
<td>Results</td>
<td>Conclusions and study considerations</td>
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<tr>
<td>Walton et al.¹⁷ Retrospective</td>
<td><strong>UKA</strong> (n = 183)</td>
<td>Postoperative average OKS (lowest function = 60; highest function = 12) $\dagger$\ddagger\ddagger\ddagger \n<strong>UKA</strong> = 22.17 (SD: 9.03; range: 12-54) \n<strong>TKA</strong> = 24.50 (SD: 9.68; range: 12-50) \n(p&lt;0.04)$\ddagger\ddagger$</td>
<td>Patients who underwent UKA provided better functional scores and greater likelihood of maintaining or increasing levels of sports activities compared with TKA patients</td>
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<td><strong>TKA</strong> (n = 142)</td>
<td>Postoperative modified Grimby score (little physical activity = 1; regular, hard exercise = 6) \n<strong>UKA</strong> = 3.89 (SD: 1.27; range: 1-6) \n<strong>TKA</strong> = 2.76 (SD: 1.12; range: 1-6) (p&lt;0.0001)</td>
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<td><strong>Follow-up:</strong> Minimum 12 months postoperatively (range of follow-up length not indicated)</td>
<td>Postoperative level of sports activities \n% of patients who increased or maintained their preoperative level of sports activities \n<strong>UKA</strong> = 67% \n<strong>TKA</strong> = 44% (p=0.0003) \n% of patients who reduced their preoperative level of sports activities \n<strong>UKA</strong> = 19% \n<strong>TKA</strong> = 43% (p&lt;0.0001)</td>
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<td><strong>Age range:</strong> 29 to 95 years old</td>
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<td>Langdown et al.¹⁹ Retrospective matched (matching factors = age,</td>
<td><strong>UKA</strong> (minimally invasive UKA for end-stage focal spontaneous osteonecrosis of the knee)</td>
<td>Average OKS (lowest function = 0; highest function = 48) \n<strong>UKA for osteonecrosis</strong> \nPreoperative = 21 (SD: 7.4) \nPostoperative = 38 (SD: 6.2) \n(Size of improvement =17; p&lt;0.05) \n<strong>UKA for osteoarthritis</strong></td>
<td>Short- and midterm outcomes of UKA for spontaneous focal osteonecrosis were reliable</td>
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Walton et al.³\textsuperscript{17} Retrospective

UKA (n = 183)

TKA (n = 142)

Follow-up: Minimum 12 months postoperatively (range of follow-up length not indicated)

Age range: 29 to 95 years old

Patients who underwent UKA provided better functional scores and greater likelihood of maintaining or increasing levels of sports activities compared with TKA patients.

Postoperative modified Grimby score (little physical activity = 1; regular, hard exercise = 6)

**UKA** = 3.89 (SD: 1.27; range: 1-6)

**TKA** = 2.76 (SD: 1.12; range: 1-6) (p<0.0001)

Postoperative level of sports activities

% of patients who increased or maintained their preoperative level of sports activities

**UKA** = 67%

**TKA** = 44% (p=0.0003)

% of patients who reduced their preoperative level of sports activities

**UKA** = 19%

**TKA** = 43% (p<0.0001)

Average OKS (lowest function = 0; highest function = 48)

**UKA for osteonecrosis**

Preoperative = 21 (SD: 7.4)

Postoperative = 38 (SD: 6.2)

(Size of improvement =17; p<0.05)

**UKA for osteoarthritis**
<table>
<thead>
<tr>
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<th>Conclusions and study considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex, time since surgery, location of the centre at which the data was collected</td>
<td>(n = 28) UKA (minimally invasive UKA for primary medial compartment OA (n = 28)</td>
<td>Preoperative = 19 (SD: 4.9) Postoperative = 40 (SD: 6.2) (Size of improvement = 21; p&lt;0.05)</td>
<td>Functional outcomes following UKA for spontaneous focal osteonecrosis were comparable to those between those for primary OA Non-significant results may be due to small sample size</td>
</tr>
<tr>
<td>Follow-up:</td>
<td></td>
<td>Revisions</td>
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<tr>
<td>Average follow-up (range) for osteonecrosis = 5.2 years (1 to 13)</td>
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<td>No revision case was reported</td>
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<tr>
<td>Average follow-up for OA = 4.8 years (1 to 13)</td>
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<tr>
<td>Age range:</td>
<td>43 to 88 years old</td>
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BMI: body mass index; CI: confidence interval; FTC: Frontal tibial component angle; GIUM: Italian Orthopaedic UKR Users Group; HKA: Hip-knee-ankle angle; KSS: Knee Society scores; n/a: not available; OA: osteoarthritis; OKS: Oxford Knee scores; ROM: range of motion; SD: standard deviation; TKA: total knee arthroplasty; UKA: unicompartmental knee arthroplasty; RR: relative risk of an event associated with UKA

† Not calculated due to small sample size;
‡ Potential differences in age, sex and types of diagnoses (e.g. primary gonoarthritis, rheumatoid arthritis) between UKA and TKA groups were taken into account to obtain the estimates
†† Significant level of improvement compared with its baseline value
‡‡ Refers to a day before the surgery
‡‡‡ Significance level of the difference between UKA and TKA scores
§ Measured at the latest follow-up date for each patient
§§ Both Issac et al.15 and Walton et al.17 used the OKS questionnaire. However, scoring for Issac et al.15 was modified from the original OKS so that lower scores represent greater functional burden.