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Development of quality indicators for hip and knee arthroplasty rehabilitation

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SUMMARY

Objective: To develop quality indicators (QIs) reflecting the minimum acceptable standard of rehabilitation care before and after elective total hip arthroplasty (THA) and total knee arthroplasty (TKA) for osteoarthritis (OA).

Methods: Informed by high quality evidence and using a modified RAND-UCLA Delphi approach, an 18-member Canadian panel of clinicians, researchers and patients considered 81 proposed QIs (40 for THA, 42 for TKA) addressing rehabilitation before and after elective THA and TKA. Panelists rated QIs for their importance and validity on a 9-point Likert scale through two rounds of online rating interspersed with a moderated and anonymous online discussion forum. Those QIs with median ratings of $\geq$7 for importance and validity with no disagreement based on the inter-percentile range adjusted for symmetry were included in the final sets.

Results: Fifteen panelists from seven provinces and varied practice settings completed the Delphi process. Of the 81 plus one additional QIs (total of 82), 67 (82%) were rated as both important and valid (31 for THA, 36 for TKA). For THA, 14 pre-op, six acute and eight post-acute QIs were accepted. For TKA, 16 pre-op, 10 acute and eight post-acute indicators were accepted. Two of three 'across-continuum' QIs were rated appropriate for both procedures.

Conclusion: This work represents the first QIs with which to measure, report and benchmark quality of care in patients receiving rehabilitation before and after THA/TKA surgery. The QIs will be further tested for reliability and feasibility before being widely disseminated in clinical settings and used to assess care gaps.

Introduction

Quality care is a goal shared by all healthcare providers and is associated with better outcomes, patient satisfaction and efficient use of healthcare resources in medical[1–4], surgical[5], and rehabilitation[2,6] contexts. The Institute of Medicine (IOM) in the United States defines quality of care as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge"[7]. In 2001, the IOM identified six quality reporting categories: safety, timeliness, effectiveness, efficiency, equity, and patient centeredness[8].

Measures to assess, monitor and report quality of care from different stakeholders' perspectives have been developed by numerous professional organizations, governmental agencies and independent research and quality evaluation networks worldwide. Quality indicators (QIs) represent one approach to measure quality of care across a variety of health conditions and healthcare interventions. A QI specifies the minimum standard of care and serves as a tool "that helps us measure or quantify healthcare processes, outcomes, patient perceptions, and organization structure and/or systems that are associated with the ability to provide

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high quality healthcare"[9]. There is a growing body of evidence to suggest that implementing and measuring QIs result in improvements in processes of cares and patient-relevant outcomes[1,2,6,10].

Total joint arthroplasty (TJA) for advanced hip and knee osteoarthritis (OA) is a high priority, high demand elective surgical procedure in Canada and other countries[11–13]. QIs have been developed and implemented for OA[14], and indicators and performance benchmarks have been established for medical and surgical TJA peri-operative care processes[5], outcomes[15], and TJA wait times[16] in some countries. Our indicator sets, in contrast, focus on rehabilitation care and outcomes along the TJA continuum. The continuum is conceptualized as the full spectrum of rehabilitation care commencing at the entry point when patients with end-stage hip or knee OA are deemed surgical candidates and are placed on the surgical waitlist (pre-op), through the acute care hospital stay and including the 1 year of recovery after TJA (post-acute)[17].

Rehabilitation services are widely utilized before and after TJA[17,18]. Prior to elective TJA, rehabilitation (pre-hab) aims to manage OA-related pain, minimize functional decline and address patient expectations and educational needs in preparation for surgery[17,19,20]. With the advent of increasingly shorter acute care stays for TJA, in-hospital rehabilitation interventions have had to focus on early mobilization and discharge planning[17]. Regardless of discharge setting, post-acute rehabilitation addresses post-surgical pain and swelling, joint mobility, and long standing strength and functional deficits as a result of chronic OA and limited physical activity[17,21–24].

Rehabilitation before and after TJA is an important healthcare topic for QI development[25]. The high volume and growing demand for TJA procedures[11–13,15,16,26], significant costs to healthcare systems[18,27,28], high quality evidence to support the effectiveness of rehabilitation on pre- and post-operative patient outcomes[19,20,22–24] and patient satisfaction[29], together with marked variations in rehabilitation practices[30,31] and outcomes[32,33], warrant the effort to develop QIs and address care gaps. Furthermore, based on our previous research and clinical experience, we identified a number of opportunities to change clinical practice behaviours and improve quality of care and patient experiences[29].

Purpose

This multi-step study aimed to develop QIs related to rehabilitation care before and after elective TJA for hip and knee OA.

Methods

To develop QIs for TJA rehabilitation, we used a multi-step approach based on the modified RAND Health and University of California Los Angeles (RAND/UCLA) methodology[34,35] (See Fig. 1). The main difference from the original method is greater use of online technology including a moderated discussion forum rather than a face-to-face meeting between rounds.

Synthesis and quality assessment of evidence

We initially searched online repositories of clinical practice guidelines, QIs and quality measures to identify existing recommendations and indicators that could inform our work (See Table I). We then performed comprehensive searches of six online databases (Medline, EMBASE, CINAHL, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Physiotherapy Evidence Database) for high quality evidence published in English between 1990–August 2014 including systematic reviews (SRs), randomized controlled trials (RCTs) and cohort studies as indicated by the QI topic. Where SRs did not exist for a given topic, we conducted rapid reviews of the literature[36,37]. Two independent raters assessed and reached consensus through discussion on the methodological quality of the supporting evidence using the AGREE II Instrument for practice guidelines[38], AGREE II-QI instrument for QIs[39], AMSTAR tool for SRs[40], Cochrane Risk of Bias tool for RCTs[41], and Newcastle Ottawa Scale for cohort studies[42]. Where several SRs and guidelines were available for a given topic, cut points for minimum methodological quality were established *a priori* at five out of nine on the AMSTAR tool and four out of seven on the AGREE II instrument (based on the overall quality rating). In total, four QI sets, five practice guidelines, three best practice recommendations and 35 SRs were used to generate the 81 initial QIs with the remaining evidence sources being high quality RCTs, cohort studies and registry data. A level of evidence (LOE) was assigned to each study based on the Oxford Centre for Evidence-based Medicine[43] criteria (See Table II).

Prior to starting this study, we formed an advisory committee consisting of a patient representative, orthopaedic surgeon, healthcare administrator, methodologist and physiotherapist with knowledge translation (KT) experience to seek feedback and approval on the scope of the review process and rehabilitation topics, and the proposed QIs. In total, 81 rehabilitation QIs were

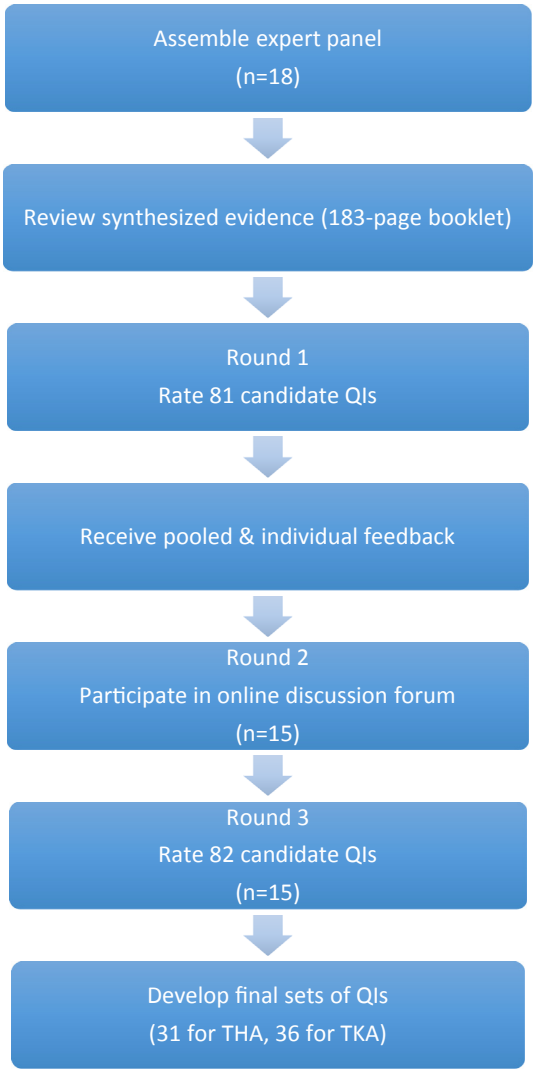

Fig. 1. Flowchart of steps involved in modified Delphi process to develop rehabilitation QIs.

Table I
List of guideline and QI sources searched

Institution/Organization	URL (accessed June 6, 2014; last updated Dec. 6, 2016)
Agency for Healthcare Research and Quality (AHRQ)	ARHQ Quality Indicators Database www.qualityindicators.ahrq.gov/ ARHQ Quality Measures Database https://qualitymeasures.ahrq.gov
Alberta Bone and Joint Health Institute (ABJHI) evidence reviews	https://www.albertaboneandjoint.com
Alberta Health Services Health Technology Assessment & Innovation (HTAI)	www.albertahealthservices.ca/research/page4122.aspx
American Academy of Orthopaedic Surgeons	www.aaos.org/Quality
American Academy of Physical Medicine and Rehabilitation	www.aapmr.org
American College of Rheumatology	www.rheumatology.org/Practice-Quality/Clinical-Support/Quality-Measurement
American Medical Association	https://www.ama-assn.org
American Physical Therapy Association	www.apta.org/Practice/
Australian Government Clinical Practice Guidelines Portal	https://www.clinicalguidelines.gov.au/
Australian Physiotherapy Association	www.physiotherapy.asn.au/
Bone & Joint Canada	www.boneandjointcanada.com
British Association of Occupational Therapists and College of Occupational Therapists	www.cot.co.uk/sites/default/files/general/public/P171-Total-Hip-Replacement.pdf
Canadian Agency for Drugs and Technology in Health	https://www.cadth.ca/about-cadth/what-we-do/products-services/hta
Canadian Medical Association CMA InfoBase: Clinical Practice Guidelines	https://www.cma.ca/En/Pages/clinica-practice-guidelines.aspx
Canadian Orthopaedics Association	www.coa-aco.org/
Canadian Physiotherapy Association	https://www.physiotherapy.ca/Practice-Resources
Canadian Rheumatology Association	https://www.rheum.ca
Chartered Society of Physiotherapy	www.csp.org.uk/
Danish Centre for Health Technology Assessment	https://www.sst.dk/en/planning/centre-for-health-technology-assessment
eGuidelines	www.eguidelines.co.uk/
Eumusc.net	www.eumusc.net
Guidelines International Network	www.g-i-n.net/library/international-guidelines-library/
Haut Autorité De Santé (HAS)	http://www.has-sante.fr/
Institute for Applied Quality Improvement and Research in Health Care (AQUA-Institute)	https://www.aqua-institut.de/en/home/
Institute for Clinical Evaluation Sciences (ICES)	www.ices.on.ca
Institute of Medicine of the National Academies	www.nationalacademies.org/hmd
IQ Scientific Institute for Quality of Healthcare	www.iqhealthcare.nl/en
National Clinical Guideline Centre (NCGC)	www.ncgc.ac.uk
National Guideline Clearinghouse	www.guideline.gov
National Institute for Health and Care Excellence	www.nice.org.uk
NSW Agency for Clinical Innovation **Musculoskeletal Network**	https://www.aci/health.nsw.gov.au/networks/musculoskeletal
New Zealand Guidelines Group	http://www.health.govt.nz/publications?f%5B0%5D=im_field_publication_type%3A26
Ontario Health Technology Assessment Series (OHTAS)	http://www.hqontario.ca/Evidence-to-Improve-Care/Health-Technology-Assessments/Journal-Ontario-Health-Technology-Assessment-Series
RAND Corporation	www.rand.org
Royal College of Physicians	www.rcplondon.ac.uk
Royal Dutch Society for Physical Therapy (KNGF)	https://www.fysionet-evidencebased.nl/index.php/kngf-guidelines-in-english
Scottish Intercollegiate Guidelines Network (SIGN)	www.sign.ac.uk/
US Bone and Joint Initiative	https://www.usbji.org
US Department of Health & Human Services (HHS)	https://www.qualitymeasures.ahrq.gov/hhs/index.aspx
World Confederation for Physical Therapy (WCPT)	www.wcpt.org/resources-and-info

Bolded organizations indicate one or more of their resources (e.g., QI, clinical practice guideline, SR) was used to inform the development of our QI sets.

developed by the investigative team and approved by this advisory group through individual feedback. The indicators address the continuum of care described previously. This initial work resulted in a 183-page booklet, which served as both the instructions and evidence syntheses for the expert panel.

Development of QI statements

The highest quality evidence available (e.g., SRs of RCTs, clinical practice guidelines) was used to generate QI statements using the 'IF-THEN-BECAUSE' format to specify context, clinical

Table II
Description of LOE (Adapted from the Oxford Centre for evidence-based medicine 2011 LOE). http://www.cebm.net/wp-content/uploads/2014/06/CEBM-Levels-of-Evidence-2.1.pdf

LOE	Intervention studies	Prognostic studies
I	SR of high quality randomized controlled trials	SR of high quality prospective cohort studies
II	High quality RCT or observational study with dramatic effect	High quality prospective cohort study
III	Non-randomized controlled trial or prospective controlled cohort/follow-up study	Retrospective cohort study or control arm of randomized trial
IV	Case-series, case-control, historically controlled studies or non-controlled studies	Case-series or case-control studies or low quality prognostic study
V	Expert opinion or other mechanism-based reasoning	Expert opinion

characteristics of eligible persons, process of care that should/should not be performed, and expected health outcomes[35]. All QIs were described using a standardized template indicating the numerator, denominator, type of indicator, applicable care settings, proposed data source(s) and supporting evidence. Indicator type (process, structure or outcome) was initially based on published definitions[25,27] and reviewed and agreed upon by co-authors and the advisory committee (See Supplementary Table 1).

Recruitment of expert panel

We recruited panelists through a network of contacts, professional and arthritis patient advocacy organizations, and leading clinical and research centres across Canada to ensure broad geographical representation and expert panel diversity. Of 20 panelists invited to participate, 18 agreed and provided informed consent. The panel consisted of rehabilitation clinicians, orthopaedic surgeons, researchers, methodologists, and individuals who had undergone TJA. Each panelist was assigned a study ID to maintain anonymity from each other throughout the process. Panelists were sent the synthesized evidence and asked to review this material prior to accessing the first round of the survey. The survey was administered through the password protected web-based Fluid Survey™ System (Ottawa, Canada). Ethics approval was obtained from the Health Research Ethics Boards at the University of Alberta and University of British Columbia.

Delphi survey and rating process

The Delphi survey was conducted October 2014–January 2015. In Round 1, each panelist independently rated the 81 proposed QIs on their importance and validity (scientific soundness) on a 9-point Likert scale (strongly disagree (1) to strongly agree (9))[34] (See Supplementary Table 1 for detailed rating instructions.). The aggregated ratings (median, range) as shown in Fig. 2 were e-mailed to the panelists along with their own ratings for each QI prior to participation in the next round.

For Round 2, two of the authors (MDW, CAJ) moderated an anonymous discussion forum over 2 weeks during which panelists were encouraged to share comments about the proposed QIs, respond to other panelists' questions and comments, and reflect on their own ratings from Round 1. This exercise was immediately followed by the Round 3 online rating process to determine the final sets of QIs. Those QIs with a median rating $\geq$7 and no disagreement for both importance and validity[34,44], were maintained for the final sets. Disagreement was calculated following the formula described by Fitch *et al.*[33] and is based on two values: the inter-percentile range (IPR) (difference between 30th and 70th percentile); and the inter-percentile range adjusted for symmetry (IPRAS) (dispersion of scores). When the IPRAS > IPR, no disagreement exists among the ratings[34,44]. Based on Round 1 feedback, one QI was revised so that two separate statements were developed to improve clarity. Therefore, 82 QIs were re-rated using the same criteria in Round 3. Panelists were also asked to suggest exclusion criteria or instances when a QI was not applicable to inform future case mix adjustments. After completion of Round 3, panelists were sent a brief questionnaire to rate various aspects of the Delphi process and their overall satisfaction on a 5-point ordinal scale.

Analysis

As established *a priori* and described earlier, those QIs with a median rating of $\geq$7 in Round 3 and with no disagreement based on IPRAS > IPR for both importance and validity, were included in the final sets[34,44]. Median scores with decimals of $\geq$0.5 were rounded up to next whole number[44].

Results

Fifteen panelists completed the Delphi survey (Table III). Two panelists (a surgeon and a methodological expert), received the synthesized evidence but did not participate in Round 1 due to work-related commitments. An additional panelist (orthopaedic surgeon), started Round 1 but was unable to continue (See Supplementary Table 2 for list of panelists). Of the 15 panelists, engagement was high with 80% contributing to the discussion forum and making 186 posts.

THA QIs

Of the 82 QIs available for rating in Round 3, 67 (82%) were accepted as important and valid. For THA, 31 of 40 (78%) QIs were accepted and include: 14 addressing the pre-operative phase (12 assessment/screening activities, two interventions); six addressing acute care (two assessment/screening activities, four interventions); eight addressing the post-acute care phase (seven assessment/screening activities, one intervention); and three appropriate across the continuum of rehabilitation care. The acute care phase had the least number of proposed QIs accepted (6/13 or 46%). The highest LOE to support the accepted THA indicators ranged from Level I (SR of high quality RCTs) for 19 QIs to Level III (retrospective cohort study) for one indicator. The QI topics which generated the greatest volume of discussion (number of posts/responses) for THA were related to pre-operative physical examination of the lower limbs, acute care interventions and post-acute

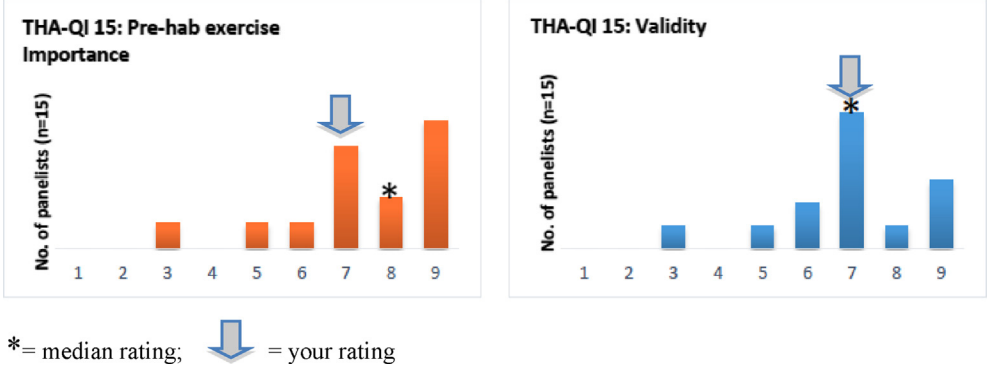

Fig. 2. Example of Round 1 feedback provided to panelists.

Table III
Delphi panelist* demographics

All panelists ($n = 15$)	
Age (%)	
40–49 years	6 (40%)
50–59 years	4 (27%)
≥60 years	5 (33%)
Gender (% female)	53%
Health professional panelists ($n = 13$)	
Orthopaedic surgeons	3 (23%)
Family physician	1 (8%)
Physiotherapists	7 (54%)
Other allied health	2 (15%)
Panelist role	
Clinical expert	8 (62%)
Research expert	2 (15%)
Clinician-scientist	2 (15%)
Methodological expert	1 (8%)
Primary affiliation	
University/college	3 (22%)
Academic/teaching hospital	8 (62%)
Regional/district hospital	1 (8%)
Other	1 (8%)
Clinician panelists ($n = 10$)†	
Clinical experience in TJA	
<10 years	1 (10%)
10–29 years	6 (60%)
≥30 years	3 (30%)
Clinical work settings‡	
Central intake clinic	2 (20%)
Inpatient acute	6 (60%)
Inpatient post-acute/rehab	2 (20%)
Outpatient department	2 (20%)
Clinical care phase	
Pre-operative	3 (30%)
Acute	1 (10%)
Post-acute	1 (10%)
All phases	5 (50%)
Volume of TKA patients	
<100 pts/year	3 (30%)
≥100 pts/year	7 (70%)
Volume of THA patients	
<100 pts/year	4 (40%)
≥100 pts/year	6 (60%)
Research panelists ($n = 4$)†	
Research experience in TJA	
<20 years	2 (50%)
≥20 years	2 (50%)
Patient experts ($n = 2$)	
Age (>70 years)	2
TJA surgery§	
THA	2
TKA	1
Work status (retired)	2
Highest education (Master's degree)	2
Arthritis advocacy group affiliation	2

* Panelists who completed the three Rounds.
† Includes the two clinician scientists.
‡ Some panelists indicated more than one work setting.
§ One patient panelist had both a THA and TKA.

care physiotherapy/therapeutic exercise (data not shown). The final THA indicator statements with their associated LOE are shown in Table IV.

TKA QIs

For TKA, 36 of 42 (86%) QIs were accepted and include: 16 addressing pre-operative care (13 assessment/screening, three interventions), 10 addressing acute care (five assessment/screening, five interventions), and eight addressing post-acute care (seven assessment/screening, one intervention). Two of three 'across-continuum' QIs were rated appropriate for TKA. One 'negative' QI pertaining to the use of continuous passive motion (CPM) after TKA was included in the final set. The highest LOE to support the accepted TKA indicators ranged from Level I for 19 QIs to Level V (expert opinion) for one indicator. Similar to THA, the QI topics which generated the greatest volume of discussion (number of posts/responses) for TKA addressed pre-operative physical examination of the lower limbs and acute care interventions. The final TKA indicator statements with their associated LOE are shown in Table V.

All but two QIs were process measures as there was insufficient evidence to propose and accept more than one rehabilitation-specific outcome indicator for both procedures which related to achievement of functional milestones prior to discharge from hospital (QI #20 and #56). The 13 proposed process indicators (eight for THA and five for TKA) and two structure indicators (one each for THA and TKA) that did not reach consensus are listed in Supplementary Table 3. The greatest proportion of proposed and accepted QIs addressed the appropriateness, acceptability and effectiveness quality domains and most pertained to more than one domain[7].

No new QIs were recommended during the consensus process; however, there were suggestions to modify wording to improve clarity or identify appropriate care providers. For example, in Round 1 for several indicators, panelists requested that "physiotherapist" be modified to "trained health professional" or "health professional with training in MSK exam skills" so as not to limit the care process to a single profession. These changes were made and Round 3 ratings were based on these modifications. During the final Round, panelists recommended that the QI on pre-operative assessment of anxiety/depression and pain catastrophizing (QI #2 and #33) be divided into two separate statements as these concepts reflect two distinct constructs. Further testing of the QIs for feasibility and reliability will address this recommendation as there was high quality evidence (Levels I and II) for both constructs and strong ratings for importance (median = 8) and validity (median = 8) (THA and TKA) for this combined statement.

The post-Delphi questionnaire was completed by the 15 panelists. Thirteen (87%) indicated they read all or most of the evidence summaries prior to starting the survey while eight (53%) referred to/used all or most of the Round 1 summarized ratings to inform their Round 3 ratings. Of the 12 panelists who contributed posts to the Round 2 forum, 67% revised their original ratings based on the discussion. Panelists agreed or strongly agreed (87%) their anonymity was maintained through the three Rounds. Most panelists (86%) indicated they would like to collaborate further on this work.

Discussion

Based on extensive literature review, a transparent and systematic consensus process and broad stakeholder engagement, we developed the first sets of TJA rehabilitation QIs. Patients' perspectives were integrated throughout the research process from conceptualization of the scope of the proposed QIs through the rating and discussion activities to finalize the QI sets. We made every effort to maintain all panelists' anonymity to ensure everyone had an equal voice in the discussion.

The availability of high quality evidence was limited for some rehabilitation topics such as pre-operative weight management in obese patients[37] and use of dedicated acute care space or specialized TJA units (See Supplementary Table 3). This required rapid reviews or reliance on single moderate to high quality RCTs or cohort studies. As the quality of evidence was reviewed for each

Table IV
QIs for rehabilitation of THA

Pre-op Phase

Assessment/screening ($n = 12$)
IF a patient is to undergo a primary THA for OA, THEN …
1. Assessment of hip pain using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
2. Screening for anxiety, depression and pain catastrophizing using a standardized tool(s) should be documented by a member of the healthcare team pre-operatively.* [LOE-I]
3. Number, type and severity of comorbidities using a standardized tool(s) and including (at a minimum):
   - Cardiovascular disease
   - High blood pressure
   - Obesity (BMI $\geq$ 30 kg/m^2)
   - Lung disease
   - Diabetes
   - Back pain
   - Other lower limb joint involvement/pain

   Should be documented by a member of the healthcare team pre-operatively. [LOE-I]
4. AND there are clinical indications of cognitive impairment, THEN screening for cognitive status using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
5. A physical examination of the lower limbs and lumbo-pelvic region using standardized methods and including (at a minimum):
   - Gait pattern and use of walking aids
   - Standing posture and lower limb alignment
   - Bilateral passive & active hip and knee range of motion
   - Bilateral lower limb soft tissue flexibility/contractures
   - Bilateral lower limb strength
   - Static and dynamic balance

   should be documented by a health professional with training in MSK exam skills pre-operatively. [LOE-I]
6. Assessment of physical function using a standardized self-report tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
7. Assessment of physical function using one of the following standardized performance-based test(s) (at a minimum):
   - Fast or self-paced walk (walking speed)
   - 30-s Chair Stand Test
   - Stair Climb Test

   should be documented by a health professional with training in MSK exam skills pre-operatively. [LOE-I]
8. Assessment of participation including care-giving activities, paid/unpaid work, leisure and sporting activities using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
9. AND lives in a non-residential care setting, THEN screening for adequate social support (social support system) using a standardized format should be documented by a member of the healthcare team pre-operatively. [LOE-I]
10. Screening for home safety and fall risk factors AND guidance on preparing the home environment to promote safety, accessibility and independent day-to-day function should be documented by a member of the healthcare team pre-operatively. LOE-I]
11. Assessment of need for assistive devices, equipment and mobility aids using a standardized format should be documented AND guidance on acquiring and using them provided by a member of the healthcare team pre-operatively. [LOE-I]
12. Individual expectations of the surgery and short- and long-term outcomes should be documented by a member of the healthcare team pre-operatively. [LOE-I]

Interventions ($n = 2$)
IF a patient is to undergo a primary THA for OA, THEN …
13. Multi-disciplinary pre-operative education that uses appropriate delivery formats (in-person, video, telehealth, print), provides an opportunity for questions to be addressed, allows participation of a family member or other support and addresses (at a minimum):
   - Surgical procedure
   - Risks and benefits
   - Patient expectations
   - Pain management strategies
   - Home preparation
   - Assistive devices
   - Post-operative care and rehabilitation

   should be documented pre-operatively. [LOE-I]
14. An individualized, structured and progressive exercise program that includes at a minimum:
   - Upper extremity strength training (in preparation for use of walking aids and transfers)
   - Lower extremity functional strength training as tolerated
   - Lower extremity ROM exercises
   - Gait training with instruction on use of walking aids
   - Guidance on remaining physically active

   should be initiated and documented at least 8 weeks prior to surgery to allow a physiologic training effect. [LOE-I]

Acute care (in-hospital) phase

Assessment/screening ($n = 2$)
IF a patient underwent a primary THA for OA, THEN …
15. Use of a standardized clinical care pathway should be documented during the acute care stay. [LOE-I]
16. Assessment of surgical hip pain using a standardized tool should be documented by a member of the healthcare team at least twice daily during the acute hospital stay. [LOE-II]

Interventions ($n = 4$)
IF a patient underwent a primary THA for OA, THEN …
17. AND has no medical contra-indications, THEN mobilization should be performed and documented by postoperative day (POD) 1 or reason patient cannot be mobilized documented. [LOE-I]
18. AND had no intra-operative complications AND regardless of surgical approach, THEN instruction that emphasizes weight-bearing as tolerated when transferring or walking should be documented. [LOE-II]
19. AND has no medical contra-indications, THEN physiotherapist-supervised exercise therapy including (at a minimum):
   - Active range of motion of lower limbs
   - Isometric and small movement isotonic lower limb strengthening

(*continued on next page*)

Table IV (*continued*)

Pre-op Phase
- Bed mobility and transfer training - Balance and gait training (level ground and on stairs if appropriate) should be initiated by postoperative day (POD) 1, provided at least once daily and documented.† [LOE-II] 20. AND there were no significant perioperative complications, THEN achievement of the following functional outcomes (at a minimum): - Transfer independently in/out of bed and on/off chair and toilet - Ambulate safely with an appropriate assistive device on level surfaces and stairs (if appropriate for home situation) - Perform basic activities of daily living (ADL) independently using related equipment - Demonstrate appropriate hip precautions (e.g., no flexion >90°) - Demonstrate independence in home exercise program should be documented by the occupational therapist or physiotherapist prior to discharge to home from the acute care hospital. [LOE-II]
Post-acute care phase
Assessment/screening (*n* = 7) IF a patient underwent a primary THA for OA, THEN … 21. Assessment of surgical hip pain using a standardized tool should be documented by the physiotherapist and other health professionals involved in the rehabilitation care at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-II] 22. A physical examination of the lower limbs and lumbo-pelvic region using standardized methods and including (at a minimum): - Bilateral passive and active hip and knee ROM - Bilateral lower limb strength including quadriceps and hip abductors - Gait and use of walking aids - Static and dynamic balance - Standing posture and lower limb alignment - Bilateral lower limb soft tissue flexibility/contractures - Leg length discrepancy (LLD) (may be delayed until 3 months post-op) should be documented by the physiotherapist at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-III] 23. Assessment of physical function using a standardized self-report tool(s) should be documented by a member of the healthcare team at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-I] 24. Assessment of physical function using a standardized performance-based test(s): - Fast paced or self-paced walk (walking speed) - 30-s chair stand test (sit-to-stand) (may be delayed until precautions removed) - Stair climb test should be documented by a health professional with training in MSK exam skills at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-I for walking speed] 25. Assessment of participation in care-giving activities, paid/unpaid work and leisure and sporting activities using a standardized tool(s) should be documented by a member of the healthcare team at baseline and prior to discharge from post-acute rehab. [LOE-II] 26. Assessment of physical activity level and sedentary behaviour using a standardized tool(s) AND guidance and support to resume a physically active lifestyle including: - Recommended level of physical activity for health benefits - Available community-based physical activity or exercise programs appropriate for individuals with TJA - Helpful resources (print, Internet, telephone support) and/or self-monitoring devices (pedometer, accelerometer) to support regular physical activity should be documented by the physiotherapist at baseline and prior to discharge from post-acute rehabilitation. [LOE-II] 27. Assessment of health-related quality of life (HRQoL) using a standardized tool should be documented by a member of the healthcare team at baseline and prior to discharge from post-acute rehabilitation. [LOE-I] **Interventions (*n* = 1)** IF a patient underwent a primary THA for OA, THEN … 28. Physiotherapy (including therapeutic exercise) that is individualized to the patient's functional needs, supervised, appropriately dosed, regularly progressed, at least 6 weeks in duration and monitored for adherence AND includes the following components (at a minimum): - Pain management strategies - Active hip range of motion exercise - Progressive resistance training for lower limb muscles - Static and dynamic balance training - Postural and core stability training - Gait training (including use of walking aids and differing walking surfaces) - Functional exercises (including stair climbing, rising/lowering to chair) - Provision of a home exercise program and education on how to progress exercises should be documented by the physiotherapist using standardized approaches (e.g., class attendances, exercise log, online health journal) prior to discharge from post-acute rehabilitation. [LOE-I]
Across continuum (all phases)
IF a patient is undergoing a primary THA for OA, THEN … 29. Assessment of satisfaction with the rehabilitation process and outcomes in all care phases (pre-, acute- and post-acute) using a standardized tool(s) should be documented by a member of the healthcare team. [LOE-II] 30. Assessment of the patient's attitude towards and engagement in rehabilitation planning and interventions using a standardized format AND provision of processes and structures to enable patient and family involvement in all care phases (pre-, acute- and post-acute) should be documented by a member of the healthcare team. [LOE-II] 31. AND the health record specifies a follow-up appointment, transfer of care to another rehabilitation provider or setting (e.g., transfer from acute care to out-patient care setting), or referral to another rehabilitation provider (e.g., referral to physiotherapy or occupational therapy), THEN a transfer form or discharge summary AND evidence that this visit or treatment took place, was postponed or was declined by the patient, should be documented in the health record. [LOE-I]

LOE[42], highest level available to support QI statement at time of Delphi survey.

* Panelists recommended these concepts be separated into two separate QIs as they represent different constructs.

† In response to panelists' comments, this statement reflects physiotherapist-supervised exercise and does not preclude a second session of exercise therapy supervised by a rehab assistant or other trained health professional.

Table V
QIs for rehabilitation of TKA

Pre-op phase

Assessment/screening ($n = 13$)
IF a patient is to undergo a primary TKA for OA, THEN …
32. Assessment of knee pain using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
33. Screening for anxiety, depression and pain catastrophizing using a standardized tool(s) should be documented by a member of the healthcare team pre-operatively.‡ [LOE-I]
34. Number, type and severity of comorbidities using a standardized tool(s) and including (at a minimum):
- Cardiovascular disease
- High blood pressure
- Obesity (BMI $\geq$ 30 kg/m^2)
- Lung disease
- Diabetes
- Back pain
- Other lower limb joint involvement/pain

should be documented by a member of the healthcare team pre-operatively. [LOE-I]
35. AND there are clinical indications of cognitive impairment, THEN screening for cognitive status using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-II]
36. A physical examination of the lower limbs and lumbo-pelvic region using standardized methods and including (at a minimum):
- Gait pattern and use of walking aids
- Standing posture and lower limb alignment
- Bilateral passive & active knee and hip range of motion
- Bilateral lower limb soft tissue flexibility/contractures
- Bilateral lower limb strength
- Static and dynamic balance

should be documented by a health professional with training in MSK exam skills pre-operatively. [LOE-I]
37. Assessment of physical function using a standardized self-report tool should be documented by a member of the healthcare team pre-operatively. [LOE-I]
38. Assessment of physical function using one of the following standardized performance-based test(s) (at a minimum):
- Fast or self-paced walk (walking speed)
- 30-s Chair Stand Test
- Stair Climb Test

should be documented by a health professional with training in MSK exam skills pre-operatively. [LOE-II]
39. Assessment of participation including care-giving activities, paid/unpaid work, leisure and sporting activities using a standardized tool should be documented by a member of the healthcare team pre-operatively. [LOE-I for paid work]
40. AND lives in a non-residential care setting, THEN screening for adequate social support (social support system) using a standardized format should be documented by a member of the healthcare team pre-operatively. [LOE-II]
41. AND lives in a non-residential care setting, THEN assessment of access to safe and efficient transportation (prior to and after surgery) should be documented AND guidance on appropriate transportation options provided by a member of the healthcare team pre-operatively. [LOE-II for return to driving]
42. Screening for home safety and fall risk factors AND guidance on preparing the home environment to promote safety, accessibility and independent day-to-day function should be documented by a member of the healthcare team pre-operatively. [LOE-I]
43. Assessment of need for assistive devices, equipment and mobility aids using a standardized format should be documented AND guidance on acquiring and using them provided by a member of the healthcare team pre-operatively. [LOE-I]
44. Individual expectations of the surgery and short- and long-term outcomes should be documented by a member of the healthcare team pre-operatively. [LOE-I]

Interventions ($n = 3$)
IF a patient is to undergo a primary TKA for OA, THEN …
45. Multi-disciplinary pre-operative education that uses appropriate delivery formats (in-person, video, telehealth, print), provides an opportunity for questions to be addressed, allows participation of a family member or other support and addresses (at a minimum):
- Surgical procedure
- Risks and benefits
- Patient expectations
- Pain management strategies
- Home preparation
- Assistive devices
- Post-operative care and rehabilitation

Should be documented pre-operatively. [LOE-I]
46. An individualized, structured and progressive exercise program that includes at a minimum:
- Upper extremity strength training (in preparation for use of walking aids and transfers)
- Lower extremity functional strength training as tolerated
- Lower extremity ROM exercises
- Gait training with instruction on use of walking aids
- Guidance on remaining physically active

should be initiated and documented at least 8 weeks prior to surgery to allow a physiologic training effect. [LOE-I]
47. AND has a BMI $\geq$27 kg/m^2, THEN provision of information on weight management and referral to a weight management program should be documented. [LOE-III]

Acute care (in-hospital) phase

Assessment/screening ($n = 5$)
IF a patient underwent a primary TKA for OA, THEN …
48. Use of a standardized clinical care pathway should be documented during the acute care stay. [LOE-I]
49. Assessment of surgical knee pain using a standardized tool should be documented by a member of the healthcare team at least twice daily during the acute hospital stay. [LOE-II]
50. A physical examination using standardized methods and including (at a minimum):
- Active and passive ROM of the surgical knee
- Surgical knee effusion (knee circumference)
- Lower limb swelling and circulation (e.g., observation, palpation, pulses)
- Sensation of the surgical limb
- Bilateral lower limb strength (including ability to activate quadriceps muscle of surgical limb)

(*continued on next page*)

Table V (*continued*)

Pre-op phase

- Gait pattern and use of walking aids
- Balance and fall risk

should be documented by a health professional with training in MSK physical exam skills prior to discharge. [LOE-II for ROM]

51. Assessment of physical function including (at a minimum):
    - Ability to safely transfer to/from chair, bed, and toilet
    - Ability to perform basic activities of daily living (ADL)
    - Walking ability or speed including ambulating on stairs (if appropriate) (e.g., timed 10 m walk test)
    - Balance and fall risk (e.g., 30 s single leg stance test)

using one or more standardized performance-based test(s) should be documented by a physiotherapist or occupational therapist prior to discharge from the acute care hospital. [LOE-IV]

52. AND there are clinical indications of cognitive impairment, THEN assessment of cognitive status using a standardized tool should be documented by a member of the healthcare team prior to discharge from the acute care stay. [LOE-II]

Interventions (*n* = 5)

IF a patient underwent a primary TKA for OA, THEN …

53. AND has no medical contra-indications, THEN mobilization should be performed and documented by postoperative day (POD) 1 or reason patient cannot be mobilized documented. [LOE-I]
54. AND can actively move the surgical knee THEN CPM should **NOT** be used during the acute care stay or reason for using CPM documented. [LOE-I]
55. AND has no medical contra-indications, THEN physiotherapist-supervised exercise therapy including (at a minimum):
    - Active ROM of lower limbs
    - Isometric and small movement isotonic lower limb strengthening
    - Bed mobility and transfer training
    - Balance and gait training (level ground and on stairs if appropriate)

should be initiated by postoperative day (POD) 1, provided at least once daily and documented.† [LOE-II]

56. AND there were no significant perioperative complications, THEN achievement of the following functional outcomes (at a minimum):
    - Transfer independently in/out of bed and on/off chair and toilet
    - Ambulate safely with an appropriate assistive device on level surfaces and stairs (if appropriate for home situation)
    - Perform basic activities of daily living (ADL) independently using related equipment
    - Demonstrate independence in home exercise program

should be documented by the occupational therapist or physiotherapist prior to discharge to home from the acute care hospital. [LOE-II]

57. AND is to be discharged to home, THEN a post-discharge follow-up and care plan which includes (at a minimum):
    - Appointment(s) for surgical follow-up care
    - Referral for community or home-based rehabilitation
    - Telephone contact numbers of appropriate healthcare providers

should be documented and written information or forms provided to the patient or family/support person by a member of the healthcare team prior to discharge. [LOE-V]

Post-acute care phase

Assessment/screening (*n* = 7)

IF a patient underwent a primary TKA for OA, **THEN** …

58. Assessment of surgical knee pain using a standardized tool should be documented by the physiotherapist and other health professionals involved in the rehabilitation care at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-II]
59. A physical examination of the lower limbs and lumbo-pelvic region using standardized methods and including (at a minimum):
    - Surgical knee effusion (knee circumference)
    - Bilateral passive and active knee and hip ROM
    - Bilateral lower limb strength (including quadriceps and hip abductors)
    - Muscle recruitment/voluntary activation of quadriceps
    - Bilateral lower limb soft tissue flexibility/contractures
    - Gait and use of walking aids
    - Static and dynamic balance
    - Standing posture and lower limb alignment

should be documented by the physiotherapist at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-I]

60. Assessment of physical function using a standardized self-report tool(s) should be documented by a member of the healthcare team at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-I]
61. Assessment of physical function using a standardized performance-based test(s):
    - Fast paced or self-paced walk (walking speed)
    - 30-s chair stand test (sit-to-stand)
    - Stair climb test

should be documented by a health professional with training in MSK exam skills at baseline and prior to discharge (at a minimum) from post-acute rehabilitation. [LOE-II]

62. Assessment of participation in care-giving activities, paid/unpaid work and leisure and sporting activities using a standardized tool(s) should be documented by a member of the healthcare team at baseline and prior to discharge from post-acute rehab. [LOE-I for return to work]
63. Assessment of physical activity level and sedentary behaviour using a standardized tool(s) AND guidance and support to resume a physically active lifestyle including:
    - Recommended level of physical activity for health benefits
    - Available community-based physical activity or exercise programs appropriate for individuals with TJA
    - Helpful resources (print, Internet, telephone support) and/or self-monitoring devices (pedometer, accelerometer) to support regular physical activity

should be documented by the physiotherapist at baseline and prior to discharge from post-acute rehabilitation. [LOE-II]

64. Assessment of health-related quality of life (HRQoL) using a standardized tool should be documented by a member of the healthcare team at baseline and prior to discharge from post-acute rehabilitation. [LOE-I]

Interventions (*n* = 1)

IF a patient underwent a primary TKA for OA, THEN ….

65. Physiotherapy (including therapeutic exercise) that is individualized to the patient's functional needs, supervised, appropriately dosed, regularly progressed, at least 6 weeks in duration and monitored for adherence AND includes the following components (at a minimum):
    - Pain management strategies
    - Active knee range of motion exercise
    - Progressive resistance training for lower limb muscles
    - Static and dynamic balance training
    - Postural and core stability training

Table V (*continued*)

Pre-op phase
- Gait training (including use of walking aids and differing walking surfaces) - Functional exercises (including stair climbing, rising/lowering to chair) - Provision of a home exercise program and education on how to progress exercises should be documented by the physiotherapist using standardized approaches (e.g., class attendances, exercise log, online health journal) prior to discharge from post-acute rehabilitation. [LOE-I]
Across continuum (all phases)
IF a patient is undergoing a primary TKA for OA, THEN … 66. Assessment of satisfaction with the rehabilitation process and outcomes in all care phases (pre-, acute- and post-acute) using a standardized tool(s) should be documented by a member of the healthcare team. [LOE-II] 67. AND the health record specifies a follow-up appointment, transfer of care to another rehabilitation provider or setting (e.g., transfer from acute care to out-patient care setting), or referral to another rehabilitation provider (e.g., referral to physiotherapy or occupational therapy), THEN a transfer form or discharge summary AND evidence that this visit or treatment took place, was postponed or was declined by the patient, should be documented in the health record. [LOE-I]

LOE[42], highest level available to support QI statement at time of Delphi survey.

† In response to panelists' comments, this statement reflects physiotherapist-supervised exercise and does not preclude a second session of exercise therapy supervised by a rehab assistant or other trained health professional.

‡ Panelists recommended these concepts be separated into two separate QIs as they represent different constructs.

proposed QI and the LOE made available to panelists in advance, their clinical judgement was designed to be informed by the supporting evidence[27,34]. For several rehabilitation topics including pre-operative pain coping skills training, post-acute rehabilitation timing, setting and format, the authors determined there was insufficient evidence to propose a QI. This decision was also supported by the external advisory committee.

While 67 QIs is a large number, these QIs deal with two surgical procedures and across multiple care phases. The majority of QIs (14 in THA; 16 in TKA) address the pre-operative phase and are applicable across an extended period of time. Median wait times for elective THA and TKA in Canada in 2015 were 86 and 104 days respectively allowing sufficient time to implement the care processes identified by the related pre-operative QIs (Available at: http://waittimes.cihi.ca/. Accessed 20 April 2017). Fewer indicators may be more feasible to apply in routine clinical practice, however, this reduced scope would fail to capture important aspects of rehabilitation care not currently assessed and monitored through TJA registries or electronic health records. It is anticipated that planned pilot testing in varied clinical settings will elucidate which QIs are most important and feasible to use. There are, however, some less tangible features which will make some QIs challenging to measure. For example, determining whether a patient's record has sufficient information to determine if an exercise program was individualized to that patient's functional needs will require exploration.

Of the 31 QIs for THA rehabilitation, 27 nearly identical QI statements were accepted for TKA. The greatest overlap was for the post-acute phase where the same eight QIs are reflected in both sets. However, the evidence supporting these overlapping statements and their respective ratings differ necessitating their being presented separately. For example, assessment of physical function using one or more standardized performance-based test received median importance and validity ratings of eight and seven for THA (QI #24) and eight and eight for TKA (QI #61) yet only one of seven sources of evidence available to support the TKA indicator was also relevant to THA.

Similar to QI sets for OA[14] and TJA surgical care with its 68 QIs[5], the majority of indicators address processes of care rather than structure or outcomes. We were only able to generate one outcome QI related to THA and TKA rehabilitation due to limited high quality evidence. While it can be argued that measures reflecting care outcomes are of greatest importance when assessing quality of care, process measures have inherent face validity and are more under providers' control, easier to interpret, and more sensitive to changes in quality of care[45]. Ryan *et al.* analysed retrospective longitudinal data from 7,228 family practices participating in the UK-based Quality and Outcomes Framework pay-for-performance program and were able to attribute between 17.7% and 34.7% of improvements in composite outcomes for five different chronic health conditions to improvements in processes of care[1]. Routine collection of outcome measure data as recommended by several QIs may enable development of additional outcome indicators in the future.

As specific measurable aspects of healthcare, clinicians can use the QIs to implement evidence-based recommendations, guide clinical decision-making, and evaluate and report on rehabilitation treatment effectiveness to key stakeholders including patients and orthopaedic surgeons[46]. Rehabilitation managers and senior decision-makers can use QI data to identify care gaps and achievement of benchmarks, and guide quality improvement initiatives[25,27,46]. Patients and their family members can use QIs to engage in their own care including making informed decisions about their rehabilitation options, select providers and programs, and monitor the quality of rehabilitation received[25]. Additional applications for QIs in physiotherapy practice have been described elsewhere[46].

Strengths

This research adhered to a rigorous Delphi methodology based on the systematic RAND/UCLA approach[34]. Broad stakeholder involvement and engagement of an external advisory committee helped to ensure relevant and timely aspects of TJA rehabilitation care were addressed. Inclusion of patient experts with processes in place to ensure they had an equal voice, is widely accepted and encouraged in QI and guideline development[47]. It was evident from the panelists' questionnaire responses that there was transparency in the research methodology and overall satisfaction with the QI development process similar to or greater than reported in other Delphi studies[47]. Use of online technology for both the rating and discussion forum activities allowed flexible participation and permitted wide geographical representation that would not have been possible with a face-to-face consensus meeting. Developing and administering our own web-based survey and discussion forum allowed us to retain greater control of the online process, analysis and participant feedback than is possible with proprietary platforms[48].

The accepted QIs span the rehabilitation continuum and acknowledge patients' and clinicians' views on the importance of

preparing for these elective surgical procedures well in advance and actively engaging in rehabilitation and therapeutic exercises for up to a year after surgery to promote optimal functional recovery and participation in valued activities[29,49]. Our indicator sets differ from those previously published for OA and TJA as they focus on rehabilitation care and outcomes rather than primarily medical[14] and surgical[5] processes of care. However, there are some similarities in measurement constructs and QI statements among these sets. For example, SooHoo *et al.*[5] included "… patient should undergo a preoperative education program including any combination of the written, electronic, video and health professional education regarding surgery and post-operative recovery"; however, provide no further details and no LOE supporting this statement. Neither do these other QI development processes include patients on their expert panels[5,14]. Further, the surgical QIs for THA and TKA address the short-term perioperative period only with the exception of one indicator suggesting routine radiographic follow-up[5]. Our indicators address the continuum of care which may extend over 18 months or longer.

Study limitations

The scientific evidence used to inform the consensus process was limited to English language literature published or reported before September 2014. High quality evidence that has since been published and/or evidence published in other languages may have influenced panelist ratings and resultant QIs. Only Canadian healthcare providers, researchers and patients comprised the expert panel which may limit the generalizability of results and applicability of the QIs to other countries, healthcare systems and care delivery models[50]. The decision to form a Canadian-only panel was based on our aim of developing QIs relevant to the Canadian and primarily publicly-funded healthcare system and awareness of differing views on provision of rehabilitation services between Canadian and American healthcare providers and researchers[21]. Use of the QIs outside of the Canadian context will need to be explored before their applicability and feasibility can be established.

Some proposed QIs were rated as highly important and valid for the one surgical procedure yet despite similar levels of available evidence, were not accepted for the other procedure. For example, the acute THA QI pertaining to provision of a discharge follow-up and care plan (e.g., follow-up appointments with surgeon, referral to community or home-based rehabilitation) received a median importance rating of nine yet a validity rating of five. The same QI for TKA (QI #57) was rated nine (importance) and seven (validity) and therefore accepted. Both statements were supported by LOE V (expert opinion). Most clinicians (and patients and their families) would agree that provision of printed information on steps to follow after hospital discharge is more likely to result in appropriate, effective and efficient patient care and better patient satisfaction and outcomes. Furthermore, discharge planning and documented follow-up care are considered important aspects of quality of care by the Centers for Medicare and Medicaid[9], and included in SooHoo *et al.'s* surgical QI set[5]. One questions the need for further research on this topic specific to patients undergoing THA.

Another limitation is that these QIs were developed for elective TJA for OA and likely do not reflect the needs and care issues of those undergoing TJA for inflammatory arthritis, acute hip fracture, or other non-arthritis causes. Finally, three panelists did not complete the consensus process and their views and ratings may have influenced the final results.

Next steps/future directions

To facilitate the implementation of these QIs in clinical practice, we will need to develop targeted strategies for different stakeholder groups[25]. The QI statements will be converted to plain language statements and patient-friendly tools developed to encourage patient and family engagement and use of the QIs throughout the TJA care continuum. For clinicians to use the QIs in real-time to inform patient care, feasibility and reliability of collecting QI data across varied practice settings and data sources (i.e., electronic health records, paper charts) will need to be established. As noted previously, detailed rehabilitation care processes and outcomes are not included in most clinical TJA registries and thus additional tools will be developed to record QI data that minimize clinician burden and optimize usability and feasibility.

The impact of implementing the QIs in varied clinical settings on short and long-term patient outcomes, experiences, adverse events and use of healthcare resources needs to be evaluated to establish their value as measures of quality of care in TJA rehabilitation. Collaboration with international colleagues will be essential to determine the applicability and feasibility of using the QIs in other healthcare systems and care delivery models. Such international partnerships will permit comparison of rehabilitation care and patient outcomes across larger groups of patients and providers and may lead to innovative quality improvement initiatives.

Conclusion

This work represents the first sets of QIs with which to measure, report and benchmark quality of care in patients receiving rehabilitation before and after THA and TKA for OA. The QIs need to be tested for reliability and feasibility before being widely disseminated and implemented in clinical settings and used to assess and address rehabilitation care gaps.

Author contributions

MDW and CAJ conceived and designed the study. MDW analysed the data and all authors interpreted the data. CAJ and MDW obtained funding for this study. MDW drafted the paper. MDW has full access to all of the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis. All authors critically revised the article for important intellectual content and approved the final article.

Conflict of interest

None of the authors has competing interests.

MDW was a postdoctoral fellow and held a Canadian Institutes of Health Research postdoctoral fellowship (2012–2015) during the study period.

DM is a Canada Research Chair in Health Services and Systems Research and the Arthur J.E. Child Chair Rheumatology Outcomes Research.

CAJ is an AIHS Population Health Investigator.

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Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.joca.2017.10.020.

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