Arthritis Care & Research
Vol. 66, No. 3, March 2014, pp 411–423
DOI 10.1002/acr.22164

ORIGINAL ARTICLE

Expert Consensus on Best Practices for Post–Acute Rehabilitation After Total Hip and Knee Arthroplasty: A Canada and United States Delphi Study

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Objective. **To synthesize professional and patient expertise with available evidence to recommend best practices for post–acute rehabilitation following primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) for osteoarthritis (OA).**

Methods. **Two expert panels of clinicians, researchers, and patients from Canada and the US participated in a 3-round, online Delphi survey.**

Results. **Consensus was reached on 22 THA and 24 TKA best practice key statements. Recommendations common to both procedures included the need for supervised rehabilitation interventions provided by trained health professionals early after discharge from the acute care setting to optimize patient outcomes. Personal and environmental contextual factors were identified as influencing the process and outcomes of THA and TKA rehabilitation. Routine outcome assessment was recommended and several standardized outcome tools identified. Short-term followup care in the first 2 years postsurgery was recommended for both procedures. Specifics on timing, rehabilitation providers, need for long-term followup, and interventions differed for THA and TKA. Some recommendations received different levels of support based on the type of panelist (patient, physical therapist, surgeon), professional role (clinician, researcher), and/or country.**

Conclusion. **A rigorous consensus method led to key recommendations for post–acute rehabilitation after primary THA and TKA for OA, which together with available evidence and acknowledgment of contextual factors will inform the development of clinical practice guidelines. This is an important step toward reducing practice variation, closing the evidence–practice gap, and improving the quality of rehabilitation services after THA and TKA.**

INTRODUCTION

There is increasing demand for total hip arthroplasty (THA) and total knee arthroplasty (TKA) surgery as a cost-effective treatment for the refractory pain and activity limitations of end-stage osteoarthritis (OA) (1–3). In 2010–2011, more than 496,000 THA and 762,000 TKA procedures were performed in Canada and the US (4,5). While rehabilitation is considered important to achieve optimal results, there are differing views on rehabilitation practices and outcomes (6) and considerable variation in program delivery and duration (7–10). Also, little is known about the contribution of rehabilitation to long-term outcomes (2). Protracted physical impairment (11) and activity limitations are reported (12–15), and systematic reviews of physical therapy interventions postsurgery conclude that no one particular approach is clearly superior in addressing these and other outcomes (16–22). There are no North American evidence-based clinical practice guidelines (10) to inform health professionals' and patients' decisions about appropriate rehabilitation care.

Ideally, high quality consistent evidence informs guidelines (23). In total joint arthroplasty (TJA) rehabilitation, the evidence is limited, of variable quality, and inconsistent (16–22). Therefore, best practice recommendations and guidelines need to be based to some extent on consen-

Supported by the British Columbia Medical Services Foundation. Dr. Westby's work was supported by a Canadian Institutes of Health Research Strategic Training Fellowship in Quality of Life Research and a Roman Babicki Fellowship in Medical Research, University of British Columbia.

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Submitted for publication January 23, 2013; accepted in revised form September 3, 2013.

Significance & Innovations

- This is the first formal consensus process to integrate available evidence and expert opinion from relevant stakeholders to recommend key aspects of post–acute rehabilitation after primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) for osteoarthritis.
- The expert panel recommended structured, health professional–led rehabilitation initiated early in the postoperative period to optimize patient outcomes after THA and TKA.
- In addition to physical rehabilitation, it is important to recognize the influence of contextual factors that impact rehabilitation structures, processes, and outcomes.
- The Delphi panels included patients and a novel "patient veto" approach to ensure that professional panelists remained patient-centered in their deliberations.

sus of relevant stakeholders and experts (24). The Delphi method integrates available evidence, attempts to ensure scientific credibility and methodologic transparency (24), and has been used in guideline development (23–25), rheumatology (26,27), and orthopedic surgery (28).

This study aimed to incorporate health professional expertise and patient experience with available evidence to achieve consensus on best practices for post–acute rehabilitation following THA and TKA, address the gaps in the literature, and inform the development of evidence-based clinical practice guidelines.

MATERIALS AND METHODS

Participant recruitment. Panelists were identified purposively through word of mouth, Canadian and US professional and consumer organizations, rehabilitation institutions, and the literature. Invited persons included individuals who had undergone THA or TKA, orthopedic surgeons specializing in TJA, primary care and specialist physicians, as well as rehabilitation professionals, researchers, and decision-makers. We asked health professionals and researchers to choose whether to serve on one or both panels based on their area of expertise and inclusion criteria (see Supplemental Appendix 1, available in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/acr.22164/abstract). The sampling intent was to include diverse perspectives to more fully explore areas of uncertainty (23–25). We aimed for 40 individuals per panel to be consistent with other Delphi surveys in health care (27,28). Panelist demographic data were collected during round 1 to reflect baseline composition of each panel (Table 1).

Delphi questionnaires (rounds). Two separate Delphi surveys were conducted for THA and TKA rehabilitation. We used a modified Delphi approach in which information is provided for initial rating, thereby reducing the number of rounds needed to reach consensus (29). A summary of evidence with assigned grades (18,21) and glossary were sent to panelists in advance to provide them

Table 1. THA (n = 38) and TKA (n = 42) panelist demographics by primary role (round 1)*

	Clinicians/ surgeons†		Academics/ researchers‡		Other§		Patients	
	THA (n = 22)	TKA (n = 22)	THA (n = 10)	TKA (n = 14)	THA (n = 3)	TKA (n = 3)	THA (n = 3)	TKA (n = 3)
Mean ± SD age, years	48 ± 8	47 ± 9	47 ± 7	46 ± 8	52 ± 10	52 ± 10	68 ± 4	71 ± 8
Female sex	55	55	40	50	33	33	67	33
Canadian residents	68	68	60	43	33	33	67	33
Professionals' TJA experience by categories								
NDC	–	–	20	22	–	–	NA	NA
5–14 years	45	50	50	57	33	33		
15–24 years	23	18	10	7	–	–		
≥25 years	32	32	20	14	67	67		
Professionals' TJA patient volume by categories								
NDC	–	–	30	36	–	–	NA	NA
1–99	36	36	20	36	33	33		
100–199	28	28	30	14	33	33		
≥200	36	36	20	14	33	33		

* Values are the percentage unless indicated otherwise. THA = total hip arthroplasty; TKA = total knee arthroplasty; TJA = total joint arthroplasty; NDC = no direct care to TJA patients; NA = not applicable.
† THA panel includes 11 physical therapists (PTs), 2 advanced practice PTs, 1 occupational therapist (OT), 1 rehabilitation assistant, 1 nurse practitioner, 1 primary care physician, 2 rheumatologists (1 dual trained as physiatrist), and 3 orthopedic surgeons. TKA panel includes 12 PTs, 2 advanced practice PTs, 1 OT, 1 rehabilitation assistant, 1 nurse practitioner, 1 primary care physician, 2 rheumatologists (1 dual trained as physiatrist), and 3 orthopedic surgeons.
‡ THA panel includes 4 PTs, 5 orthopedic surgeons, and 1 physiatrist. All are self-identified as "clinician researchers." TKA panel includes 7 PTs, 4 orthopedic surgeons, 1 physiatrist, and 1 physician health services researcher. All are self-identified as "clinician researchers."
§ THA and TKA panels include decision makers/managers (2 orthopedic surgeons) and clinical educator (orthopedic nurse).

with a similar level of knowledge (25). Panelists were surveyed about their use of these tools after the last round. Round 1 addressed rehabilitation parameters and contextual factors from our own (6,18,21) and other literature (30,31). We pilot tested the questionnaires with 13 health professionals and either 3 THA or 3 TKA patients, which led to minor revisions (32,33). Panelists rated their level of agreement on key statements using a 5-point Likert scale (where 1 = strongly disagree, 2 = disagree, 3 = neutral/no opinion, 4 = agree, and 5 = strongly agree) and were instructed to comment and/or justify their responses after each section. Each statement included several related items aimed at generating greater detail. Additional statements were added to round 2 based on panelist comments. The questionnaires were administered online using the Arthritis Research Centre of Canada's Survey System.

Descriptive group statistics, individual responses, and comments were fed back to panelists after rounds 1 and 2 (34,35). We asked panelists to reflect on this feedback before subsequent rounds (29,34). To maximize response rates, regular reminders, personalized thank-you notes, and a $100 honorarium were provided (29).

Data analysis. Panelists were asked a priori to state the level of agreement that would ensure confidence about the recommendations (24), and 80% was established as consensus for key statements and related items. The cut point for items to be included in subsequent rounds was set at ≥50% (25); however, if 2 of 3 patient panelists felt an item was important despite <50% of full panel agreement, the item was flagged and included in the subsequent round for further consideration. This novel "patient veto" approach was used to ensure that professionals remained patient centered in their deliberations. Panelists were advised of these procedures prior to the first round.

Consistent with other Delphi studies (36,37), we used descriptive statistics (mean ± SD, range) and level of agreement (percentage of respondents selecting "agree" or "strongly agree" for Likert items or "yes" for dichotomous items) after each round (33). In round 3, panelists were asked to rate rehabilitation interventions, outcomes, and outcome measurement according to their importance or clinical feasibility.

Exploratory subgroup analyses were conducted when there was lack of agreement or highly divergent ratings. Three subgroups were determined a priori based on earlier research (6): panelist type (physical therapist [PT], surgeon, or patient), professional role (clinician/surgeon or researcher), and country (Canada or US). Group means for key statements were compared using one-way analysis of variance (SPSS, version 17). Statistical significance was set at P less than or equal to 0.05. Categorical data for individual items were analyzed descriptively by comparing frequency counts and proportions.

After each round, new topics/items were identified. Two authors (MDW and AB) independently reviewed and coded data using an agreed upon coding framework. Common concepts were grouped into categories and themes (33,35). Examples of positive (supportive), negative, and outlier comments were independently selected, agreed upon, and then fed back to panelists (23,38) along with their individual and pooled ratings approximately 10 days before rounds 2 and 3.

The study was approved by the University of British Columbia Behavioural Research Ethics Board and other appropriate institutions. Participants were assured anonymity during the Delphi rounds and all gave permission to be acknowledged by name (see Supplemental Appendix 1, available in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/acr.22164/abstract).

RESULTS

Participants and response rates. *THA panel.* Of the 60 professionals and patients invited to participate on the THA panel, 40 (67%) accepted, of whom 34 (85%) completed the 3 rounds. Response rates and reasons for withdrawal are shown in Figure 1. All patient panelists were retired and had participated in structured rehabilitation following their THA; 2 patient panelists had postgraduate degrees.

TKA panel. Of the 60 experts invited to serve on the TKA panel, 47 (78%) accepted, of whom 38 (81%) completed the 3 rounds. Thirty professionals served on both THA and TKA panels. Panelist withdrawals and reasons by round are shown in Figure 1. All patient experts had some college or higher education, 2 of 3 were working part time, and all had participated in some form of structured rehabilitation after their surgery.

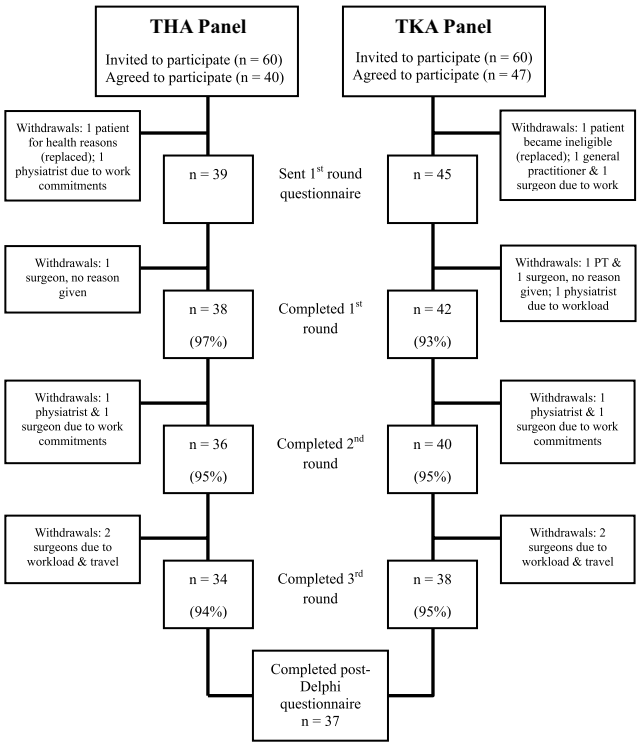

Figure 1. Flow chart of panelist response rates and withdrawals by round. THA = total hip arthroplasty; TKA = total knee arthroplasty; PT = physical therapist.

Table 2. Summary of key best practice recommendations and level of agreement for post–acute rehabilitation after primary THA and TKA for OA*

After primary TJA for OA with a typical acute care length of stay ≤5 days and no perioperative complications, the expert panels recommend that:
Patients be offered structured post–acute rehabilitation for THA (91%) and TKA (95%)
For THA, patients be screened preoperatively to assess their needs for structured post–acute rehabilitation (82%)
Personal (THA [94%], TKA [97%]) and external (THA [85%], TKA [90%]) factors be identified and considered for their influence on need for post–acute rehabilitation
It is important to distinguish between an early and late phase of post–acute rehabilitation, based on stages of tissue healing and recovery of muscle function after THA (94%) and TKA (97%)
Patient-specific needs and preferences be considered when applying rehabilitation best practice recommendations for THA (94%) and TKA (97%)
Post–acute rehabilitation be provided by trained professionals with knowledge and clinical experience in arthritis and THA (97%) and TKA (97%) surgery
Standardized, evidence-based training be available to health professionals to ensure they have the knowledge and skills to provide safe and effective rehabilitation care to individuals undergoing THA (88%) and TKA (95%)
For TKA, post–acute rehabilitation be provided through direct health professional supervision (87%); self-directed rehabilitation is not recommended (82%)
Timing of post–acute rehabilitation is important for optimal patient outcomes after THA (88%) and TKA (97%)
Personal (THA [100%], TKA [95%]) and external (THA [85%], TKA [90%]) factors be identified and considered for their influence on setting for post–acute rehabilitation
Appropriate rehabilitation interventions be provided for optimal patient outcomes after THA (88%) and TKA (92%)†
For TKA, overall dose of post–acute rehabilitation is important for optimal patient outcomes (84%)
Personal (THA [97%], TKA [92%]) and external (THA [91%], TKA [95%]) factors be identified and considered for their influence on overall dose of post–acute rehabilitation
Body structure and function outcomes be routinely assessed after THA (94%) and TKA (95%)
Activity and participation outcomes be routinely assessed after THA (94%) and TKA (97%)
Personal (THA [94%], TKA [100%]) and external (THA [94%], TKA [97%]) factors be identified and considered for their influence on patient outcomes
Appropriate tools or methods be used to measure body structure and function outcomes after THA (97%) and TKA (97%)
Appropriate tools or methods be used to measure activity and participation outcomes after THA (94%) and TKA (97%)
Patients be monitored on a short-term followup basis (for a 2-year period) after THA (88%) and TKA (95%) and on a long-term basis after TKA (84%)
Patients have access to appropriate followup services to address their needs in the initial 2-year period after THA (94%) and TKA (97%)

* Percentages show key statements achieving ≥80% agreement in round 3. THA = total hip arthroplasty; TKA = total knee arthroplasty; OA = osteoarthritis; TJA = total joint arthroplasty.
† "Appropriate" refers to rehabilitation interventions that are judged suitable for primary THA and TKA patients during the post–acute rehabilitation period and were not further defined for panelists.

All THA and TKA panelists reported English as their first language. Only panelists who completed the previous round were included in the subsequent round. All recommendations are based on round 3 results.

Of the 37 (84%) panelists who completed the THA and/or TKA round 3 and responded to the post-Delphi questionnaire, 73% and 57% "read most" or "read all" of the evidence summary and glossary of terms, respectively, and 80% responded that the evidence summary "somewhat" or "significantly" influenced their Delphi ratings (data not shown).

Results by rounds. Of the 28 key statements in round 1, consensus was achieved for 17 THA and 19 TKA statements. Of the 89 THA items below the 50% cut point, 21 were selected by 2 or more patient panelists and therefore retained for round 2, and 75 new items were suggested. For TKA, 94 items received <50% support; however, 22 of these were retained through the patient veto process and 57 new items were generated.

In round 2, consensus was achieved for 19 of 31 key THA statements and 22 of 32 TKA statements, both reflecting additional key statements generated in round 1. For THA, 27 new items were suggested, 52 items were below the cut point, and 21 of these were retained by patient veto for round 3. For TKA, 43 new items arose and of the 38 items below the cut point, 12 were selected by patient veto for round 3.

For THA in round 3, consensus was achieved on 22 of 33 key statements (reflecting 3 additional key statements available in this round). For TKA, panelists reached consensus on 24 of 33 key statements (reflecting 1 new statement available in round 3) (Table 2). Key statements not achieving consensus continued to have the greatest variability and number of comments. The patient veto process resulted in 2 THA items reaching consensus in this final round, but had no impact on TKA items. Detailed ratings by round are in Supplemental Appendices 2 and 3 (available in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/acr.22164/abstract).

Table 3. Contextual factors that influence delivery and outcomes of post–acute rehabilitation after THA and TKA*

	Need for rehabilitation		Timing		Setting		Dose		Outcomes	
	THA	TKA	THA	TKA	THA	TKA	THA	TKA	THA	TKA
Personal factors										
General health	●	●			●	●	●	●	●	●
Body weight									●	
Other symptomatic joints									●	●
Fitness level	●	●			●	●			●	●
Pain status			●	●			●	●	●	●
Healing/wound status			●	●						
Postoperative complications			●	●	●			●	●	
Functional status	●	●	●	●	●	●		●	●	●
Psychological status	●								●	●
Mental/cognitive status		●		●	●	●	●		●	●
Patient expectations and goals	●	●					●	●	●	●
Patient attitude							●		●	●
Patient engagement and motivation							●	●	●	●
Physical response to rehabilitation							●	●		
Patient adherence										●
External factors										
Support of spouse/family	●	●	●		●	●	●	●		●
Attitude of physician	●									
Access/availability of rehabilitation professionals			●	●	●	●	●	●	●	●
Access to rehabilitation programs									●	●
Waiting time for rehabilitation services				●						
Access to transportation				●	●	●	●			●
Health insurance policies/coverage						●	●			
Health care system/policies				●				●		
Health professional skills									●	●
Surgeon skills									●	●

* Bullets show factors achieving ≥80% agreement in round 3. THA = total hip arthroplasty; TKA = total knee arthroplasty.

Results by rehabilitation topic. *Rehabilitation phases.* Both panels agreed it was important to differentiate between an early and late phase of post–acute rehabilitation based on stages of tissue healing and recovery of muscle function. However, neither panel reached consensus on timing and duration of each phase. For THA, "early phase" suggestions ranged from 3 to 16 weeks and "late phase" from 12 weeks to 8 months postsurgery. For TKA, early phase suggestions similarly ranged from 3 to 16 weeks; however, late phase extended from 12 weeks to 12 months. Consensus was not reached on need for a "maintenance" or "post-rehab" phase for either procedure (for panelists' comments, see Supplemental Appendix 4, available in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/acr.22164/abstract).

Subgroup analysis showed no difference in mean ratings by panelist type regarding the importance of a phased approach among THA ($P = 0.63$) and TKA ($P = 0.75$) panelists. Surgeons rated the value of a maintenance phase lower than patients and PTs; however, differences were not statistically significant ($P = 0.07$ for TKA, $P = 0.73$ for THA).

Need for post–acute rehabilitation. Both panels reached consensus on the need for structured post–acute rehabilitation and this view was consistent across panelist type ($P = 0.10$ for THA, $P = 0.14$ for TKA) and country ($P = 0.45$ for THA, $P = 0.98$ for TKA). Panelists identified a number of personal and environmental factors that influenced this need (Table 3). Preoperative screening to identify patients most in need of rehabilitation was recommended by THA panelists with no significant differences by subgroups ($P = 0.20$ to $P = 1.00$).

Rehabilitation providers. Both panels agreed that trained health professionals should provide rehabilitation after TJA. Fewer TKA researchers agreed with this statement than did clinicians ($P = 0.04$), while no difference by role ($P = 0.13$) was observed among THA panelists. PTs were suggested as appropriate rehabilitation providers by 95% of THA and 100% of TKA panelists. Occupational therapists were identified as appropriate providers for THA rehabilitation only. Other providers with >50% support were rehabilitation or PT assistants (THA 77%, TKA 70%) and advanced practice PTs (70% TKA). Panelists agreed there was a need for standardized, evidence-based training on TJA rehabilitation for health professionals.

Rehabilitation format. The recommendation of direct supervision, defined as "in-person supervision or guidance from a health professional through individual or group treatment," did not reach consensus for THA but did for TKA. Individual or 1-to-1 treatment was supported by

both panels. Group treatment with THA-only patients missed consensus (77%); likewise for groups of TKA-only patients (70%). Of the panelists supporting group treatment, 87% (THA) and 70% (TKA) indicated that small groups (1 provider to 3–4 patients) were most appropriate. There was no consensus (THA 53%, TKA 39%) on the appropriateness of reduced or indirect supervision. Self-directed rehabilitation with no professional supervision or guidance was rated inappropriate by 79% of THA panelists and 82% of TKA panelists.

Subgroup analyses revealed no differences in Canadian and American views on appropriateness of various levels of professional supervision ($P = 0.34$ to $P = 0.84$); however, significant differences were found for all supervision levels when comparing THA panelist type ($P < 0.01$ to $P = 0.03$) with patients and PTs recommending greater supervision than surgeons. While TKA surgeons rated appropriateness of direct supervision slightly lower and reduced supervision higher than did patients and PTs, differences were not statistically significant ($P = 0.14$ for both comparisons).

Rehabilitation timing. A high proportion of both panels agreed timing of post–acute rehabilitation was important for optimal outcomes; however, neither panel reached consensus on the ideal timing. Overall, 61% of THA panelists suggested "within 1 week" of discharge from the acute-care hospital and a further 27% selected "1 to 3 weeks." Recommendations differed among subgroups with all patients suggesting within 1 week compared to 59% of PTs and 43% of surgeons. All patients, 88% of PTs, and 86% of surgeons agreed rehabilitation for THA should start within 3 weeks of discharge. For THA, patients and PTs rated timing as more important than did surgeons ($P < 0.01$).

For TKA, just under half of PTs and surgeons and 2 of 3 patients agreed rehabilitation should start "within 72 hours" of hospital discharge. The final recommendation that structured TKA rehabilitation be initiated within 1 week of discharge was determined by combining response options and 89% of panelists agreeing with this time frame. Several contextual factors were identified as influencing rehabilitation timing (Table 3).

Rehabilitation setting. The importance of rehabilitation setting after THA did not reach consensus as 38% of panelists remained undecided or neutral regarding its impact on outcomes. At 79%, TKA panelists approached consensus on this parameter. There was unanimous support for rehabilitation provided in outpatient PT departments with similar levels of support for private PT clinics (THA 97%, TKA 94%). Acute hospital rehabilitation units, inpatient rehabilitation facilities, and skilled nursing facilities received <70% support by both panels, and home-based rehabilitation was endorsed by 77% (THA) and 78% (TKA). Contextual factors influencing rehabilitation setting are in Table 3.

More TKA patients than PTs and surgeons ($P = 0.03$) rated rehabilitation setting as important after TKA and there was a similar trend for THA ($P = 0.09$). More clinicians than researchers rated setting as important after THA ($P = 0.06$) and TKA ($P = 0.11$), although differences were not significant. There was no difference by country for THA and TKA ($P = 0.68$ and $P = 0.48$, respectively).

Table 4. Recommended post–acute rehabilitation interventions after primary THA and TKA*

	THA	TKA
Therapeutic and functional exercises		
Active ROM	●	●
Passive ROM		●
Strength training	●	♦
Stretching	♦	●
Postural training	●	●
Core stability training	●	
Home exercises	♦	♦
Static balance	●	●
Dynamic balance	♦	♦
Neuromuscular re-education		●
Stair climbing	♦	♦
Rising/lowering to chair	♦	♦
Rising/lowering to floor	●	●
Transfer in/out of car	●	●
Transfer in/out of bathtub	●	●
Transfer on/off toilet	●	●
Dressing	●	
Gait training		
Correct use/progression of walking aids	♦	●
Correction of altered gait pattern	♦	●
Ensuring proper weight-bearing status on operated extremity	♦	
Indoor/outdoor training		●
Variable surface training		●
CV training		
Low–moderate intensity CV training		●
Use of appropriate CV machines (e.g., stationary bike)		●
Electrical/thermal modalities		
Ice (cryotherapy)		●
Manual therapy		
Massage for swelling		●
Massage for scar mobility		●
Passive stretching techniques		●
Proprioceptive neuromuscular facilitation		●
Joint mobilizations (e.g., glides)		●
Patient education topics		
Monitoring for complications	♦	♦
Position/movement restrictions	♦	●
Return to driving	♦	●
Sexual activity/safe positioning	●	●
Safe use of toilet	●	●
Safe use of bath/shower	●	●
Return to recreational/sporting activities	●	●
Ergonomic/work station set-up	●	●
Use of assistive devices	●	●
Appropriate footwear	●	●
Use of medications for pain management	●	●
Use of nonmedication techniques for pain management	●	●
Long-term joint protection	●	●
Safe exercise intensity/progression	●	●

* THA = total hip arthroplasty; TKA = total knee arthroplasty; ROM = range of motion; ● = interventions rated as "appropriate and somewhat important" or "appropriate and very important" by ≥80% of panelists; ♦ = interventions rated as "appropriate and very important" by ≥80% of panelists; CV = cardiovascular.

Rehabilitation interventions. Both panels agreed that appropriate rehabilitation interventions were needed to achieve optimal outcomes, and a number of specific inter-

Table 5. Recommended outcomes to routinely assess and/or monitor after primary THA and TKA*

	THA	TKA
Body structure and function outcomes		
Pain (at rest)	♦	♦
Pain (with activity)	♦	♦
Pain (coping)	●	●
Knee effusion		●
Lower extremity edema		●
Sleep functions	●	
ROM (operated joint)	●	♦
ROM (other lower extremity joints)	●	●
Leg length discrepancy	●	
Posture and alignment	●	●
Gait (pattern, use of aids)	♦	♦
Joint proprioception (position sense)	●	●
Joint (ligamentous) stability		●
Muscle strength (operated extremity)	♦	♦
Muscle strength (nonoperated extremity)	●	●
Muscle strength (upper extremities)	●	●
Muscle recruitment/voluntary activation	●	●
Muscle atrophy	●	●
Core stability (trunk/pelvic deep muscle control)	●	●
Coordination		●
Soft tissue flexibility (contractures)	●	♦
Wound/tissue healing	●	●
Energy and vigor	●	●
Emotional functioning (stress, coping)		●
Activity and participation outcomes		
Static balance	●	●
Dynamic balance	♦	♦
Walking speed	●	●
Walking distance	●	●
Stair ascent/descent	♦	♦
Carrying/lifting	●	●
Ability to use public transportation	●	●
Ability to drive a vehicle	●	●
Run errands/shop	●	●
Ability to do self-care (dressing)	♦	♦
Ability to attend social functions		●
Ability to attend/participate in religious activities (pray, kneel)	●	●
Ability to travel (air travel, bus tour)		●
Ability to do light household activities (cooking, dusting)	●	●
Ability to do moderate/heavy household activities (laundry, vacuum)		●
Ability to do light outdoor work		●
Ability to do moderate/heavy outdoor work (rake leaves, shovel snow)		●
Ability to participate in sexual activity	●	●
Ability to perform care-giving activities (to child or spouse)	●	●
Ability to participate in low/moderate intensity leisure/sporting activities	●	●
Ability to participate in paid employment	●	●
Ability to participate in unpaid/volunteer employment		●
Other outcomes		
Patient satisfaction with rehabilitation outcomes/process	●	●
Self-efficacy for exercise	●	●
Self-efficacy for rehabilitation	●	●
Health-related quality of life	●	
Patient knowledge (e.g., postoperative complications, precautions)	●	●
Patient global assessment (self-rating of how he/she is doing)	●	●
Health professional/surgeon global assessment (how patient is doing)	●	●

* THA = total hip arthroplasty; TKA = total knee arthroplasty; ♦ = outcomes rated as "very important" by ≥80% of panelists; ● = outcomes rated as "somewhat" or "very important" by ≥80% of panelists; ROM = range of motion.

ventions reached consensus (Table 4). More TKA interventions reached consensus, while THA panelists rated several interventions as "appropriate but not important," including low to moderate intensity cardiovascular train-

ing, pool-based exercises, cryotherapy, and passive stretching (data not shown). Subgroup analyses revealed that THA patients rated the overall importance of appropriate interventions higher than PTs and surgeons ($P < 0.01$), while TKA patients rated importance lower ($P = 0.02$). No differences were observed by country ($P = 0.65$ for THA, $P = 0.19$ for TKA).

Rehabilitation dose. Panels missed consensus (77%) for THA and achieved consensus for TKA regarding the importance of overall rehabilitation dose for optimal outcomes. However, this statement was inadvertently left out of the first 2 rounds of the THA Delphi and initial round of the TKA Delphi due to a technical error, so we could not explore rating trends. Several contextual factors were felt to influence dose (Table 3). There was no consensus on specific dose parameters of duration, frequency, and number of treatment sessions. For THA, greatest support was for "4 to 8" weeks of supervised post–acute rehabilitation (range <4 weeks to 20–24 weeks); however, this differed by panelist type with patients recommending no less than "8 to 12" weeks of treatment. Treatment frequency was more consistent with greatest support for 2 to 3 times per week. Almost half of PTs, however, recommended an "individualized approach" as did a smaller proportion of surgeons and patients. The recommended number of sessions ranged from "5 to 9" to "24 to 36"; however, greatest support (56%) was for an individualized approach.

For TKA, there was equal support (40%) for 4 to 8 weeks and 8 to 12 weeks (range <4 weeks to 20–24 weeks) of supervised rehabilitation. Similarly, consensus was not reached for treatment frequency (42% selected 2 to 3 times per week) or number of sessions (29% selected "15 to 19" sessions, range "5 to 9" to "24 to 36" sessions).

Surgeons rated rehabilitation dose less important than patients and PTs for both THA ($P = 0.02$) and TKA ($P < 0.01$), while no statistically significant differences were noted by professional role ($P = 0.51$ for TKA) and country ($P = 0.15$ for THA, $P = 0.68$ for TKA). Approximately one-quarter of both panels indicated that dose parameters should be tailored to patients' specific needs and rehabilitation goals.

Rehabilitation outcomes. Both panels agreed it is important to routinely assess and monitor "body structure and function" and "activity and participation" outcomes after primary THA and TKA. While there was not overall consensus on the importance of outcomes not captured by the International Classification of Functioning, Disability and Health (ICF; THA 53%, TKA 79%), individual constructs including health-related quality of life (HRQOL) and patient satisfaction were recommended (Table 5). Panelists agreed that several contextual factors influenced outcomes (Table 3).

More Canadian panelists felt that "access to rehabilitation professionals" after THA (91% versus 67%) and TKA (95% versus 77%) impacted outcomes, while a similar proportion from both countries agreed "health insurance coverage and policies" and "health care systems and policies" were factors after THA. More American TKA panelists felt a patient's health insurance (94% versus 75%) influenced outcomes. Further, TKA subgroup analysis revealed different views on non-ICF outcomes with patients rating this category highest and surgeons lowest ($P = 0.02$). There was no significant difference between TKA clinicians and researchers in their ratings of non-ICF outcomes ($P = 0.28$).

Rehabilitation outcome measurement. Routine use of appropriate tools or methods to assess and monitor body structure, function, activity, and participation outcomes was recommended, while measures to assess non-ICF outcomes did not reach consensus. Table 6 lists outcome measures rated as both important and clinically feasible. The importance of routine use of tools beyond ICF categories did not differ by provider type for TKA ($P = 0.30$); however, it was significantly different for THA ($P < 0.01$) with PTs rating this statement higher than patients and surgeons.

Followup care. Both panels recommended short-term followup of patients for up to 2 years after surgery. Long-term followup beyond 2 years approached consensus for THA (79%) and reached consensus for TKA. There was large support for patients having access to appropriate short-term followup services after TJA with surgeon-led followup care recommended. Only PTs (THA 65%, TKA 66%) and advanced practice PTs (THA 62%, TKA 74%) received >50% endorsement as additional followup providers. More Canadian panelists selected advanced practice PTs (THA 77% versus 33%, TKA 91% versus 53%), while more Americans indicated physician assistants (PAs) (THA 33% versus 23%, TKA 59% versus 38%) as appropriate followup providers.

Consensus was not reached on the appropriate schedule of short-term followup visits for either surgery. For THA, recommendations ranged from "once at 6 months" to "6 weeks, 3 months, 6 months, and 1 and 2 years." The greatest support (21%) was for 6 weeks, 3 months, and 1 and 2 years. There was a similar lack of agreement on the duration of long-term followup, which ranged from 1 year to "life time every 3 years." The greatest support (32%) was for "indefinitely." For TKA, recommended followup visits ranged from "once a year" to 4 times at varied intervals in the first 2 years. The greatest support (51%) was for 6 weeks, 3 months, and 1 and 2 years. Again, there was no agreement on the duration of long-term followup, which ranged from 2 years to indefinitely with the greatest support (27%) for the latter.

Other than scheduled clinic visits with the surgeon, the only other recommended followup service achieving consensus was telephone support from a health professional after TKA (87%). Services selected by at least 50% of panelists included community-based THA (50%) and TKA (55%) exercise programs and booster TKA exercise review sessions with a PT (55%).

Qualitative findings. Three themes emerged common to both THA and TKA: 1) the need to distinguish between an early and later phase of post–acute rehabilitation, 2) "best practice" guidelines are not a substitute for clinical judgment and individual patient needs, preferences, and response to treatment, and 3) the need for standardized training to ensure rehabilitation providers have appropriate knowledge and clinical experience to work with TJA

Table 6. Recommended assessment methods and outcome measures to routinely assess and/or monitor outcomes after primary THA and TKA*

	THA	TKA
Body structure and function measures		
Pain visual analog scale	●	●
Numeric pain rating scale	♦	♦
Standard goniometer to assess passive ROM	●	♦
Standard goniometer to assess active ROM	●	♦
Visual observation to assess passive ROM	●	
Visual observation to assess active ROM	●	
Tape measure to assess leg lengths	●	
Visual observation to assess leg lengths	●	
Standard goniometer to assess lower extremity alignment		●
Visual observation to assess lower extremity alignment	●	●
Visual observation of gait	●	♦
Trendelenburg's test	●	●
Patient's ability to reproduce target angle (joint position sense)	●	●
Skin sensation over operated extremity	●	●
Manual muscle testing (e.g., grades 0–5)	●	♦
Palpation/observation to assess voluntary activation/muscle recruitment	●	●
Standardized test positions to assess flexibility/muscle lengths (e.g., Thomas Test for hip flexor length)	●	●
Visual observation of patellar alignment and tracking		●
Ligamentous stress testing (for joint stability)		●
Activity and participation measures		
Timed walk (no distance specified)	●	●
TUG	●	●
Single leg static balance test	●	●
Repeated stands test (sit-to-stand)	●	●
Functional reach test (for balance)		●
Timed stair ascent/descent	●	●
6-minute Walk Test		●
WOMAC score	●	●
Lower Extremity Functional Scale		●
Performance battery (e.g., timed walk, stair climb, and TUG)		●
Other measures		
Numeric rating of patient satisfaction with functional outcome	●	●
Patient satisfaction with rehabilitation process		●
Self-efficacy for self-management		●

* THA = total hip arthroplasty; TKA = total knee arthroplasty; ● = outcome measures rated as "somewhat important and clinically feasible" or "very important and clinically feasible" by ≥80% of panelists; ♦ = outcome measures rated as "very important and clinically feasible" by ≥80% of panelists; ROM = range of motion; TUG = Timed Up and Go test; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

patients. A fourth theme arose from THA panelists: acknowledgment of patient subgroups, such as the frail elderly and young active individuals. Verbatim quotes are in Supplemental Appendix 4 (available in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/acr.22164/abstract). Themes were integrated into subsequent rounds by adding new key statements and items.

DISCUSSION

There were increasing levels of agreement (convergence) for two-thirds of the key statements for both THA and TKA over the 3 rounds, resulting in specific recommendations. However, several rehabilitation topics did not achieve consensus nor was a there a trend toward greater agreement evident. Whether additional rounds would have led to consensus on these topics is unknown; however, examination of mean ratings and variance suggests this was unlikely. For example, TKA panel agreement on indirect or reduced health professional supervision only differed by 4% over 3 rounds and continued to range from strongly disagree to strongly agree. Disparate views regarding rehabilitation format, setting, dose, and specific interventions are strongly entrenched in local practices and widely reported (7–10). There is little evidence supporting any one approach as being superior despite cost savings associated with group programs and mixed economic findings for home-based versus inpatient physical therapy (39).

Differences in THA and TKA rehabilitation key recommendations included the need for preoperative screening, direct health professional supervision, importance of rehabilitation timing and dose, and long-term follow-up. These findings reinforce the need for separate guidelines and rehabilitation regimens, as well as confirm literature showing differing experiences (6) and outcomes (1,11,40,41) for the 2 procedures.

Both panels recommended individual rather than group treatment. Studies published subsequent to our data-gathering period provide additional insights. In a randomized crossover trial, group and individual inpatient rehabilitation were equally effective in restoring ambulation and self-reported function after THA and TKA (42). Similarly, a prospective cohort study (43) and recent randomized controlled trial (RCT) (44) found no difference in self-reported or performance-based function for outpatient group-based exercise compared to individual therapy at home (43) or in an outpatient setting (44). Following TKA, patients report equal preference for group versus individual rehabilitation in an outpatient setting (45).

Panelists' lack of consensus on importance of rehabilitation setting is reflected in the conflicting findings in the literature regarding home-based rehabilitation, with little or no PT supervision, compared to outpatient rehabilitation with direct PT supervision (44–47). A systematic review of acute and post–acute rehabilitation following THA concluded that interventions, in particular progressive resistance training, commenced within a month of surgery resulted in better physical function outcomes when performed in an outpatient center than a patient's home (20).

While both panels agreed post–acute rehabilitation tim-

ing was important, there were disparate views within panels on what was optimal and on differing recommendations for THA and TKA. The literature contributes little to our understanding of optimal timing. One RCT examined the effects of initiating inpatient rehabilitation at different time points and found that only walking speed was significantly better at 1 year post-THA in patients who started rehabilitation within 2 months compared to those who delayed treatment by 3 to 4 months and 11 months postsurgery (48). However, important benefits can be achieved with a progressive and functional exercise program performed as much as 8 months after THA (49).

It is difficult to draw conclusions about the specific contributions of treatment format (i.e., group versus individual), setting, and timing on outcomes without head-to-head comparisons. Therefore, these rehabilitation parameters will likely continue to be determined by patient needs, preferences (45), available resources, reimbursement schemes, and longstanding local practices unless clear cost benefits can be established for one format over another in future research.

Therapeutic exercise comprised most of the recommended rehabilitation interventions after THA and TKA. While a similar number of therapeutic exercise modes reached consensus, a greater number and variety of other therapeutic approaches were suggested for TKA, including cryotherapy, manual therapy, and cardiovascular training. Treatment specifics such as key muscle groups to target and optimal exercise dose, intensity, and progression were beyond the scope of this study. There is some evidence suggesting more intensive, progressive exercise leads to better outcomes (49), greater satisfaction, and exercise adherence (50); however, "intensity" is often poorly described, adherence is inadequately monitored, and results are complicated by marked variability in treatment duration and frequency (18,20,21). Lack of clear consensus in the present study is consistent with literature, indicating optimal exercise dose and progression is unknown (17,18,20,21,51), and there remains a need to identify the "active ingredients" of effective rehabilitation interventions for THA and TKA.

Both panels strongly recommended at the outset that trained health professionals should provide post-TJA rehabilitation. The importance of highly qualified providers was further supported by emergence of the recommendation for standardized evidence-based TJA training. To our knowledge, no widely available training exists in North America.

A similar proportion of recommended outcomes to be measured after TJA fell under "body structure and function" and "activity and participation" domains, yet both panels recommended almost 3 times more of the former. While the recommended outcomes are consistent with previous literature (30,31,52,53), it could be argued that none of them adequately capture participation or "involvement in a life situation" (52). This is of concern because patients value outcomes, such as returning to hobbies and regular exercise/sport early in their recovery from TJA surgery (53). Although patient and PT experts identified HRQOL as an important outcome, no HRQOL tools reached consensus.

Routine use of measures to evaluate treatment effectiveness, monitor patient progress, and communicate findings to patients and other health care professionals is a key element of evidence-based practice (54,55). The marked variation in use of outcome measures in TJA rehabilitation trials (56) and practice makes clinical interpretation and comparison of treatment effects problematic. Our Delphi process represents a first step toward identifying a core set of measures for routine clinical use.

Panelists' ratings reflect the importance of identifying and acknowledging contextual factors that influence the delivery and outcomes of TJA rehabilitation (3,57,58). As examples, personal factors including patient motivation and engagement in the rehabilitation process are linked to better outcomes (59) and a better patient experience (6), and preoperative expectations predict pain and functioning 6 months after surgery (60). Preoperative screening to identify patients most in need of structured post–acute rehabilitation was recommended by the THA panel and suggested as a means to address modifiable personal and provider-level factors that may adversely influence patient outcomes.

As anticipated from our earlier research (6), patients, PTs, and surgeons differed in their ratings for several key statements, including those related to level of supervision, timing, appropriate interventions, and treatment dose. No significant differences were found comparing clinicians and researchers or when comparing Canadian and American panelists' ratings on the key statements examined. However, analysis of individual items revealed some marked differences among the latter groups. For example, at the time of the Delphi survey, there was 1 accredited PA training program in Canada compared to 149 such programs in the US (Jones I: unpublished observation, Canadian Association of Physician Assistants, December 23, 2009), which may explain why fewer Canadian panelists endorsed PAs as followup providers. Subgroup differences should be interpreted with caution due to small and uneven sample sizes.

Regarding the strengths of our study, and to our knowledge, this is the first formal consensus process with Canada–US multidisciplinary panels to recommend best practices for post–acute rehabilitation after primary THA and TKA for OA. "Real world" contextual factors and their impact on rehabilitation structures, processes, and outcomes are also acknowledged. A rigorous Delphi method ensured validity and transparency at all stages while being pragmatic and minimizing panelist burden. Effort was made to ensure panel diversity with respect to consumer and professional representation, practice settings, and geography to enhance external validity of recommendations (35,38). Patients have not been included in recent Delphis in rheumatology (26–28), yet their lived experience undergoing a TJA is important expertise (61). Stakeholder involvement is 1 of 6 domains contributing to guideline quality (62) and often lacking. Our use of the patient veto has not been used in Delphi exercises and resulted in 21 THA and 12 TKA items being retained through 3 rounds. While Delphi response rates of 100% are rare (63), our procedures were successful as evidenced by response rates

that equal or exceed those of other Delphi exercises (29,36,37).

There are some limitations in our study. The greater proportion of surgeon withdrawals from both panels may have led to nonresponse bias, in that those who did not complete the 3 rounds systematically differed in their views from those who did. However, descriptive analyses of these surgeons' round 1 responses suggest they did not represent outlier views. We reported mean ± SD ratings together with percentage agreement and range, similar to other Delphi studies (36,37) and in response to feedback during pilot testing; however, a more appropriate indication of central tendency and dispersion of ratings from ordinal data would be median and interquartile range (23). To maintain a manageable panel size, we limited the number of participants by stakeholder group; thus, not all geographic areas of Canada and the US were included and potentially important regional health policy and practice issues may be missed. Subgroup analyses must be interpreted with caution, as they were exploratory with small sample sizes; yet, statistically significant differences were observed for several aspects of rehabilitation process and outcomes, which may have implications for future guidelines. Including only 3 patients on each panel cannot reflect the range of rehabilitation experiences and outcomes following TJA surgery; however, the patient veto helped ensure their perspectives were valued. Recommendations are limited to post–acute rehabilitation for primary THA and TKA for OA and not generalizable to the continuum of care, revision or bilateral surgery, and individuals undergoing TJA for other diagnoses. Finally, it may have been difficult for the 30 professionals who served on both panels to separate their views and recommendations regarding the 2 procedures.

In conclusion, this study generated expert consensus on best practices for post–acute rehabilitation after primary THA and TKA for OA in Canada and the US. While there was strong overall support for structured, health professional–supervised rehabilitation, details on process, dose, and outcomes were less conclusive. Findings will inform clinical practice guidelines, an important step toward reducing practice variation, closing the evidence–practice gap, and improving the quality, efficiency, and effectiveness of rehabilitation services after THA and TKA.

ACKNOWLEDGMENTS

We thank Drs. Matthew Liang and Donna MacIntyre for their valuable contributions as members of Dr. Westby's thesis committee. Ms Michelle Raglin assisted with retrieving literature, designing and administering the online survey, and processing data. Dr. Jonathan Berkowitz conducted the statistical analysis and Dr. Eric Sayre provided guidance on the online survey system. We benefitted from the support of the Consumer Advisory Board of the Arthritis Research Centre of Canada in helping with panelist recruitment. We appreciate the expertise and time commitment from all panelists and those health professionals and patients who participated in pilot testing.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Westby had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Westby, Backman.
Acquisition of data. Westby, Brittain.
Analysis and interpretation of data. Westby, Brittain, Backman.

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