Journal of Primary Care & Community Health
Volume 15: 1–28

DOI: 10.1177/21501319241271953
journals.sagepub.com/home/jpc
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Development of a Soft Tissue Knee Clinical Decision-Making Tool for Patients Presenting to Primary Point-of-Care Providers in Alberta, Canada

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Abstract

Several barriers exist in Alberta, Canada to providing accurate and accessible diagnoses for patients presenting with acute knee injuries and chronic knee problems. In efforts to improve quality of care for these patients, an evidence-informed clinical decision-making tool was developed. Forty-five expert panelists were purposively chosen to represent stakeholder groups, various expertise, and each of Alberta Health Services' 5 geographical health regions. A systematic rapid review and modified Delphi approach were executed with the intention of developing standardized clinical decision-making processes for acute knee injuries, atraumatic/overuse conditions, knee arthritis, and degenerative meniscus. Standardized criteria for screening, history-taking, physical examination, diagnostic imaging, timelines, and treatment were developed. This tool standardizes and optimizes assessment and diagnosis of acute knee injuries and chronic knee problems in Alberta. This project was a highly collaborative, province-wide effort led by Alberta Health Services' Bone and Joint Health Strategic Clinical Network (BJH SCN) and the Alberta Bone and Joint Health Institute (ABJHI).

Keywords

algorithm, clinical care pathway, clinical decision-making, Delphi consensus, soft tissue knee injuries

Dates received: 29 May 2024; revised: 25 June 2024; accepted: 26 June 2024.

Introduction

An estimated 45 000 acute knee injuries occur each year and require access to primary point-of-care and surgical screening services. Within this group, there are approximately 2500 Albertans who tear the anterior cruciate ligament (ACL) of their knee each year based on an estimated nominal incidence rate of 30 to 80 injuries per 100 000 persons.[1] As such, evidence-informed clinical assessment and management should be initiated within days to weeks after the injury.[2] Several challenges exist in Alberta, Canada, however, to providing accurate and accessible diagnoses in the traditional medical model.[3] First, there is a serious labour shortage in the health workforce coupled with a high demand for services.[1] The current ratio for patient to provider in Canada is 247 primary care physicians and 3.5 orthopedic surgeons per 100 000 people, respectively.[4,5] Combined with the backlog and demands placed on our health system resulting from the COVID-19 pandemic, subsequent delays in assessment and surgery have resulted.

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Second, primary care physicians have limited training in musculoskeletal (MSK) medicine, whereby the Canadian medical curriculum dedicates roughly ~3% to MSK education.[6,7] Primary care physicians are required to provide a wide range of services across multiple health conditions with minimal resources. They have a heavy workload with high levels of clinical responsibility. Further, lack of confidence and training also exist in other primary care providers groups that lead to missed or incorrect diagnoses.[1,8,9] Studies have estimated that 1 out of 5 patients presenting to primary care with a medical condition are misdiagnosed.[10,11] Additionally, many primary care providers do not employ evidence-based guidelines or appropriate use criteria when ordering diagnostic imaging or referring for surgery.[12] Although between 30%[13] and 88%[14] of Albertans will receive magnetic resonance imaging (MRI) for their knee pain, some of these may not be indicated. Moreover, approximately 1/3 of patients presenting with knee pain are referred to an orthopedic surgeon, many of whom could be managed successfully with non-operative treatment (eg, non-steroidal anti-inflammatory drugs, active exercise therapy).[15] In addition to waiting months for MRI, patients suffer an additional average wait time of 3 to 7 months in Alberta before appropriate diagnoses and secondary non-operative care measures are received.[16,17]

Clinical decision-making tools incorporate evidence-informed recommendations designed to optimize patient care, wayfinding, and outcomes. This includes establishing appropriate decisions and services involved in treating a condition and recommending appropriate timing and integration of interventions. Adherence to clinical decision-making tools standardize care and reduce unacceptable variations in practice.[18] In Alberta, Canada, the Bone and Joint Health Strategic Clinical Network (BJHSCN) has created clinical decision-making tools for hip and knee osteoarthritis and hip fractures in response to the need for quality improvement.[16,19] These tools have resulted in wait time reductions to assessment and surgery, improved efficiency of healthcare resources, and improved patient outcomes.[16,19]

As part of the MSK-Transformation Initiative, the BJHSCN has engaged province-wide stakeholder groups (ie, administrators, physicians, allied health providers, researchers, and patient advisors) to transform the quality of care for patients presenting with acute knee injuries and chronic knee problems.[20] In partnership with the Alberta Bone and Joint Health Institute, the BJHSCN has set out to transform the way MSK care is delivered in Alberta. Several initiatives are underway to standardize care, improve management of waitlists, increase effectiveness in delivering care, and support innovative models of care that shifts the burden of care and dollars from downstream management (ie, surgery) toward prevention, early detection, and appropriate community management.[20] Therefore, the aim of this project is to develop a clinical tool to facilitate clinical decision-making and uptake of evidence-based assessment, diagnosis, and treatment criteria for patients presenting with acute knee injuries and chronic knee problems. Acute injuries include fractures, dislocations, and injuries to the cruciate ligaments, collateral ligaments, tendons, and cartilage. Chronic knee problems include arthritis and degenerative disease. The development of the knee clinical decision-making tool occurred over 4 phases: (1) a systematic rapid review to identify existing decision-making tools; (2) grading of the evidence; (3) development of a Knee Delphi Questionnaire; and (4) a modified Delphi approach.

Methods

Leadership Team

The development of this tool was guided by a BJHSCN Knee Leadership Team. The Knee Leadership Team was comprised of 8 members from 3 stakeholder groups (administrative leaders, researchers, and clinicians) represented by a BJHSCN executive director, BJHSCN medical director, ABJHI quality improvement manager, guideline methodologist, provincial physical therapist practice lead, orthopedic surgeon, sport medicine physician, and athletic therapist. Each member was assigned to a different role depending on expertise and previous experience. The Knee Leadership Team provided project management and quality control over all 4 phases of the project, including drafting the knee clinical decision-making tool. Institutional ethical approval was received from the University of Calgary Ethics Committee (REB22-0249) on April 22, 2022.

Delphi Expert Panel

Forty-five experts were chosen to form the Delphi expert panel. To serve on the Panel, experts must have possessed clinical expertise in knee injury assessment and/or management. Experts were purposefully chosen across all 5 provincial health zones and to include representation from a wide range of disciplines including emergency medicine, family medicine, sports medicine, radiology, orthopedic surgery, athletic therapy, physical therapy, chiropractic, nursing, public policy, and healthcare administration. Table 1 presents the distribution of experts by geographical location and discipline.

Rapid Review

The rapid review utilized systematic review methods and was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[21] Rapid reviews are recommended for promptly evaluating a large body of evidence.[22] The literature was

Table 1. Expert Panel Demographic Profile.

Category	Baseline (n=45)	Round 1 (n=42)	Round 2 (n=40)	Round 3 (n=31)	Round (n=35)
Occupation					
Physicians	27	25	23	19	21
Orthopaedic surgeon	10	10	9	7	6
Sport medicine	10	9	8	8	9
Family/general practitioner	2	1	1	1	1
Emergency physician	2	2	2	0	2
Radiologist	1	1	1	1	1
Physiatrist	2	2	2	2	2
Allied health practitioner	18	17	17	12	14
Physiotherapist	12	11	11	6	8
Athletic therapist	4	4	4	4	4
Chiropractor	2	2	2	2	2
Demographic					
Physicians	27	25	23	19	21
Calgary	8	8	7	6	7
Edmonton	11	11	10	8	10
North	2	2	2	1	0
Central	3	2	2	2	2
South	3	2	2	2	2
Allied health practitioner	18	17	17	12	14
Calgary	6	6	6	5	6
Edmonton	9	8	8	4	5
North	0	0	0	0	0
Central	1	1	1	1	1
South	2	2	2	2	2

searched for protocols, patient flow charts, algorithms, appropriate use criteria, and clinical practice guidelines for the following: cruciate ligamentous injuries (anterior cruciate ligament, posterior cruciate ligament); collateral ligamentous injuries (medial collateral, lateral collateral); patellofemoral joint injuries (including medial patellofemoral ligament, patellar ligament injuries); osteochondral injuries; meniscal injuries; fractures (patella, distal femoral, proximal tibial, proximal fibula); other muscle injuries (hamstring and quadriceps group, popliteus); other tendon injuries (distal hamstring, quadriceps tendon, iliotibial band, and popliteal tendon); neurological injuries; and vascular injuries. Supplemental Material File 1 presents the inclusion and exclusion search criteria.

Medline, EMBASE, and CINAHL were searched from inception to December 2020. The search strategy incorporated a combination of Medical Subject Headings (MeSHs), text words by means of "wild cards," and Boolean operators, and was developed in consultation with a health services library scientist within the Knowledge Management Department of Alberta Health Services. Only English articles and human studies were included in the final synthesis. Supplemental Material File 2 outlines the search strategy. Articles were also identified by screening the reference lists of relevant articles. Citations were imported into Mendeley Reference Manager Platform for organization and to remove duplicates. Citations were then exported into a Microsoft Excel worksheet designed for title and abstract screening.

Titles and abstracts were independently screened by 2 reviewers (BE and CH). Both reviewers first screened a random sample of 50 titles and abstracts ($K=0.65$, 95% CI 0.50, 0.80) to improve consistently in screening. Once the title and abstract screening was completed, both reviewers met to discuss and resolve disagreements. Full texts were screened by BE and CH. BE performed data extraction and evidence quality appraisal, which was ratified by the Knee Leadership Group. Each article was graded according to the Oxford Centre of Evidence-Based Medicine (OCEBM) 2009[23] model. The quality appraisal worksheet can be found in Supplemental Material File 3. Data extraction included author, publication year, study aim, design, population, and one of the following: protocols, patient flow charts, algorithms, appropriate use criteria, and clinical practice guidelines.

Delphi Questionnaire Development

The search results were used to generate evidence-based statements for the Knee Delphi Questionnaire to create clinical definitions for acute knee injuries and chronic knee problems and to inform 6 clinical domains: screening indicators, history-taking, physical examination, timelines, investigations, and treatment. Research Electronic Data Capture (REDCap) software was used to distribute the Knee Delphi Questionnaire and consisted of 161 statements.[24,25] Experts were given 2 weeks to complete the Questionnaire before a reminder email was sent.

Modified Delphi Approach

Between March and August 2022, a 4-round modified Delphi approach was carried out according to the process outlined in Nasa et al[26] for Delphi methodology in healthcare research. However, this modified Delphi approach deviated slightly with the inclusion of a virtual "face-to-face" meeting in Round 3 facilitated using Zoom Video Communications (version 5.14.2). This deviation allowed participants to seek clarification, provide constructive feedback, and revise the tool. Voting in rounds 1, 2, and 4 were completed via REDCap's survey distribution tools. Voting in Round 3 was facilitated using Mentimeter's interactive polling platform[27] to allow for anonymity during the face-to-face meeting. To ensure content validity, 80% was chosen a priori as an appropriate cut off point based on work by Lynn.[28] Participants were asked to select "yes" or "no" for each statement to indicate whether the evidence should be included (ie, yes) or not included (ie, no) in the final clinical tool. Only statements that reached 80% consensus, where participants voted "yes," were included in the final clinical decision-making tool. Those that did not meet consensus, were revised using participant feedback, and redistributed for voting. Round 4 was used to circulate the revised clinical decision-making tool to the entire expert panel for a final round of voting.

Results

Rapid Review and Grading of the Evidence

The search strategy identified 9867 articles. After removing 167 internal and 2118 external duplicates, a total of 7585 citations were included for title and abstract screening. Three additional articles were retrieved after searching the reference lists of studies that met the inclusion criteria. Eight hundred and eighty-six articles were selected for full-text review, of which 109 articles were included in the final narrative synthesis. The levels of evidence ranged from Level 1b: Prospective cohort study to Level 5: Literature Review. The majority of studies were categorized as Level 5 evidence. Study characteristics are presented in Supplemental Material File 3. Figure 1 illustrates the PRISMA-P flow diagram of the study identification process.

Modified Delphi Approach

Round 1. Forty-two experts participated in Round 1; 3 experts were lost to follow-up resulting in a response rate of 93%. One hundred and thirty-one of 181 statements reached consensus: 1 of 2 definitions; 14 of 20 clinical presentations; 17 of 28 screening questions; 33 of 36 history-taking questions; 22 of 26 physical examination criteria; 15 of 30 diagnostic imaging criteria; and 29 of 39 treatment recommendations. Feedback provided by the expert group was used to revise the remaining content. New questions were also created to fill in gaps identified throughout all 6 clinical domains.

Round 2. Forty experts participated in Round 2 resulting in a response rate of 89%. A revised Delphi Questionnaire was circulated to the expert group consisting of 76 statements, in which 49 met consensus: 4 of 4 definitions; 11 of 11 clinical presentations; 12 of 14 screening questions; 6 of 7 history-taking questions; 2 of 11 physical examination criteria; 9 of 15 diagnostic imaging criteria; and 5 of 14 treatment recommendations. Twenty-seven statements failed to reach consensus after 2 rounds and were not retained for Round 3.

Round 3. Statements reaching consensus in Rounds 1 and 2 were used to draft the knee clinical decision-making tool. The draft knee tool was circulated to the expert group prior to the 2-hour meeting, which also included 41 discussion points. Thirty-one experts attended the virtual discussion (response rate = 74%). The meeting was used to seek consensus for each discussion point and review all steps within the knee clinical decision-making tool, including optimal sequencing and timing of interventions. During the meeting, 33 discussion points reached consensus. Subsequently, conversations surrounding each discussion point were used to inform revisions for the remaining 8 discussion points. After the meeting, these revisions were carried out, and an updated version was circulated to the entire expert group (n = 42). Figure 2 illustrates the results of the Delphi approach.

Round 4. Thirty-five experts participated in Round 4 voting, resulting in a response rate of 83%. All revisions reached consensus resulting in the final knee clinical decision-making tool as presented in Figures 3 to 20.

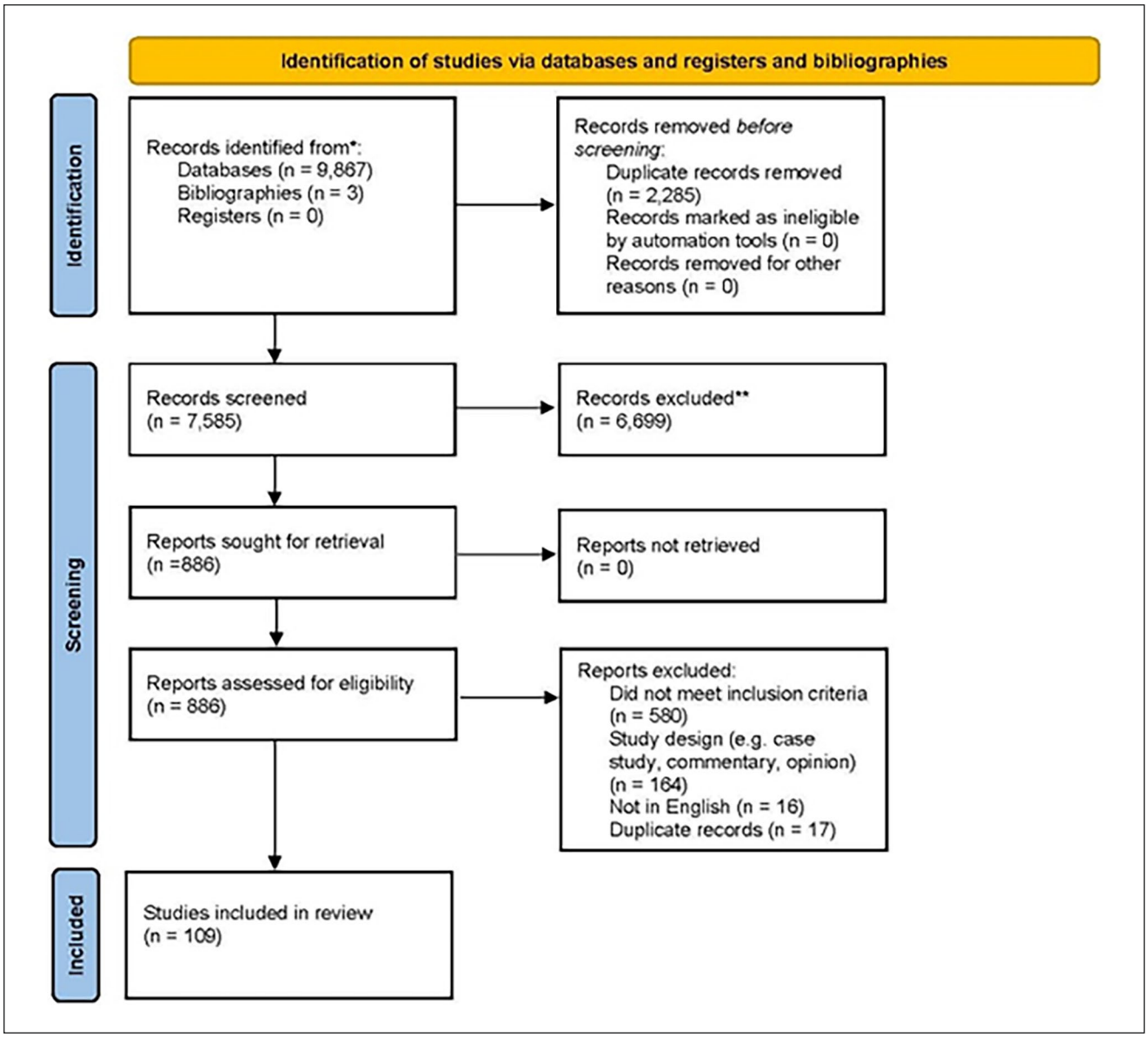

Figure 1. PRISMA-P flow diagram of the identified studies.

A Clinical Decision-Making Tool for Soft Tissue Knee Injuries

The clinical decision-making tool for patients presenting with acute knee injuries and chronic knee problems to primary care reached consensus using an expert panel representing various health disciplines and geographical regions across the province. This tool serves as a reference standard for primary care providers practicing in both public and private sectors. The clinical examination is a 4-step initial assessment process with the mandate of initiating early, non-operative treatment for suitable patients; reducing unnecessary diagnostic imaging; increasing the appropriateness of surgical referrals; and reducing waiting lists for surgical consult for suitable patients (Figure 3). The knee clinical-decision making tool also consists of screening criteria for medical red and yellow flags (Figure 4); history-taking and diagnostic questions (Figure 5); physical examination criteria (Figure 6); an MRI knee appropriateness checklist (Figure 7); 1 pathway selection algorithm (Figure 8), and 6 differential diagnoses aids and associated clinical decision-making algorithms (Figures 9-20).

Clinical scope. The knee clinical decision-making tool has been developed for point-of-care providers (ie, primary care and allied health) who are managing patients with acute

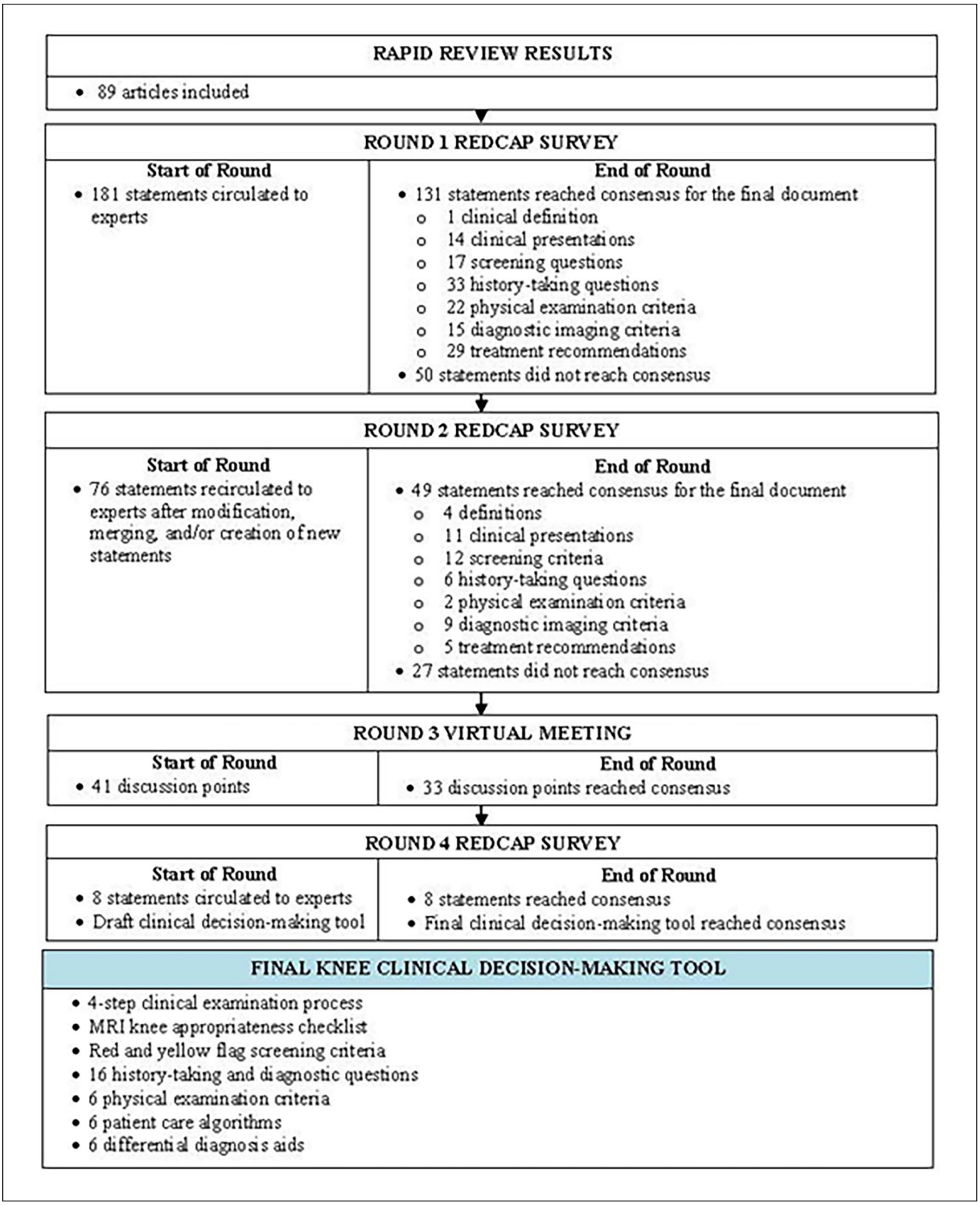

Figure 2. Summary of the modified delphi process.

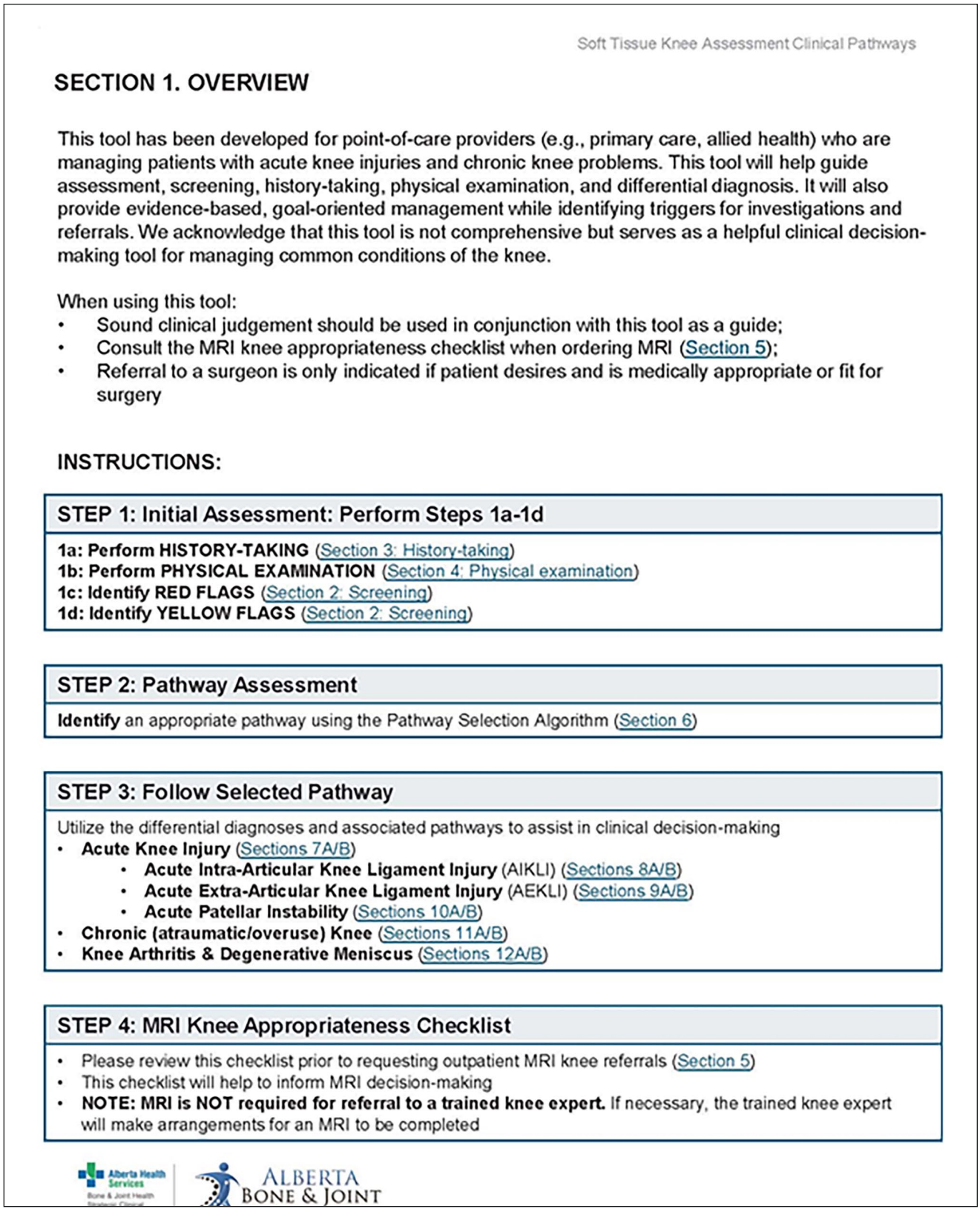

Figure 3. A step-wise clinical examination process.

SECTION 2. SCREENING

RED FLAGS
Red flags identified during the primary care assessment require urgent secondary care referral

DIFFERENTIAL DIAGNOSIS	INDICATION	URGENT SECONDARY CARE REFERRAL
Irreducible fracture or dislocation	Obvious deformity	Same day emergency referral to ED
Neurovascular compromise	Altered or absent pulse, motor function, or sensation	Same day emergency referral to ED
Compartment syndrome	Constant or progressive intractable pain; reduced or absent distal pulse; neurological disturbance (absent or altered sensation)	Same day emergency referral to ED
Severe cut or laceration	Obvious wound; severe bleeding; constant or progressive pain	Same day emergency referral to ED
Infection or septic arthritis	Systemically unwell; fever; significant swelling not related to trauma; pain unrelated to activity; pain not relieved with rest	Same day emergency referral to ED
Tumour	History of cancer; night sweats; unremitting night pain; unexplained, unintentional, or sudden weight loss; unexplained deformity or mass; acute onset with no identifiable cause; pain unrelated to activity; pain not relieved with rest	Urgent referral to orthopaedic oncology surgeon

*ED: emergency department

YELLOW FLAGS
Yellow flags identified during the primary care assessment may a) require additional resources to help manage the patient if not already being managed or b) need referral to alternative pathway measures

INDICATION	SUGGESTED COLLABORATIVE MANAGEMENT PATHWAY
Inflammatory arthropathy (e.g., rheumatoid arthritis, gout, psoriatic arthropathy)	Rheumatologist
Receiving active treatment at chronic pain clinic (e.g., knee pain part of a generalized pain condition)	Pain management specialist
Receiving active treatment for a neurological or neuromuscular condition (e.g., stroke, multiple sclerosis)	Neurology/ Neurosurgeon
Receiving active treatment for a medical condition such as diabetes, renal disease, respiratory disease, or ischemic heart disease	General internal specialist
Unexplained neurological disturbance or deficit in the affected knee (e.g., altered power or sensation, numbness, tingling, burning)	Neurology/ Neurosurgeon
Referred pain from lumbar spine or pelvis resulting in knee and/or other lower limb pain or altered sensation or altered power	Spine SCN Pathway
Traumatic knee injury is a part of an active medicolegal or third-party claim (e.g., motor vehicle accident)	General practitioner and/or treating medical team
Traumatic knee injury is a part of a work-related incident (Workers' Compensation Board related)	Workers' Compensation Board case manager
Patients presenting with kinesiophobia	Psychosocial support
Patients presenting with psychological distress or inability to cope with knee injury	Psychosocial support
Patients lacking a support network or system to help with knee injury	Psychosocial support and/or Social Worker

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Figure 4. Screening criteria for medical red and yellow flags.

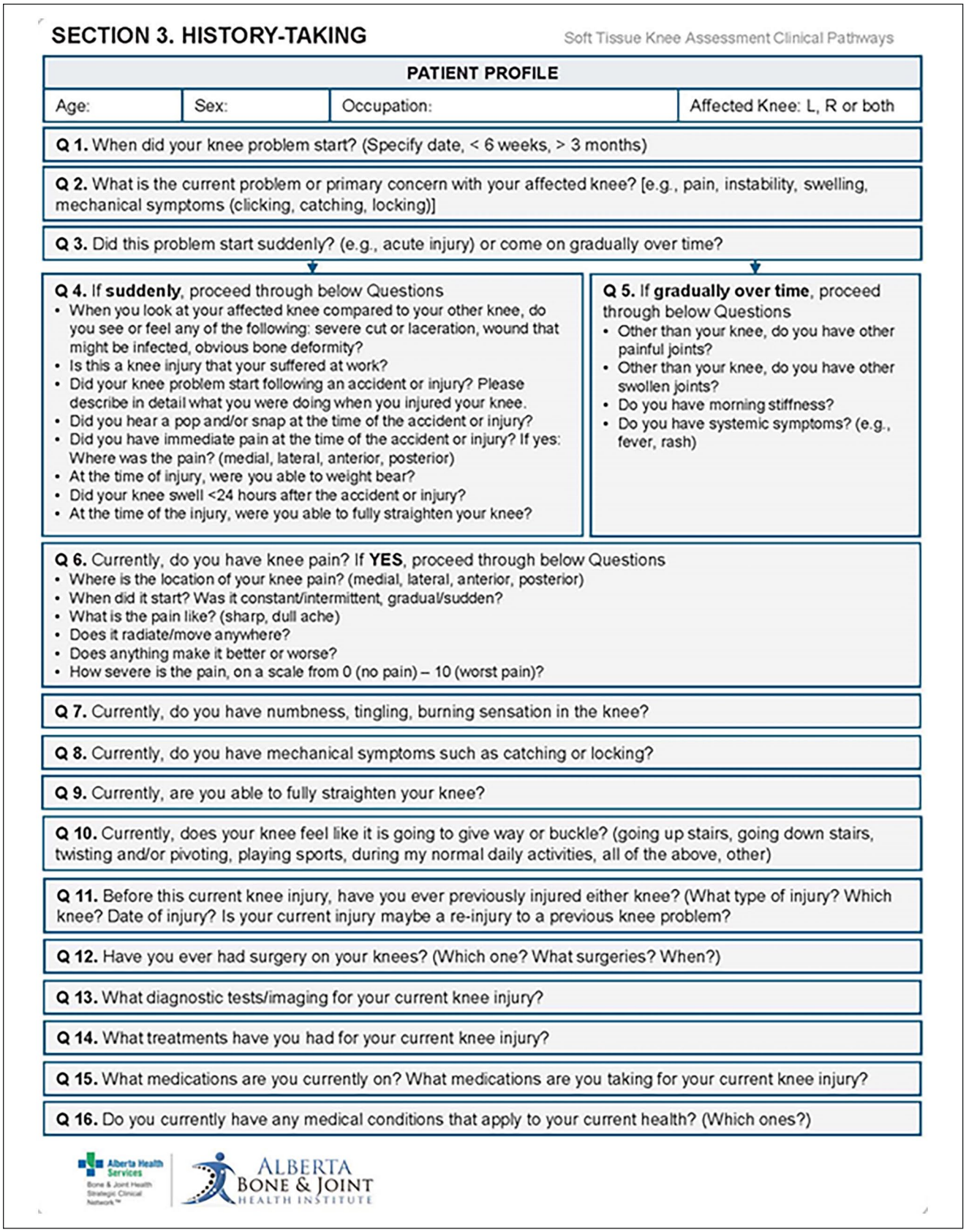

Figure 5. History-taking and diagnostic questions.

SECTION 4. PHYSICAL EXAMINATION

Soft Tissue Knee Assessment Clinical Pathways

STEP 1. Observe gait (e.g., antalgic, flexed knee) and lower limb alignment (e.g., varus, valgus, neutral)

STEP 2. Inspect for effusion, bruising, deformities, atrophy, prior scars, and lacerations

STEP 3. Palpate: a) point of maximal tenderness; b) patella borders; c) joint lines; d) pes anserine

STEP 4. Perform: a) active range-of-motion (ROM); b) passive ROM; and c) strength testing of the knee bilaterally

		Knee Flexion	Knee Extension
ACITIVE ROM	LEFT	Full **OR** Limited	Full **OR** Limited
	RIGHT	Full **OR** Limited	Full **OR** Limited
PASSIVE ROM	LEFT	Full **OR** Limited	Full **OR** Limited
	RIGHT	Full **OR** Limited	Full **OR** Limited
STRENGTH	LEFT	Full **OR** Limited	Full **OR** Limited
	RIGHT	Full **OR** Limited	Full **OR** Limited

STEP 5. Examine a) joints above and below affected knee; and/or 2) lumbar spine if indicated.
To examine joints above/below/lumbar spine, perform active ROM, dermatomes, myotomes, and reflexes if indicated

If joint above and below are normal, proceed to Section 6: Pathway Selection Algorithm

If pain/symptoms are reproduced with examination of joints other than the knee during STEP 5, ALTERNATIVE OR SPINE SCN PATHWAY IS REQUIRED. Refer to Section 2.

STEP 6. Indicate point of maximal tenderness on diagram with "X"

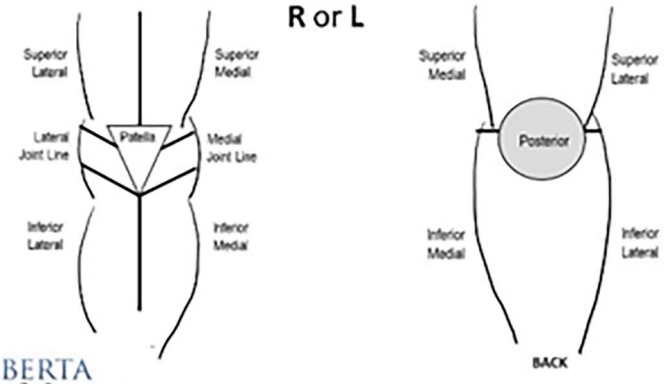

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Figure 6. Physical examination criteria.

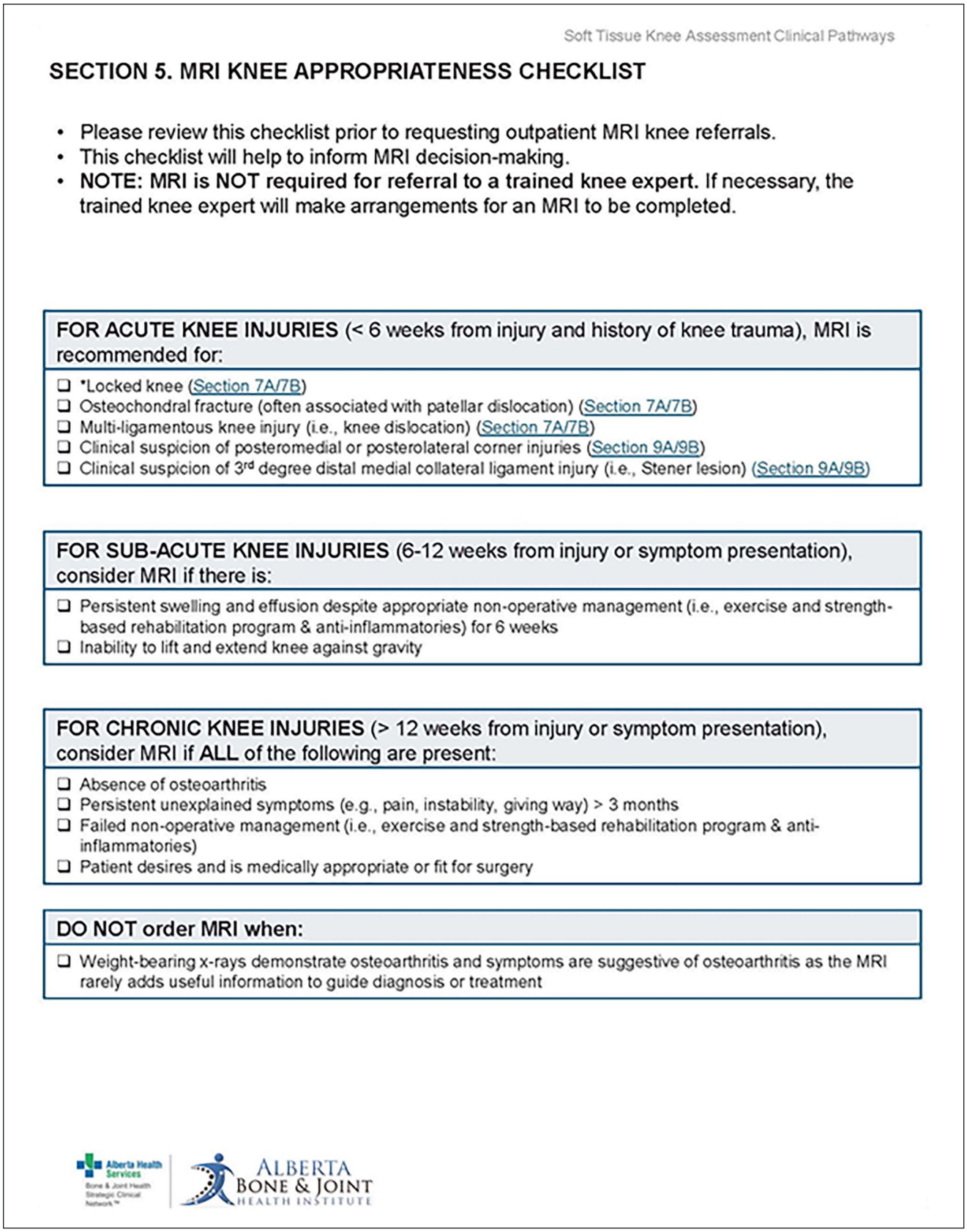


Figure 7. MRI knee appropriateness checklist.

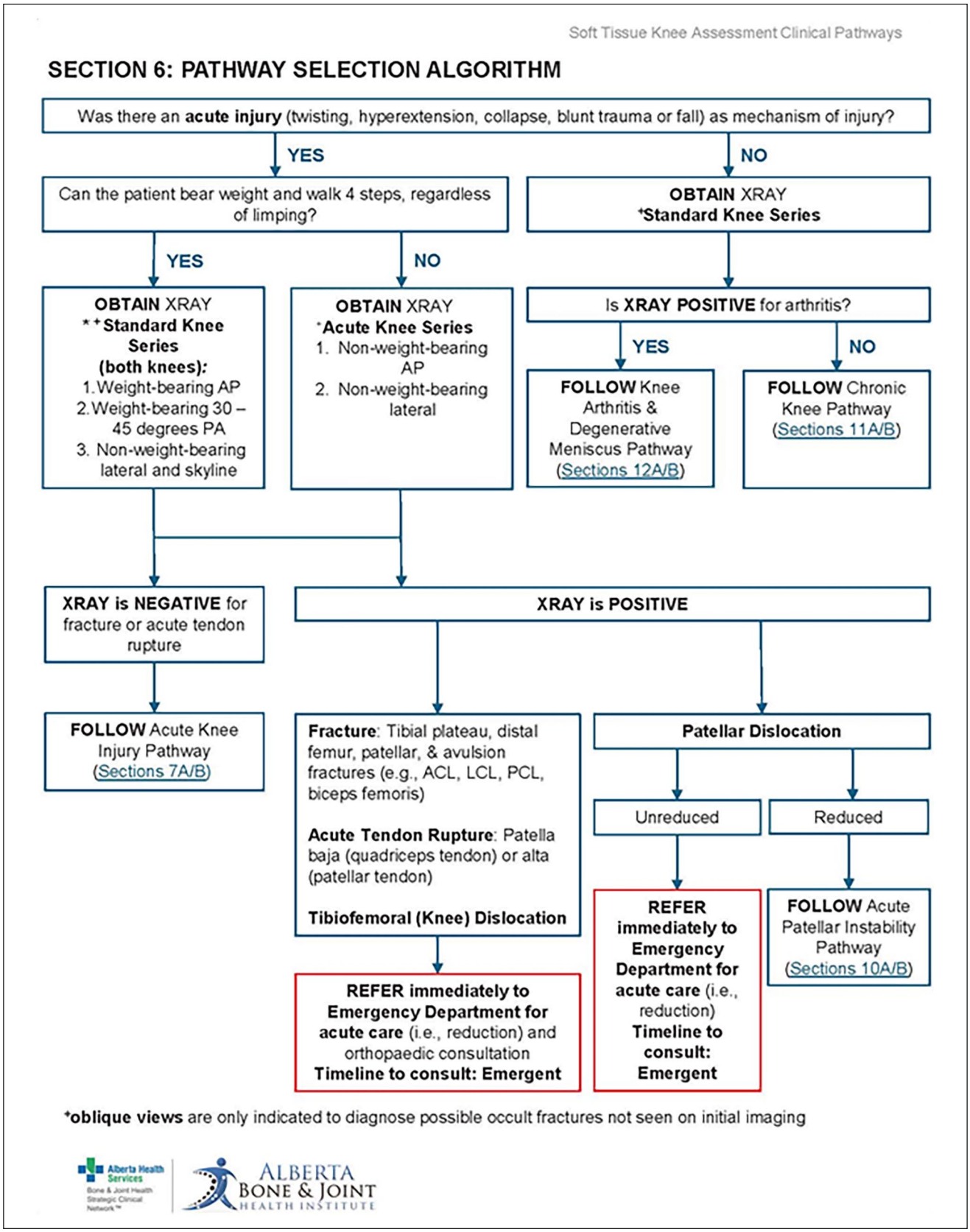
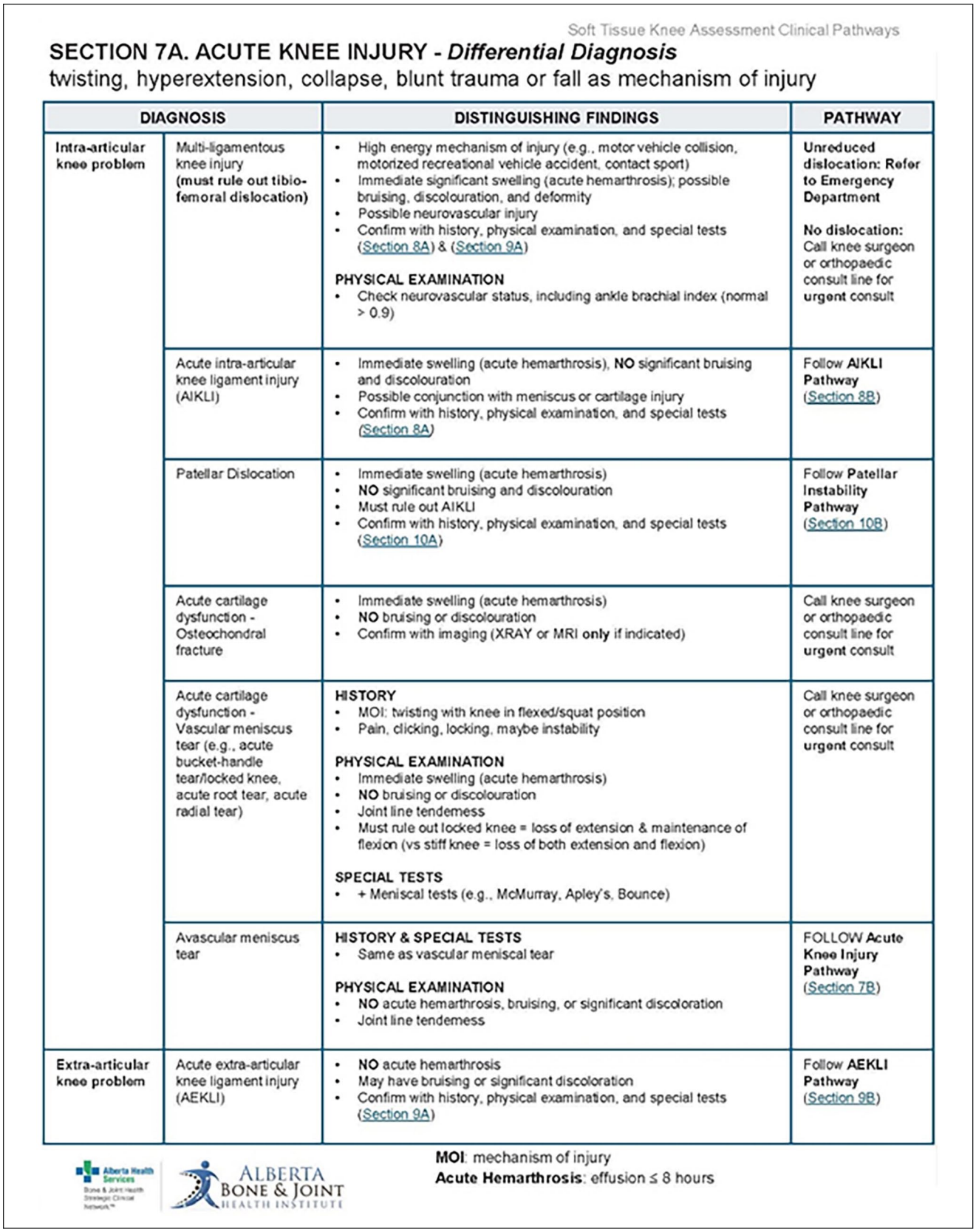


Figure 8. Pathway selection algorithm.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 7A. ACUTE KNEE INJURY - *Differential Diagnosis*

twisting, hyperextension, collapse, blunt trauma or fall as mechanism of injury

DIAGNOSIS		DISTINGUISHING FINDINGS	PATHWAY
Intra-articular knee problem	Multi-ligamentous knee injury **(must rule out tibio-femoral dislocation)**	• High energy mechanism of injury (e.g., motor vehicle collision, motorized recreational vehicle accident, contact sport) • Immediate significant swelling (acute hemarthrosis); possible bruising, discolouration, and deformity • Possible neurovascular injury • Confirm with history, physical examination, and special tests (Section 8A) & (Section 9A) **PHYSICAL EXAMINATION** • Check neurovascular status, including ankle brachial index (normal > 0.9)	**Unreduced dislocation: Refer to Emergency Department** **No dislocation:** Call knee surgeon or orthopaedic consult line for **urgent** consult
	Acute intra-articular knee ligament injury (AIKLI)	• Immediate swelling (acute hemarthrosis), **NO** significant bruising and discolouration • Possible conjunction with meniscus or cartilage injury • Confirm with history, physical examination, and special tests (Section 8A)	Follow **AIKLI Pathway** (Section 8B)
	Patellar Dislocation	• Immediate swelling (acute hemarthrosis) • **NO** significant bruising and discolouration • Must rule out AIKLI • Confirm with history, physical examination, and special tests (Section 10A)	Follow **Patellar Instability Pathway** (Section 10B)
	Acute cartilage dysfunction - Osteochondral fracture	• Immediate swelling (acute hemarthrosis) • **NO** bruising or discolouration • Confirm with imaging (XRAY or MRI **only** if indicated)	Call knee surgeon or orthopaedic consult line for **urgent** consult
	Acute cartilage dysfunction - Vascular meniscus tear (e.g., acute bucket-handle tear/locked knee, acute root tear, acute radial tear)	**HISTORY** • MOI: twisting with knee in flexed/squat position • Pain, clicking, locking, maybe instability **PHYSICAL EXAMINATION** • Immediate swelling (acute hemarthrosis) • **NO** bruising or discolouration • Joint line tenderness • Must rule out locked knee = loss of extension & maintenance of flexion (vs stiff knee = loss of both extension and flexion) **SPECIAL TESTS** • + Meniscal tests (e.g., McMurray, Apley's, Bounce)	Call knee surgeon or orthopaedic consult line for **urgent** consult
	Avascular meniscus tear	**HISTORY & SPECIAL TESTS** • Same as vascular meniscal tear **PHYSICAL EXAMINATION** • **NO** acute hemarthrosis, bruising, or significant discoloration • Joint line tenderness	FOLLOW **Acute Knee Injury Pathway** (Section 7B)
Extra-articular knee problem	Acute extra-articular knee ligament injury (AEKLI)	• **NO** acute hemarthrosis • May have bruising or significant discoloration • Confirm with history, physical examination, and special tests (Section 9A)	Follow **AEKLI Pathway** (Section 9B)

MOI: mechanism of injury
Acute Hemarthrosis: effusion ≤ 8 hours

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Figure 9. Acute knee injury differential diagnosis.

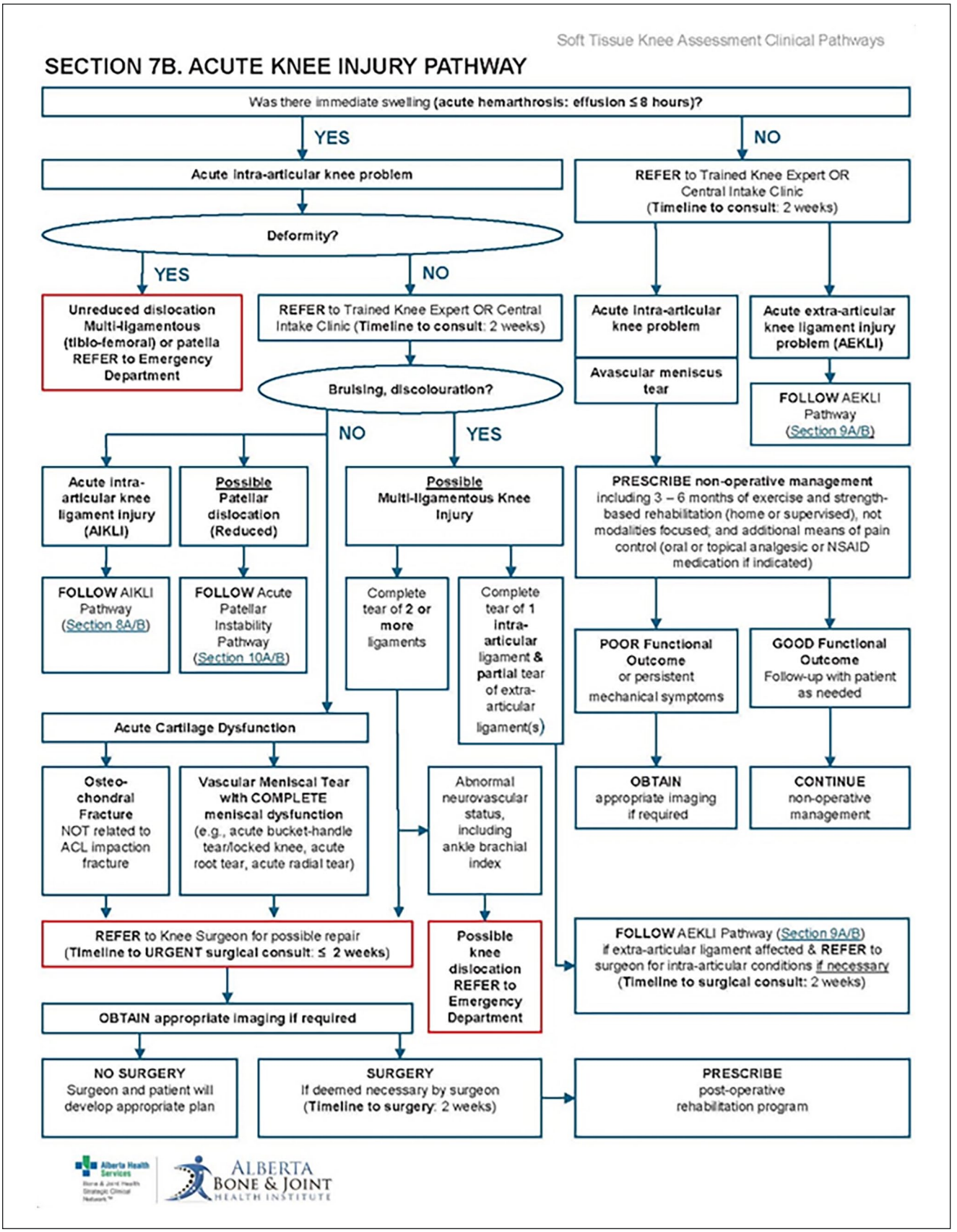
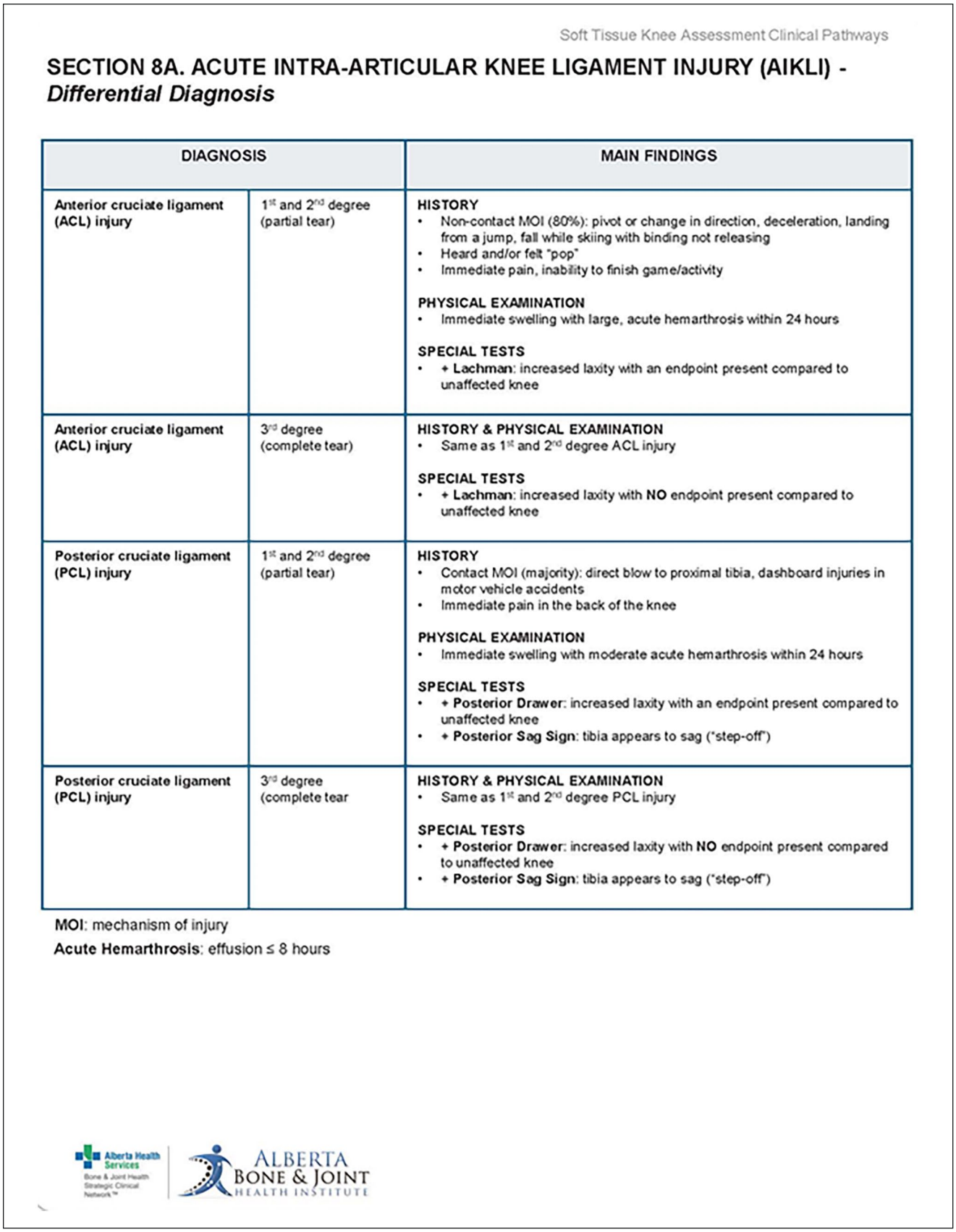


Figure 10. Acute knee injury pathway.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 8A. ACUTE INTRA-ARTICULAR KNEE LIGAMENT INJURY (AIKLI) - *Differential Diagnosis*

DIAGNOSIS		MAIN FINDINGS
Anterior cruciate ligament (ACL) injury	1st and 2nd degree (partial tear)	**HISTORY** • Non-contact MOI (80%): pivot or change in direction, deceleration, landing from a jump, fall while skiing with binding not releasing • Heard and/or felt "pop" • Immediate pain, inability to finish game/activity **PHYSICAL EXAMINATION** • Immediate swelling with large, acute hemarthrosis within 24 hours **SPECIAL TESTS** • **+ Lachman**: increased laxity with an endpoint present compared to unaffected knee
Anterior cruciate ligament (ACL) injury	3rd degree (complete tear)	**HISTORY & PHYSICAL EXAMINATION** • Same as 1st and 2nd degree ACL injury **SPECIAL TESTS** • **+ Lachman**: increased laxity with **NO** endpoint present compared to unaffected knee
Posterior cruciate ligament (PCL) injury	1st and 2nd degree (partial tear)	**HISTORY** • Contact MOI (majority): direct blow to proximal tibia, dashboard injuries in motor vehicle accidents • Immediate pain in the back of the knee **PHYSICAL EXAMINATION** • Immediate swelling with moderate acute hemarthrosis within 24 hours **SPECIAL TESTS** • **+ Posterior Drawer**: increased laxity with an endpoint present compared to unaffected knee • **+ Posterior Sag Sign**: tibia appears to sag ("step-off")
Posterior cruciate ligament (PCL) injury	3rd degree (complete tear	**HISTORY & PHYSICAL EXAMINATION** • Same as 1st and 2nd degree PCL injury **SPECIAL TESTS** • **+ Posterior Drawer**: increased laxity with **NO** endpoint present compared to unaffected knee • **+ Posterior Sag Sign**: tibia appears to sag ("step-off")

MOI: mechanism of injury

Acute Hemarthrosis: effusion ≤ 8 hours

Figure 11. Acute intra-articular knee ligament injury differential diagnosis.

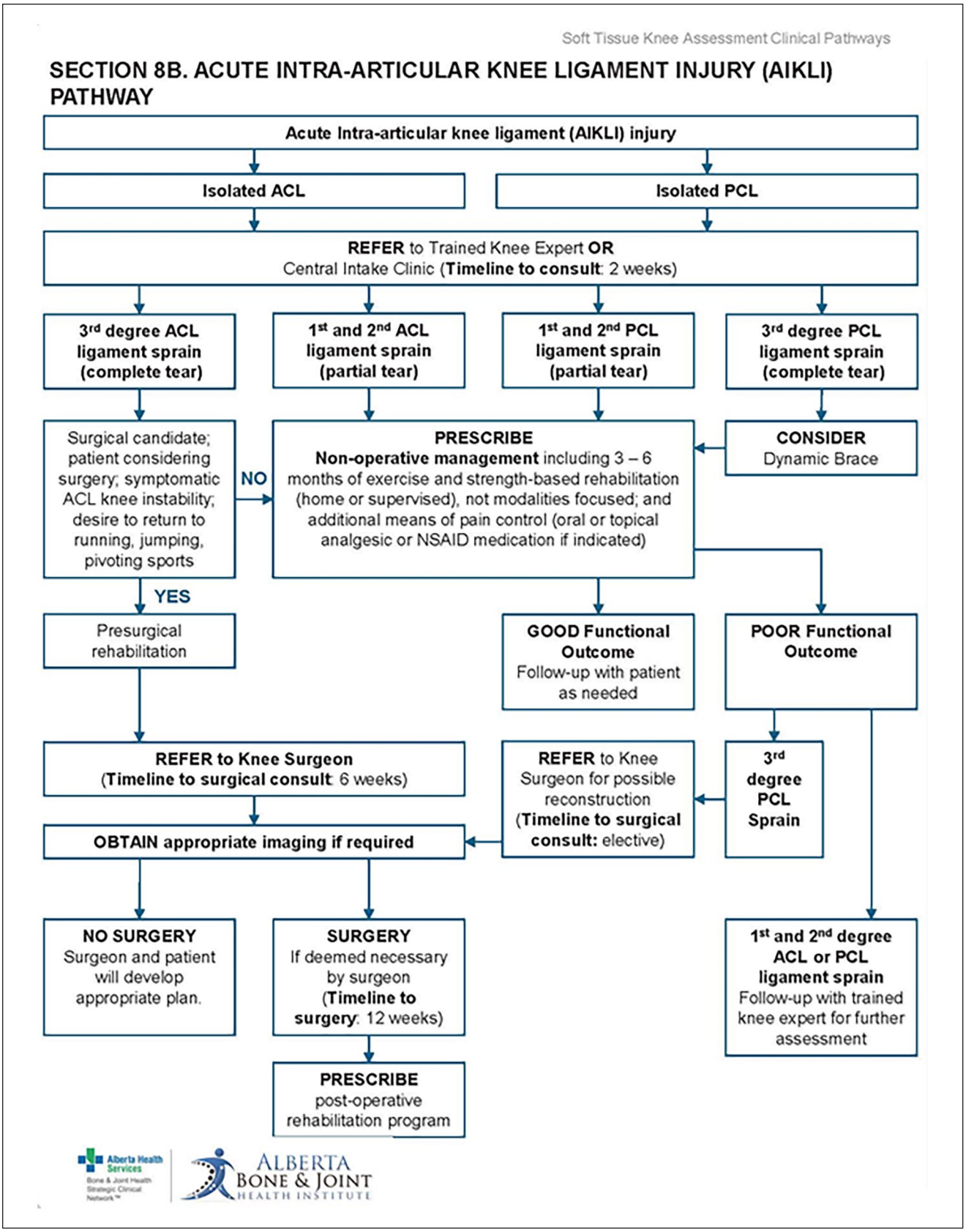
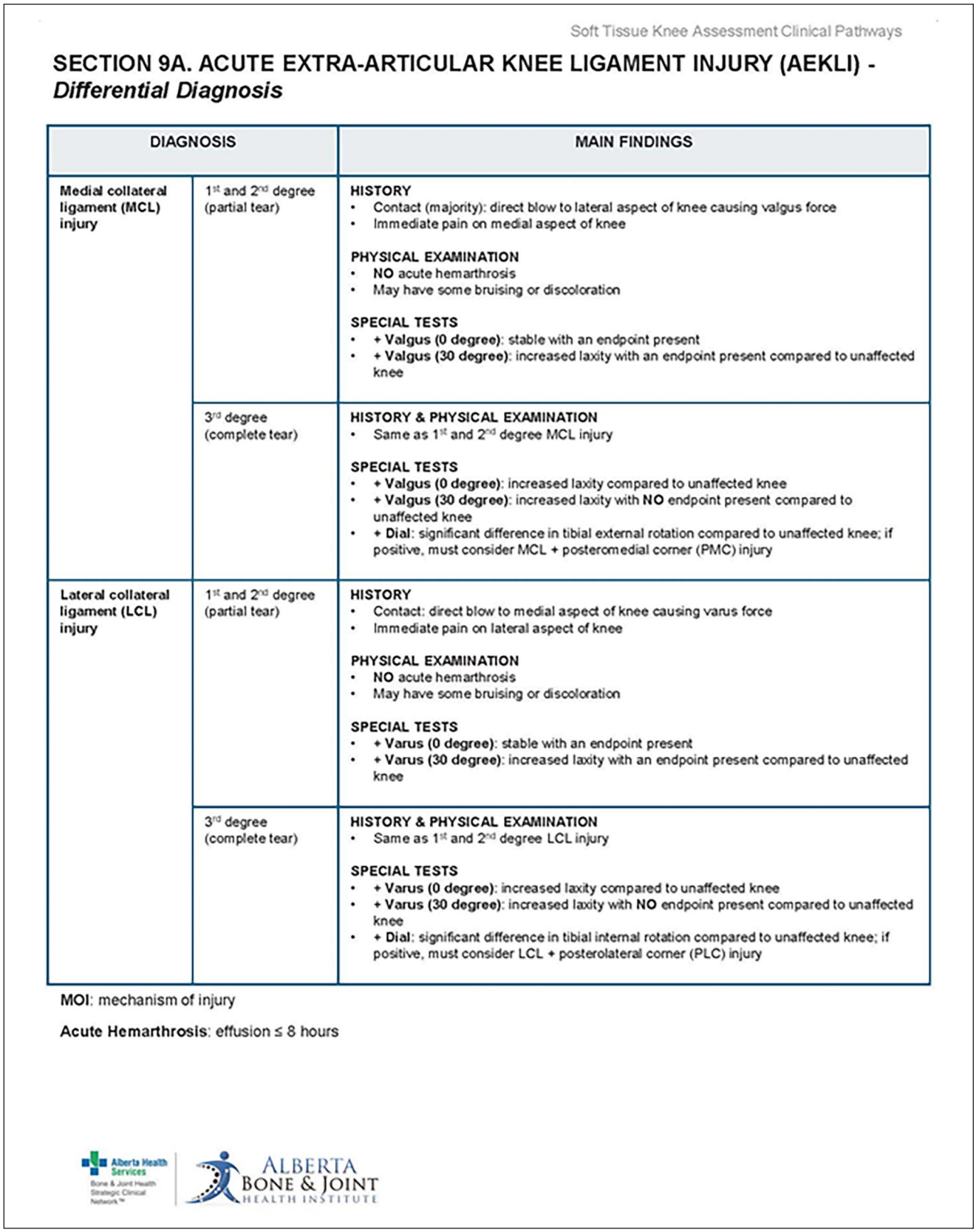


Figure 12. Acute intra-articular knee ligament injury pathway.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 9A. ACUTE EXTRA-ARTICULAR KNEE LIGAMENT INJURY (AEKLI) - *Differential Diagnosis*

DIAGNOSIS		MAIN FINDINGS
Medial collateral ligament (MCL) injury	1st and 2nd degree (partial tear)	**HISTORY** • Contact (majority): direct blow to lateral aspect of knee causing valgus force • Immediate pain on medial aspect of knee **PHYSICAL EXAMINATION** • **NO** acute hemarthrosis • May have some bruising or discoloration **SPECIAL TESTS** • **+ Valgus (0 degree)**: stable with an endpoint present • **+ Valgus (30 degree)**: increased laxity with an endpoint present compared to unaffected knee
	3rd degree (complete tear)	**HISTORY & PHYSICAL EXAMINATION** • Same as 1st and 2nd degree MCL injury **SPECIAL TESTS** • **+ Valgus (0 degree)**: increased laxity compared to unaffected knee • **+ Valgus (30 degree)**: increased laxity with **NO** endpoint present compared to unaffected knee • **+ Dial**: significant difference in tibial external rotation compared to unaffected knee; if positive, must consider MCL + posteromedial corner (PMC) injury
Lateral collateral ligament (LCL) injury	1st and 2nd degree (partial tear)	**HISTORY** • Contact: direct blow to medial aspect of knee causing varus force • Immediate pain on lateral aspect of knee **PHYSICAL EXAMINATION** • **NO** acute hemarthrosis • May have some bruising or discoloration **SPECIAL TESTS** • **+ Varus (0 degree)**: stable with an endpoint present • **+ Varus (30 degree)**: increased laxity with an endpoint present compared to unaffected knee
	3rd degree (complete tear)	**HISTORY & PHYSICAL EXAMINATION** • Same as 1st and 2nd degree LCL injury **SPECIAL TESTS** • **+ Varus (0 degree)**: increased laxity compared to unaffected knee • **+ Varus (30 degree)**: increased laxity with **NO** endpoint present compared to unaffected knee • **+ Dial**: significant difference in tibial internal rotation compared to unaffected knee; if positive, must consider LCL + posterolateral corner (PLC) injury

MOI: mechanism of injury

Acute Hemarthrosis: effusion ≤ 8 hours

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Figure 13. Acute extra-articular knee ligament injury differential diagnosis.

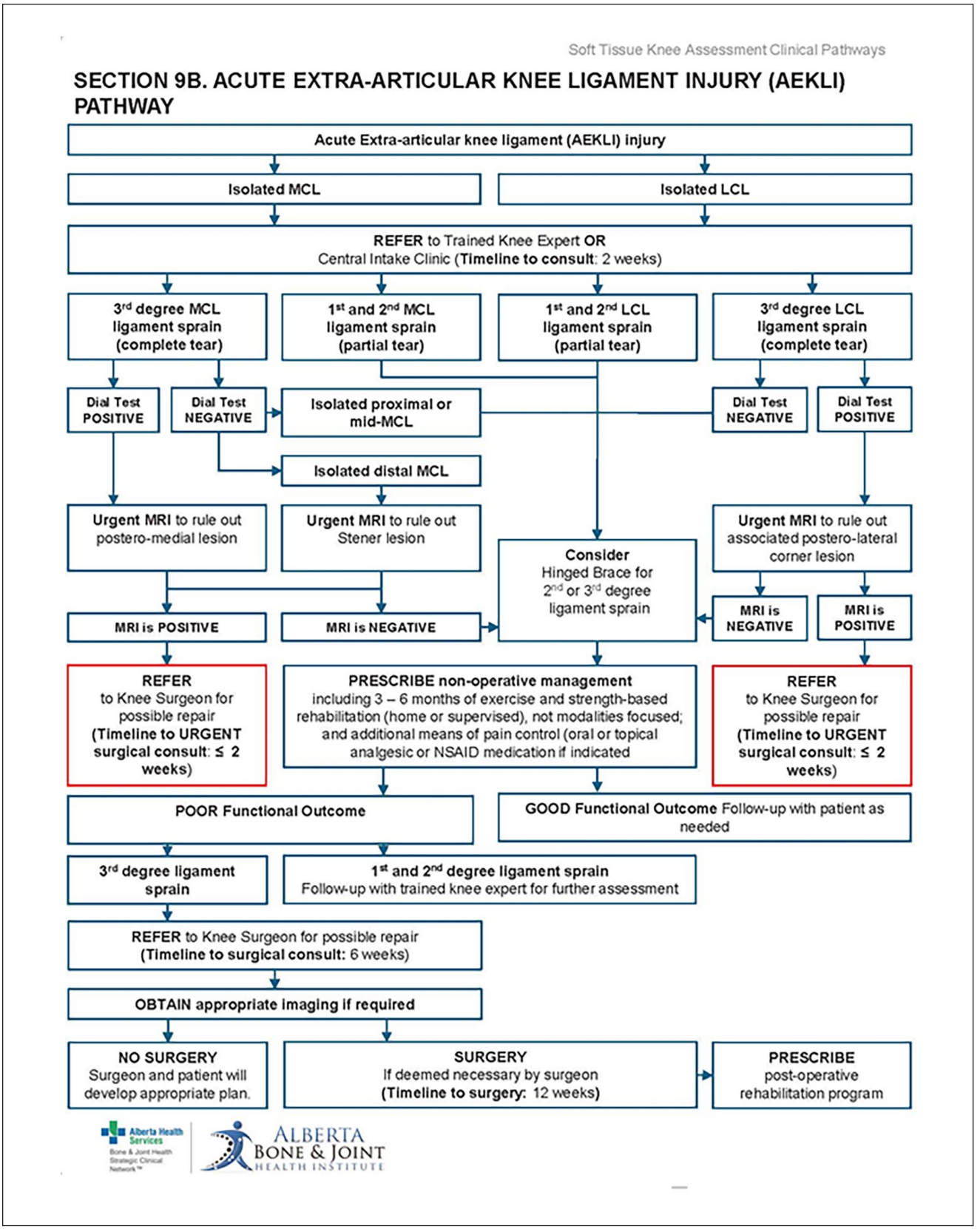
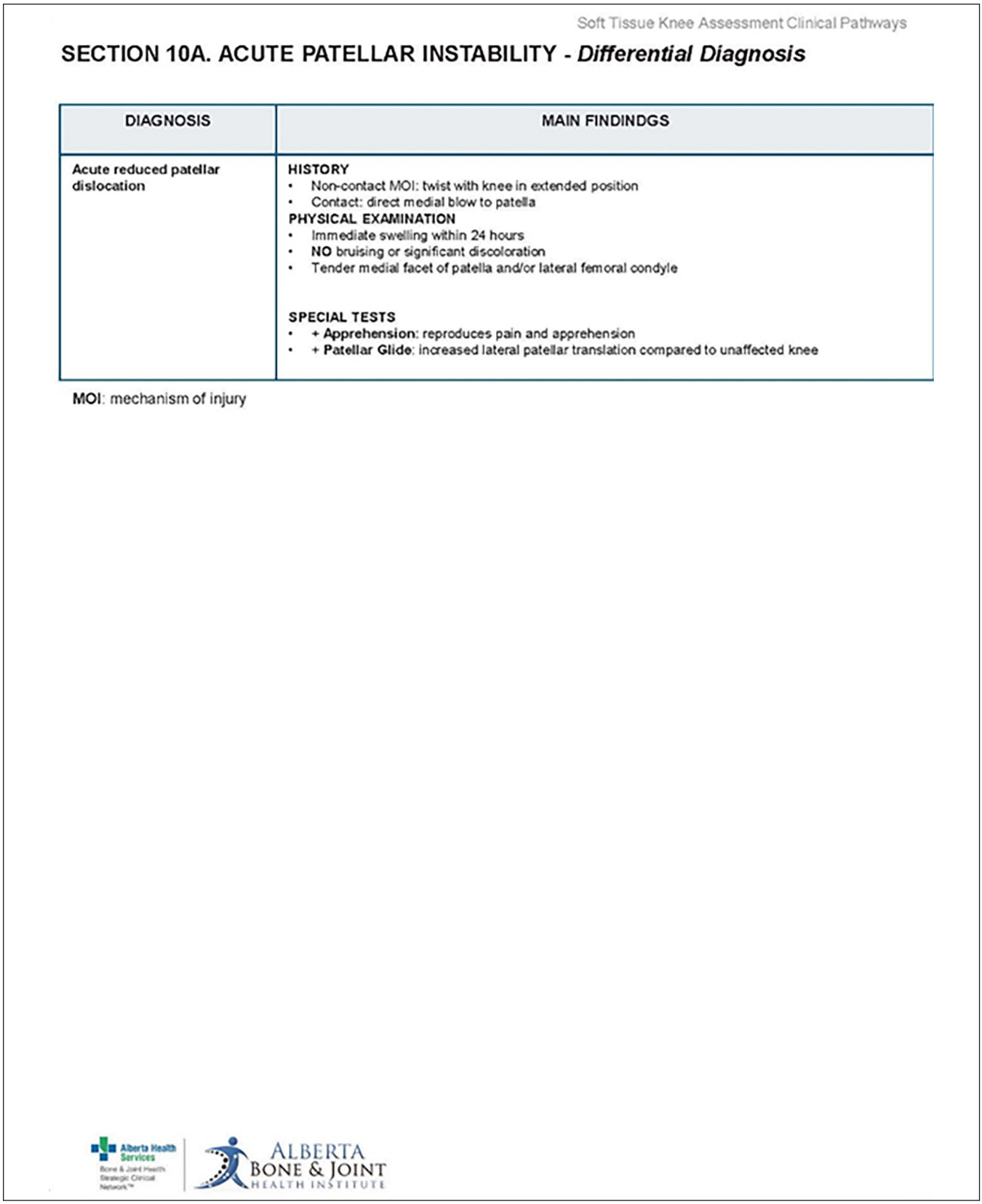


Figure 14. Acute extra-articular knee ligament injury pathway.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 10A. ACUTE PATELLAR INSTABILITY - *Differential Diagnosis*

DIAGNOSIS	MAIN FINDINDGS
Acute reduced patellar dislocation	**HISTORY** • Non-contact MOI: twist with knee in extended position • Contact: direct medial blow to patella **PHYSICAL EXAMINATION** • Immediate swelling within 24 hours • **NO** bruising or significant discoloration • Tender medial facet of patella and/or lateral femoral condyle **SPECIAL TESTS** • **+ Apprehension**: reproduces pain and apprehension • **+ Patellar Glide**: increased lateral patellar translation compared to unaffected knee

MOI: mechanism of injury

Figure 15. Acute patellar instability differential diagnosis.

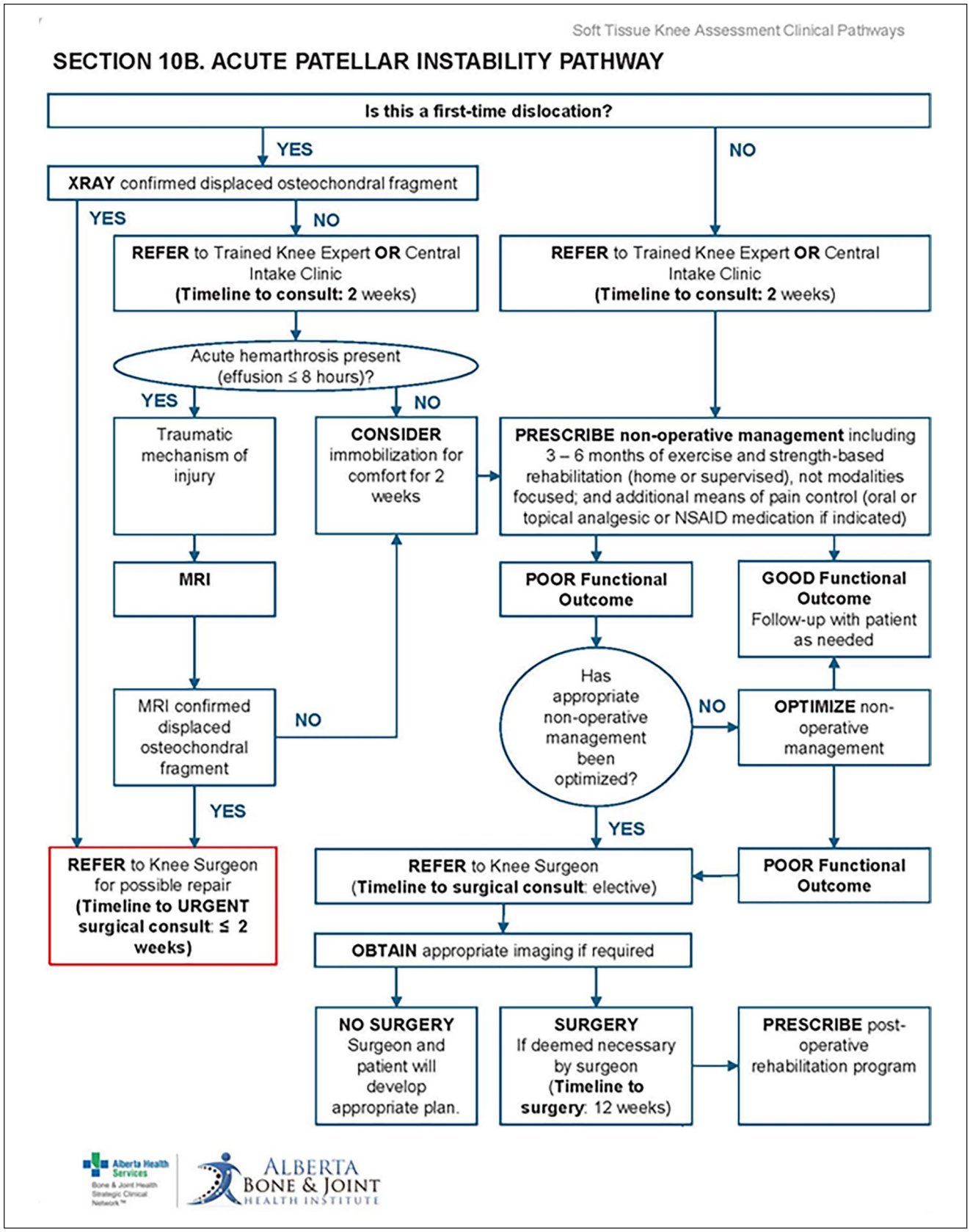
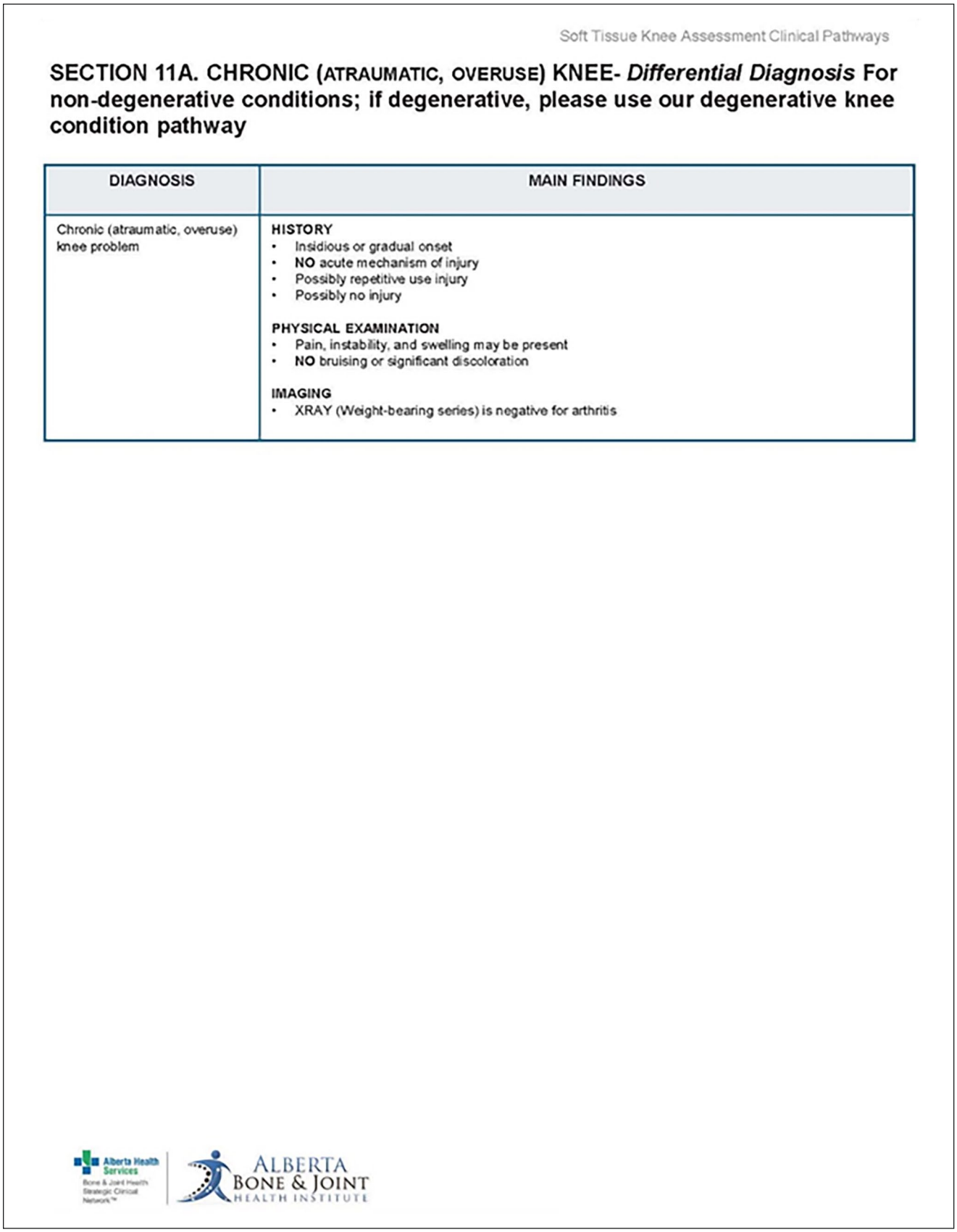


Figure 16. Acute patellar instability pathway.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 11A. CHRONIC (ATRAUMATIC, OVERUSE) KNEE- *Differential Diagnosis* For non-degenerative conditions; if degenerative, please use our degenerative knee condition pathway

DIAGNOSIS	MAIN FINDINGS
Chronic (atraumatic, overuse) knee problem	**HISTORY** • Insidious or gradual onset • **NO** acute mechanism of injury • Possibly repetitive use injury • Possibly no injury **PHYSICAL EXAMINATION** • Pain, instability, and swelling may be present • **NO** bruising or significant discoloration **IMAGING** • XRAY (Weight-bearing series) is negative for arthritis

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Figure 17. Chronic knee injury differential diagnosis.

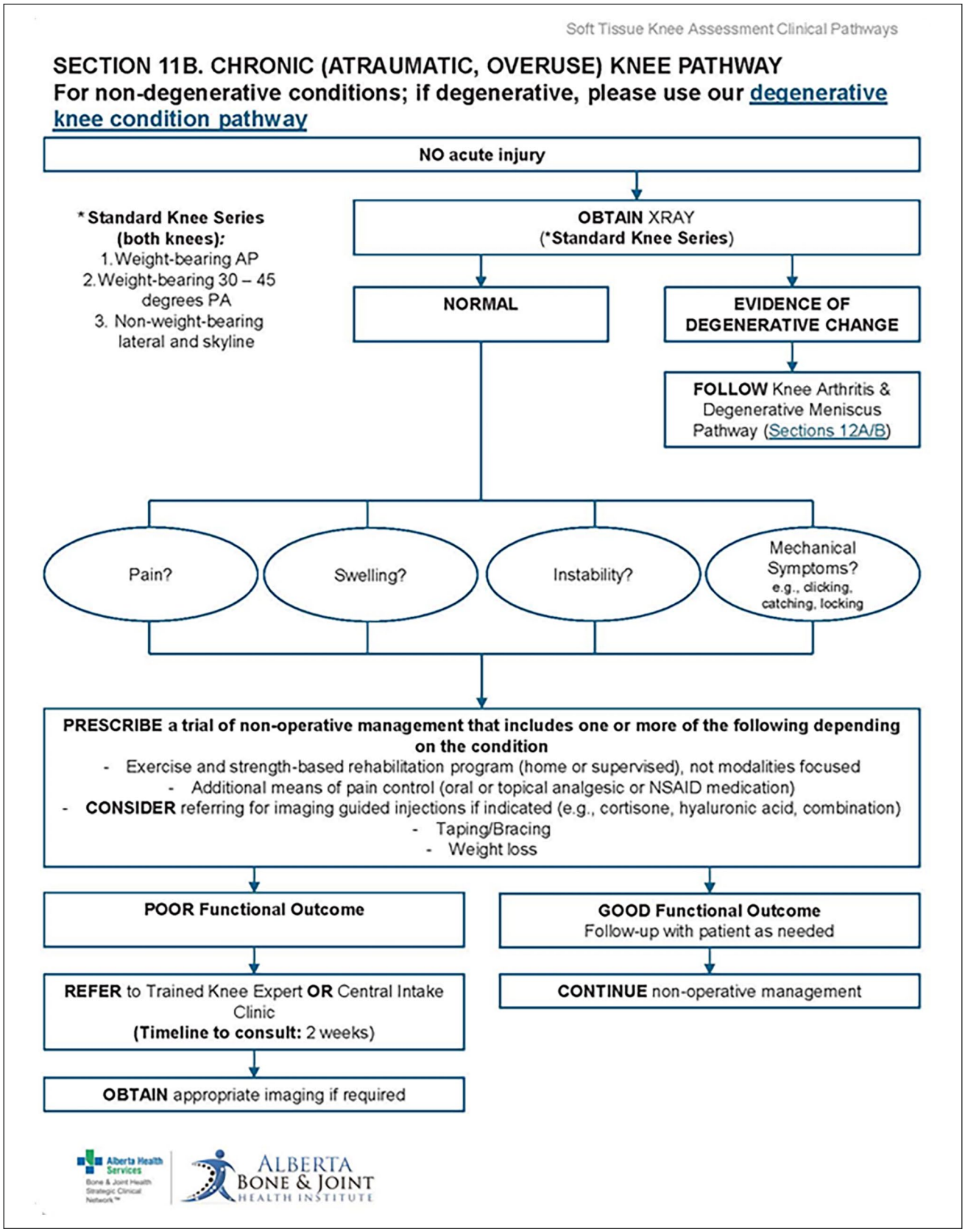
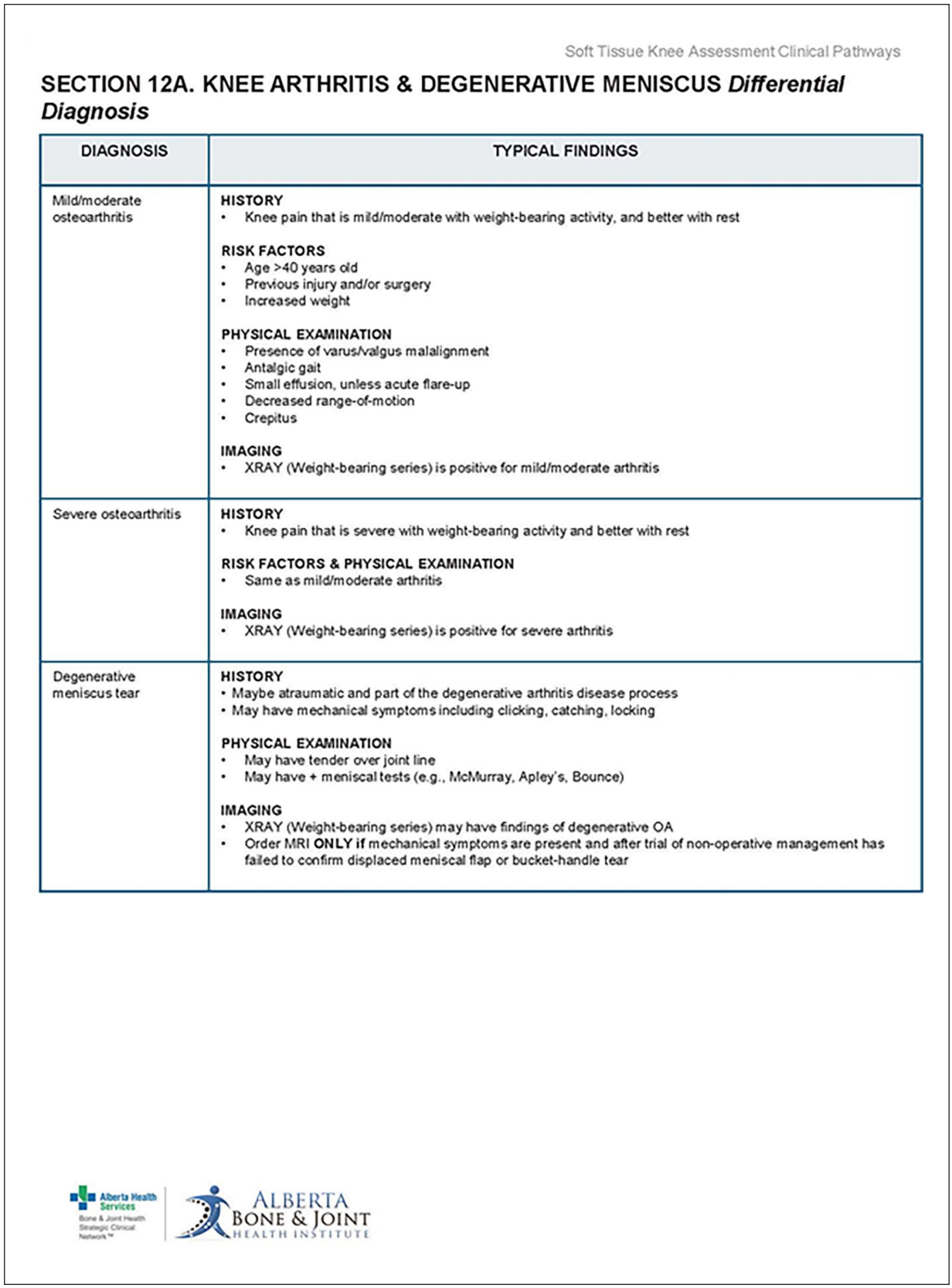


Figure 18. Chronic knee pathway.



Soft Tissue Knee Assessment Clinical Pathways

SECTION 12A. KNEE ARTHRITIS & DEGENERATIVE MENISCUS *Differential Diagnosis*

DIAGNOSIS	TYPICAL FINDINGS
Mild/moderate osteoarthritis	**HISTORY** • Knee pain that is mild/moderate with weight-bearing activity, and better with rest **RISK FACTORS** • Age >40 years old • Previous injury and/or surgery • Increased weight **PHYSICAL EXAMINATION** • Presence of varus/valgus malalignment • Antalgic gait • Small effusion, unless acute flare-up • Decreased range-of-motion • Crepitus **IMAGING** • XRAY (Weight-bearing series) is positive for mild/moderate arthritis
Severe osteoarthritis	**HISTORY** • Knee pain that is severe with weight-bearing activity and better with rest **RISK FACTORS & PHYSICAL EXAMINATION** • Same as mild/moderate arthritis **IMAGING** • XRAY (Weight-bearing series) is positive for severe arthritis
Degenerative meniscus tear	**HISTORY** • Maybe atraumatic and part of the degenerative arthritis disease process • May have mechanical symptoms including clicking, catching, locking **PHYSICAL EXAMINATION** • May have tender over joint line • May have + meniscal tests (e.g., McMurray, Apley's, Bounce) **IMAGING** • XRAY (Weight-bearing series) may have findings of degenerative OA • Order MRI **ONLY if** mechanical symptoms are present and after trial of non-operative management has failed to confirm displaced meniscal flap or bucket-handle tear

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Figure 19. Knee arthritis and degenerative meniscus differential diagnosis.

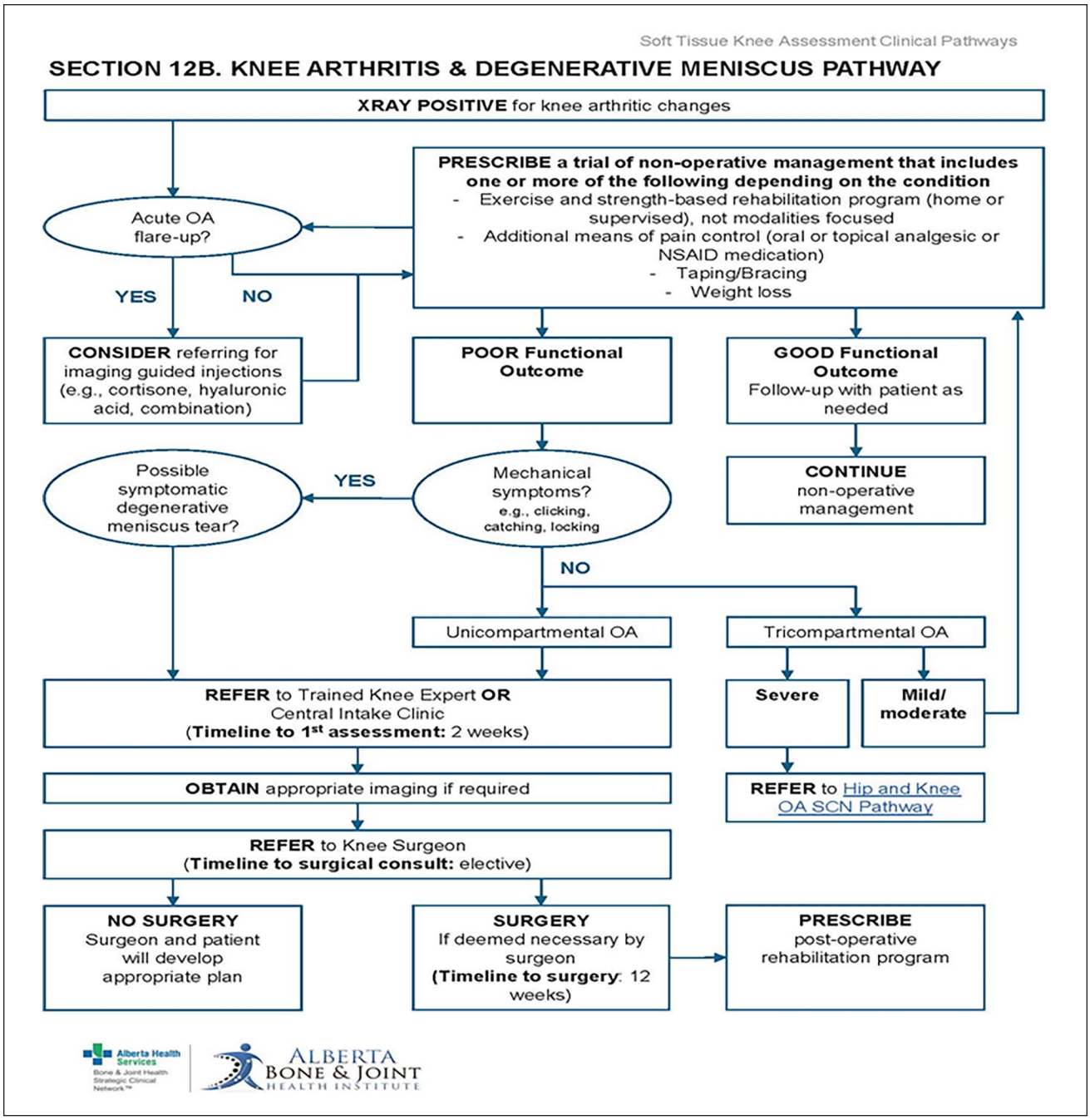

Figure 20. Knee arthritis and degenerative meniscus pathway.

knee injuries and chronic knee problems. In conjunction with sound clinical judgment, this tool will provide evidence-based, goal-oriented management while identifying triggers for investigations and referrals. We acknowledge that this tool is not comprehensive but serves as a helpful guide for managing common conditions of the knee.

This tool is suitable for adult men and women (≥18 years old) presenting with acute knee injuries and chronic knee problems. Children and young adults (<18 years old) and patients presenting concomitant symptomatic pathologies (eg, malignancy, inflammatory arthropathy) pose additional concerns that require a different standard of care. This

population of patients are likely to require alternative or collaborative management pathways.

Step 1: Initial assessment. Step 1 comprises of 4 components in the initial assessment process: (1) perform a focused history-taking; (2) perform a physical examination; (3) identify red flags; and (4) identify yellow flags. The intent is to guide the appropriateness of the focused history-taking and physical examination. The focused history-taking comprises of 16 questions (Figure 5) to assist in differential diagnosis of acute knee injuries and chronic knee problems, and screening for red and yellow flags. If red or yellow flags are identified, Figure 4 suggests additional resources and referral pathways that should be activated to manage these patients.

Step 1 also outlines 6 components to include in the physical examination (Figure 6). Clinicians should assess lower limb alignment and perform a gait analysis to assess gait pattern. The affected side should be assessed and compared to the contralateral side. Inspection should include effusion, bruising, deformities, atrophy, prior scars, and lacerations. The patellar borders, joint lines, and pes anserine should be palpated to identify the point of maximum tenderness. Clinicians should also perform bilateral active and passive knee flexion and extension, and strength testing. Pain or neurological symptoms originating from the hip, ankle, or lumbar spine can be ruled out by performing active range-of-motion, dermatomes, myotomes, and reflexes if indicated. If pain and symptoms are reproduced during this screening process, additional resources may be required to help manage the patient, which may include referral to other health care professionals. Orthopedic special tests were not prescribed due inherent challenges to validity and reliability when performed at the primary care level.[29] However, primary care providers are not precluded from performing special tests if they confidently possess additional orthopedic assessment skills or training.

Step 2: Pathway assessment. Step 2 directs providers to a pathway selection algorithm (Figure 8) to help triage patients into appropriate care pathways, including referral of emergent conditions to the Emergency Department for acute care. Figures 9 and 10 aid in assessment and management for acute knee injuries. The complex nature of acute knee injuries motivated the development of 3 additional differential diagnosis aids and respective algorithms to manage acute intra-articular knee ligament injuries (Figures 11 and 12), acute extra-articular knee ligament injuries (Figures 13 and 14), and acute patellar instability (Figures 15 and 16). Figures 17 and 18 aid in assessment and management chronic knee problems, while Figures 19 and 20 pertain to knee arthritis/degenerative menisci.

Step 3: Follow selected pathway. Findings from Step 1: Initial Assessment inform decision points within each algorithm including appropriate criteria for diagnostic imaging, surgical referral, and benchmark timelines. Each differential diagnosis aid corresponds to a specific algorithm and includes main findings from the focused history-taking, physical examination, and orthopedic special tests.

Step 4: MRI Knee Appropriate Checklist. Step 4 comprises of an MRI Knee Appropriate Checklist (Figure 7) to inform MRI decision-making and highlights that MRI should be reserved for when unique conditions are suspected (ie, postero-medial lesion of the medial collateral ligament) after expert orthopedic assessment and in planning for surgery by an orthopedic surgeon. The tool advises against ordering MRI at the primary care level. This document has adopted The Choosing Wisely Canada Orthopaedic Recommendations[30] and serves as a central message for clinicians *against* routine MRI of patients with acute knee injuries and chronic knee problems.

Discussion

Acute knee injuries and chronic knee problems are complex due to the abundance of injury mechanisms and resultant spectrum of injuries that exist. Even experienced medical professionals often have difficulties making appropriate diagnoses.[31] A clinical decision-making tool can help to support difficulties in decision-making, while aiding patients and clinicians in navigating the complexities of the health system. It is also difficult to plan treatment without an accurate diagnosis.[32] Prompt identification and triage of non-surgical and surgically treatable acute knee injuries enables early intervention, which reduces the risk of secondary injury to other knee tissues.[33] Delays can result in a sixfold increased risk of osteoarthritis (OA) development at 11-year,[34] with a sixfold risk of requiring arthroplasty.[35] ACL tears are particularly burdensome as they primarily occur in young persons aged 16 to 35 years, resulting in greater years lived with disability.[17,36]

Additionally, there is a high rate of ordering MRI at the primary care level before orthopedic consultation. This is largely influenced and not limited to: an overreliance of MRI for diagnosing acute knee injuries and chronic knee problems; pressures placed on primary care physicians by patients; and a misconstrued notion that MRI is a necessary component prior to referring to specialist care or surgical screening.[37] Approximately 17 500 patients in Alberta will receive MRI for their knee problem each year, where the primary intent is to help with diagnosing injuries.[3] This amounts to ~10% of all MRIs performed in the province.[3] Additionally, the estimated wait time for an MRI in Alberta is 27 to 32 weeks,[23] where unnecessary

MRI delays diagnosis and subsequent treatment of patients in which MRI is indicated. Conversely, this also delays appropriate treatment for patients in which MRI was unwarranted. At approximately $400 for Albertans and $800 for out-of-province patients per knee scanned, over-reliance of MRI has the potential to cost the province between $2 and $6 million each year. This estimate does not include capital costs. This has significant health system implications, whereby a reduction in MRI would allow more patient care to be provided with the same budgetary constraints.

The goal of this project was to guide clinical decision-making for primary care physicians and allied healthcare professionals in Alberta, Canada. Adoption of the knee clinical decision-making tool may standardize care and provide logic and flow to clinical practice, which has the potential to improve quality of care and patient outcomes. It also has the potential to guide and improve diagnostic accuracy of acute knee injuries and chronic knee problems, which leads to earlier intervention and reduces the risk of secondary injury to other knee tissues.[15] This reduces the risk of re-injury and additional irreparable damage to the knee, while mitigating degenerative changes and delaying OA onset.[15] The development of the knee tool was guided by evidence-based best practice in collaboration with a diverse clinical stakeholder group, which included professionals from a range of disciplines, expertise, and geographic health regions across Alberta to ensure generalizability of the tool. This purposive recruitment strategy was carried out to maximize integration and uptake of the knee tool into local health care settings across the province. Collaboration and engagement between all stakeholder groups was a key aspect of this project.

Limitations

Although a thorough and systematic search was conducted to gather the best available evidence, recommendations were limited by the availability of high-grade evidence in the literature. Therefore, the Delphi expert group was used to fill in gaps and recommend best practices to enable practicality and acceptability within our local clinical settings. This practice has been accepted and is often used by health systems to create an integrated care environment that is appropriate for the population it serves.[38]

Additionally, the knee clinical decision-making tool should only be used as a reference standard in conjunction with sound clinical judgment. Tools are most valid and reliable when utilized in the context and setting in which it was developed. Therefore, the impact of this tool on healthcare providers outside of Alberta, Canada will vary accordingly. However, the knee clinical decision-making tool provides a systematic approach, best-evidence synthesis, and standardized criteria for screening, history-taking, physical examination, diagnostic imaging, timelines, and treatment. It will serve as a useful guidance document and starting point for other regions to borrow or adapt.

Finally, the COVID-19 pandemic had a dramatic effect on workforce and workplace productivity, which delayed completion, development, and publication of the knee clinical decision-making tool. It is possible that new studies possessing high levels of evidence have emerged since the original systematic search was completed in December 2020. However, as the tool is a dynamic document, the Knee Leadership Team has been mandated to update the document every 5 years.

Conclusion

The knee clinical decision-making tool was developed through a multi-phase process involving evidence synthesis and provincial expert consultation. The result was a clinical decision support tool with implications for patients, providers, healthcare administrators, and policy makers. This tool aims to improve clinical uncertainty with respect to knee assessment, treatment, diagnostic imaging, and community management. To ensure the tool retains accuracy and appropriateness, periodic updates of this tool will be carried out as part of ongoing BJHSCN quality improvement initiatives. Next steps will also aim to evaluate the clinical effectiveness of this tool within the Alberta health system setting.

Acknowledgments

The authors would like to thank the members of the Consensus Expert Delphi Group who contributed to the development of the knee clinical decision-making tool.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Supplemental Material

Supplemental material for this article is available online.

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