AMERICAN COLLEGE OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE

Knee Disorders

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ACOEM acknowledges the following organizations and their representatives who served as reviewers of the "Knee Disorders" Guideline. Their contributions are greatly appreciated. By listing the following individuals or organizations, it does not infer that these individuals or organizations support or endorse the knee treatment guidelines developed by ACOEM.

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Summary of Recommendations

The Evidence-based Practice Knee Disorders Panel's recommendations are based on critically appraised higher quality research evidence and on expert consensus observing First Principles when higher quality evidence was unavailable or inconsistent (see Methodology). The reader is cautioned to utilize the more detailed indications, specific appropriate diagnoses, temporal sequencing, preceding testing or conservative treatment, and contraindications that are elaborated in more detail for each test or treatment in the body of this Guideline in using these recommendations in clinical practice or medical management. These recommendations are not simple "yes/no" criteria.

All ACOEM guidelines include analyses of numerous interventions, whether or not FDA-approved. For non-FDA-approved interventions, recommendations are based on the available evidence; however, this is not an endorsement of their use. In addition, many of the medications recommended are utilized off-label. (For example, anti-epileptic agents have been used off-label since the 1960s to treat chronic pain.)

Recommendations are made under the following categories:

- Strongly Recommended, "A" Level
- Moderately Recommended, "B" Level
- Recommended, "C" Level
- Insufficient-Recommended (Consensus-based), "I" Level
- Insufficient-No Recommendation (Consensus-based), "I" Level
- Insufficient-Not Recommended (Consensus-based), "I" Level
- Not Recommended, "C" Level
- Moderately Not Recommended, "B" Level
- Strongly Not Recommended, "A" Level

Acetaminophen	Acetaminophen for Treatment of Acute, Subacute, Chronic or Post-operative Knee Pain	Recommended, Evidence (C)
	Acetaminophen or Aspirin as First-Line Therapy for Patients at Risk for Cardiovascular Adverse Effects	Strongly Recommended, Evidence (A)
Activity Modification	Activity Modification for Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Modifying Activities to Avoid Kneeling or Other Pressure Over the Knee for Bursitis	Recommended, Insufficient Evidence (I)
Acupuncture	Acupuncture for Acute or Subacute Knee Pain	No Recommendation, Insufficient Evidence (I)
	Acupuncture for Anterior Knee Pain	No Recommendation, Insufficient Evidence (I)
	Acupuncture for Chronic Osteoarthrosis of the Knee	Moderately Recommended, Evidence (B)
Antibodies	Antibodies for Diagnosing Knee Pain with Suspicion of Chronic or Recurrent Rheumatological Disorder	Recommended, Insufficient Evidence (I)
	Antibodies to Confirm Specific Disorders	Strongly Recommended, Evidence (A)
Antibiotics	One-day Use of Systemic Antibiotics for Knee Surgery	Moderately Recommended, Evidence (B)
Anticonvulsants	Topiramate for Acute Knee Pain	Not Recommended, Insufficient Evidence (I)

	Topiramate for Subacute or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Topiramate for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
Antidepressants	Norepinephrine Reuptake Inhibiting Anti-depressants for Acute Knee Pain	Not Recommended, Insufficient Evidence (I)
	Norepinephrine Reuptake Inhibiting Anti-depressants for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Norepinephrine Reuptake Inhibiting Anti-depressants for Subacute or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Selective Serotonin Reuptake Inhibitors for Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)
	Selective Serotonin Reuptake Inhibitors, SSRIs, or Tricyclic Anti-depressants for Chronic Knee Pain in Patients with Co-morbid Depression	Recommended, Evidence (C)
Aspiration	Aspiration for Infected Bursa	Recommended, Insufficient Evidence (I)
	Fluid Aspiration and Analyses for Knee Bursitis	Recommended, Insufficient Evidence (I)
Aspirin	Aspirin for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)
Biofeedback	Biofeedback for Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Biofeedback for Patellofemoral Pain	Not Recommended, Evidence (C)
Bone Scans	Bone Scanning for Select Use in Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Routine Use of Bone Scanning for Knee Joint Evaluations	Not Recommended, Insufficient Evidence (I)
Braces	Functional Bracing for Anterior Cruciate Ligament Injuries Post-operatively	Not Recommended, Evidence (C)
	Functional Bracing for Prevention of Anterior Knee Pain	No Recommendation, Insufficient Evidence (I)
	Functional Bracing for Treatment of Non-Operative Anterior Cruciate Ligament Injuries	No Recommendation, Insufficient Evidence (I)
	Knee Braces for All Other Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Knee Braces for Knee Sprains	Recommended, Insufficient Evidence (I)
	Knee Braces for Moderate to Severe Chronic Knee Osteoarthrosis	Recommended, Evidence (C)
	Off-loader Braces for Knee Osteoarthrosis	Recommended, Evidence (C)
	Post-operative Braces for Knee Arthroplasty Patients	Moderately Not Recommended, Evidence (B)
Canes / Crutches	Canes and Crutches for Moderate to Severe Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
CT	CT for Evaluating Patients with Osteonecrosis (AVN)	Recommended, Insufficient Evidence (I)
	CT for Evaluating Patients with Periprosthetic Osteolysis after Total Knee Arthroplasty	Recommended, Insufficient Evidence (I)

	Routine CT for Evaluating Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)
Education	Educational Sessions for Treatment of Knee Osteoarthrosis	Recommended, Insufficient Evidence (I)
	Pre-operative Educational Program Prior to Arthroplasty	Moderately Recommended, Evidence (B)
Electrical Therapy	Electrical Stimulation Therapies for Treatment of Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Electrical Stimulation for Anterior Knee Pain	Not Recommended, Evidence (C)
	Electrical Stimulation Therapies for Treatment of Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Extracorporeal Shockwave Therapy for Patellar Tendinosis	Moderately Not Recommended, Evidence (B)
	Interferential Therapy for Post-Operative Knee Patients	Recommended, Evidence (C)
	Iontophoresis for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Iontophoresis for Acute, Subacute, or Chronic Knee Pain	
	Microcurrent Therapy for Post-Operative Total Knee Arthroplasty Patients	No Recommendation, Insufficient Evidence (I)
	Percutaneous Electric Therapy for Knee Osteoarthrosis	Recommended, Evidence (C)
	Percutaneous Electric Therapy for Other Knee Pain	Recommended, Insufficient Evidence (I)
	Pulsed Electromagnetic Fields for Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Pulsed Electromagnetic Fields for Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	TENS for Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	TENS for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
EMG	Electromyography for Diagnosing Subacute or Chronic Peripheral Nerve Entrapments	Recommended, Insufficient Evidence (I)
Ergonomics	Ergonomic Interventions for Knee MSDs	No Recommendation, Insufficient Evidence (I)
	Fall Protection	Recommended, Insufficient Evidence (I)
	Knee Pads for Kneeling Activities	Recommended, Insufficient Evidence (I)
Exercise	Aerobic Exercise for Treatment of Knee Osteoarthrosis	Strongly Recommended, Evidence (A)
	Aquatic Therapy for Knee Osteoarthrosis	Recommended, Insufficient Evidence (I)
	Exercise for Patellofemoral Joint Pain	Moderately Recommended, Evidence (B)
	Pre-operative Exercise Program	Recommended, Insufficient Evidence (I)
	Strengthening Exercises for Treatment of Knee Osteoarthrosis	Moderately Recommended, Evidence (B)
	Stretching Exercises for Treatment of Knee Osteoarthrosis	Recommended, Insufficient Evidence (I)
	Yoga for Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)

Gabapentin	Gabapentin for Acute Knee Pain	Not Recommended, Insufficient Evidence (I)
	Gabapentin for Subacute or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Gabapentin for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Gabapentin for Peri-Operative Pain	Recommended, Insufficient Evidence (I)
Glucosamine	Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Osteoarthrosis Prevention	No Recommendation, Insufficient Evidence (I)
Heat	Heat for ACL Tears	No Recommendation, Insufficient Evidence (I)
	Heat for Knee Sprains	Recommended, Insufficient Evidence (I)
	Heat for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Heat for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	Heat for Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	Self-application of Heat Therapy for Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Self-application of Heat Therapy for Osteoarthrosis	Recommended, Insufficient Evidence (I)
Heparin	Low-molecular Weight Heparin for Prevention of Venous Thromboembolic Disease	Strongly Recommended, Evidence (A)
	Warfarin and Heparin for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)
Ice	Cryotherapy for Treatment of Knee Arthroplasty and Arthroscopy and Other Surgery Patients	Recommended, Insufficient Evidence (I)
	Home Use of Cryotherapies for Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Home Use of Cryotherapies for Knee Osteoarthrosis	Recommended, Insufficient Evidence (I)
	Ice for ACL Tears	No Recommendation, Insufficient Evidence (I)
	Ice for Knee Sprains	Recommended, Insufficient Evidence (I)
	Ice for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Ice for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	Ice for Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	Progressive Agility, Trunk Stabilization and Icing (PATS) for Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Evidence (C)
Inflammatory Markers	Non-specific Inflammatory Markers for Screening for Inflammatory Disorders in Subacute or Chronic Knee Pain Patients	Recommended, Insufficient Evidence (I)
Injections	Aprotinin Injections for Patellar Tendinopathy	Recommended, Evidence (C)
	Autologous Blood Injections for Moderate to Severe Knee Osteoarthorosis	No Recommendation, Insufficient Evidence (I)

	Botulinum Injections for Knee Osteoarthrosis or Other Knee Disorders	No Recommendation, Insufficient Evidence (I)
	Glucocorticosteroid Injections after Arthroscopy	Recommended, Evidence (C)
	Glucocorticosteroid Injections for Iliotibial Band Syndrome	Recommended, Evidence (C)
	Glucocorticosteroid Injections for Knee Bursitis	No Recommendation, Insufficient Evidence (I)
	Glucocorticosteroid Injections for Meniscal Tears	Not Recommended, Insufficient Evidence (I)
	Glucocorticosteroid Injections for Select Patients with Patellar Tendinopathy	Recommended, Insufficient Evidence (I)
	Glucosamine Sulfate Intraarticular Injections for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Glucosamine Sulfate Intramuscular Injections for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Glycosaminoglycan Injections for Patellar Tendinosis	Not Recommended, Evidence (C)
	Intraarticular Glucocorticosteroid Injections for Knee Osteoarthrosis	Recommended, Evidence (C)
	Intraarticular Knee Viscosupplementation Injections for Moderate to Severe Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Intraarticular Platelet-Rich Plasma and Plasma Rich in Growth Factor, and Injections for Moderate to Severe Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Local Anesthetic Injections to Diagnose Subacute or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Other Modalities/Injections for ACL Tears	No Recommendation, Insufficient Evidence (I)
	Other Modalities/Injections for Meniscal Tears	No Recommendation, Insufficient Evidence (I)
	Other Modalities/Injections for Knee Sprains	No Recommendation, Insufficient Evidence (I)
	Other Modalities/Injections for Patellofemoral Joint Pain	No Recommendation, Insufficient Evidence (I)
	Percutaneous Needle Tenotomy for Chronic Tendinosis	No Recommendation, Insufficient Evidence (I)
	Periarticular Glucocorticosteroid Injections for Arthroplasty Patients	No Recommendation, Insufficient Evidence (I)
	Platelet-Rich Plasma or Autologous Blood Injections for Meniscal Tears	No Recommendation, Insufficient Evidence (I)
	Platelet-Rich Plasma or Autologous Blood Injections for Patellar Tendinopathy	Not Recommended, Insufficient Evidence (I)
	Polidocanol Injection for Acute, Subacute, or Post-operative Patellar Tendinopathy	No Recommendation, Insufficient Evidence (I)
	Prolotherapy Injections for Acute, Subacute, or Chronic Knee Pain	Not Recommended, Evidence (C)
	Prolotherapy Injections for Chronic Patellar Tendinopathy	Recommended, Insufficient Evidence (I)

	Radiation Synovectomy for Knee Osteoarthrosis	Not Recommended, Evidence (C)
	Stem Cell Therapy	Not Recommended, Insufficient Evidence (I)
	Tidal Knee Joint Irrigation for Knee Osteoarthrosis	Not Recommended, Insufficient Evidence (I)
Laser Therapy	Low-level Laser Therapy for Acute, Subacute, or Chronic Knee Pain	Not Recommended, Evidence (C)
	Low-level Laser Therapy for Knee Osteoarthrosis	Not Recommended, Evidence (C)
	Low-level Laser Therapy for Meniscal tears	Not Recommended, Insufficient Evidence (I)
Magnets	Magnets and Magnetic Stimulation for Acute, Subacute and Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Magnets and Magnetic Stimulation for Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Pulsed Electromagnetic Fields for Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Pulsed Electromagnetic Fields for Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
Manipulation / Mobilization	Manipulation or Mobilization for Acute Knee Pain	No Recommendation, Insufficient Evidence (I)
	Manipulation or Mobilization for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Manipulation or Mobilization for Surgical or Knee Fracture Patients	No Recommendation, Insufficient Evidence (I)
	Manipulation or Mobilization for Post-operative Patients with Significantly Reduced Range of Motion	Recommended, Insufficient Evidence (I)
	Manipulation or Mobilization for Subacute or Chronic Knee Pain	Recommended, Evidence (C)
	Manipulation under Anesthesia for Post-operative Patients with Significantly Reduced Range of Motion	Recommended, Insufficient Evidence (I)
	Manual Therapy and Manipulation for Meniscal Tears	Not Recommended, Insufficient Evidence (I)
	Mobilization and Manipulation for Anterior Knee Pain	No Recommendation, Insufficient Evidence (I)
Massage	Massage for Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Massage for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Reflexology for Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)
	Reflexology for Knee Osteoarthrosis	Not Recommended, Insufficient Evidence (I)
	Transverse Friction Massage for Iliotibial Band Syndrome	No Recommendation, Insufficient Evidence (I)
Medications, Other	Complementary or Alternative Treatments, Dietary Supplements, Etc., for Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)
	Diacerein for Treatment of Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Factor Xa Inhibitors for Prevention of Venous Thromboembolic Disease	Strongly Recommended, Evidence (A)

	Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Osteoarthrosis Prevention	No Recommendation, Insufficient Evidence (I)
	Herbal and Other Preparations for Acute, Subacute, or Chronic Knee Pain	No Recommendation, Insufficient Evidence (I)
	Interleukin-1 Receptor Antagonists for Knee Osteoarthrosis	Not Recommended, Insufficient Evidence (I)
	Low-molecular Weight Heparin for Prevention of Venous Thromboembolic Disease	Strongly Recommended, Evidence (A)
	Muscle Relaxants for Acute and Subacute Knee Pain with Significant Muscle Spasm	No Recommendation, Insufficient Evidence (I)
	One-day Use of Systemic Antibiotics for Knee Surgery	Moderately Recommended, Evidence (B)
	Routine Peri-operative Use of Bisphosphonates	No Recommendation, Insufficient Evidence (I)
	Routine Post-operative Use of Calcitonin	No Recommendation, Insufficient Evidence (I)
	Warfarin and Heparin for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)
MRA	MR Arthrogram for Evaluation of Select Patients Needing Advanced Meniscal and Cartilage Imaging and Following Chondrocyte Implantation	Recommended, Insufficient Evidence (I)
MRI	MRI for Diagnosing Osteonecrosis (AVN)	Recommended, Insufficient Evidence (I)
	MRI for Evaluation of Knee Sprains	Recommended, Insufficient Evidence (I)
	MRI for Evaluation of Meniscal Tears	Recommended, Insufficient Evidence (I)
	MRI for Knee Joint Pathology, Including Diagnosing Meniscal Tears, Cruciate Ligament Tears, Hamstring and other Muscular Tears, and for Select Patients with Post-arthroplasty Chronic Pain or Periarticular Masses	Recommended, Insufficient Evidence (I)
	MRI for Routine Evaluation of Acute, Subacute, or Chronic Knee Joint Pathology	Not Recommended, Insufficient Evidence (I)
	MRI for Severe Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	MRI for the Evaluation of ACL Tears	Recommended, Insufficient Evidence (I)
	MRI for the Evaluation of Patellofemoral Joint Pain	No Recommendation, Insufficient Evidence (I)
NSAIDs	Acetaminophen for Treatment of Acute, Subacute, Chronic or Post-operative Knee Pain	Recommended, Evidence (C)
	Acetaminophen or Aspirin as First-Line Therapy for Patients at Risk for Cardiovascular Adverse Effects	Strongly Recommended, Evidence (A)
	Aspirin for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)

	Concomitant Prescriptions of NSAIDs and Cytoprotective Medications for Patients at Risk for GI Adverse Effects (H2 Blockers)	Recommended, Evidence (C)
	Concomitant Prescriptions of NSAIDs and Cytoprotective Medications for Patients at Risk for GI Adverse Effects (Proton Pump Inhibitors, Misoprostol)	Strongly Recommended, Evidence (A)
	Concomitant Prescriptions of NSAIDs and Cytoprotective Medications for Patients at Risk for GI Adverse Effects (Sucralfate)	Moderately Recommended, Evidence (B)
	NSAIDs Counseling for Patients at Risk for Cardiovascular Adverse Effects	Recommended, Insufficient Evidence (I)
	NSAIDs for ACL Tears	Recommended, Insufficient Evidence (I)
	NSAIDs for Iliotibial Band Syndrome	Recommended, Insufficient Evidence (I)
	NSAIDs for Knee Bursitis	No Recommendation, Insufficient Evidence (I)
	NSAIDs for Knee Sprains	Recommended, Insufficient Evidence (I)
	NSAIDs for Meniscal Tears	Recommended, Insufficient Evidence (I)
	NSAIDs for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	NSAIDs for Quadriceps, Gastrocnemius, and Soleus Strains	Recommended, Insufficient Evidence (I)
	NSAIDs for Treatment of Acute Flares of Knee Pain	Recommended, Evidence (C)
	NSAIDs for Treatment of Acute, Subacute, or Post-operative Knee Pain	Recommended, Insufficient Evidence (I)
	NSAIDs for Treatment of Chronic Knee Pain	Strongly Recommended, Evidence (A)
Opioids	Limited Use of Opioids for Post-operative Pain	Recommended, Evidence (C)
	Opioid Dose Limits in Acute Pain	Recommended, Evidence (C)
	Opioid Dose Limits in Post-opertive Pain	Recommended, Insufficient Evidence (I)
	Opioid Dose Limits in Subacute and Chronic Pain	Recommended, Evidence (C)
	Opioids for Treatment of Acute, Severe Pain	Recommended, Evidence (C)
	Opioids for Treatment of Subacute or Chronic Severe Pain	Recommended, Insufficient Evidence (I)
	Routine Use of Opioids for Subacute and Chronic Non-malignant Pain	Moderately Not Recommended, Evidence (B)
	Routine Use of Opioids for Treatment of Non-Severe Acute Pain	Strongly Not Recommended, Evidence (A
	Screening Patients Prior to Initiation of Opioids	Recommended, Insufficient Evidence (I)
	Screening Patients Prior to Continuation of Opioids	Recommended, Insufficient Evidence (I)
	Urine Drug Screening for Patients Prescribed Opioids	Recommended, Evidence (C)
	Use of an Opioid Treatment Agreement (Opioid Contract, Doctor/Patient Agreement, Informed Consent)	Recommended, Insufficient Evidence (I)

Orthoses	Orthoses for Moderate to Severe Chronic Knee Osteoarthrosis	Moderately Not Recommended, Evidence (B)
	Orthotics or Knee Splints for Patellofemoral Knee Pain	No Recommendation, Insufficient Evidence (I)
Psychological / Behavioral	Cognitive Behavioral Therapy (CBT) for Patients with Subacute or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Psychological Evaluation for Chronic Knee Pain	Recommended, Insufficient Evidence (I)
Rehabilitation	Continuous Passive Motion for Knee Arthroplasty Patients	Not Recommended, Evidence (C)
	Early Post-operative Rehabilitation After ACL Reconstruction Surgery	Recommended, Evidence (C)
	Home-Based Physical Therapy for Post-ACL Operative Repair Patients	Recommended, Evidence (C)
	Interdisciplinary Pain Rehabilitation Program for Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	Meniscal Tear Rehabilitation after Surgical Repair	Recommended, Insufficient Evidence (I)
	Meniscal Tear Rehabilitation without Surgical Repair	Recommended, Evidence (C)
	Perturbation Training As Part of a Rehabilitation Program for ACL Injured Patients	Recommended, Insufficient Evidence (I)
	Post ACL Injury Rehabilitation with or without Surgical Repair	Recommended, Evidence (C)
	Post-Operative Vocational or Avocational Activities	No Recommendation, Insufficient Evidence (I)
	Post-Operative Rehabilitation of Knee Arthroplasty Patients	Recommended, Insufficient Evidence (I)
	Rehabilitation Therapy for Knee Sprains	Recommended, Insufficient Evidence (I)
	Rehabilitation Therapy for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Rehabilitation Therapy for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	Rehabilitation Therapy for Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	Work Conditioning, Work Hardening, or Early Intervention Programs for Chronic Knee Pain Syndromes	Recommended, Insufficient Evidence (I)
Rest	Bed Rest and Knee Immobilization for ACL Tears	Not Recommended, Insufficient Evidence (I)
	Bed Rest and Knee Immobilization for Knee Sprains	Not Recommended, Insufficient Evidence (I)
	Bed Rest and Knee Immobilization for Meniscal Tears	Not Recommended, Insufficient Evidence (I)
	Bed Rest and Knee Immobilization for Patellofemoral Joint Pain	Not Recommended, Insufficient Evidence (I)
	Bed Rest and Non-weight Bearing for Patients with Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)

	Bed Rest and/or Non-weight Bearing for Unstable Fractures	Recommended, Insufficient Evidence (I)
	Bed Rest for Quadriceps, Gastrocnemius, or Soleus Strains	Not Recommended, Insufficient Evidence (I)
	Knee Immobilization for Iliotibial Band Syndrome	Not Recommended, Evidence (C)
Return to Work	Work Limitations for Other Cases of ACL Tears	No Recommendation, Insufficient Evidence (I)
	Work Limitations for Other Cases of Knee Sprains	No Recommendation, Insufficient Evidence (I)
	Work Limitations for Other Cases of Meniscal Tears	No Recommendation, Insufficient Evidence (I)
	Work Limitations for Other Cases of Patellofemoral Joint Pain	No Recommendation, Insufficient Evidence (I)
	Work Limitations for Other Cases of Quadriceps, Gastrocnemius, or Soleus Strains	No Recommendation, Insufficient Evidence (I)
	Work Limitations for Select Cases of ACL Tears	Recommended, Insufficient Evidence (I)
	Work Limitations for Select Cases of Meniscal Tears	Recommended, Insufficient Evidence (I)
	Work Limitations for Select Cases of Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	Work Limitations for Select Cases of Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	Work Limitations for Select Knee Sprains	Recommended, Insufficient Evidence (I)
Saline Load	Saline Load Test for Select Knee Lacerations	Recommended, Insufficient Evidence (I)
Scooters	Motorized Scooters for Severe Chronic Knee Osteoarthrosis	Recommended, Insufficient Evidence (I)
Sleeves	Ace Wraps, Supports or Sleeves for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Neoprene Knee Sleeves for Moderate to Severe Chronic Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
	Sleeves for Knee Osteoarthrosis	Moderately Not Recommended, Evidence (B)
	Supports or Sleeves for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
Splints	Orthotics or Knee Splints for Patellofemoral Knee Pain	No Recommendation, Insufficient Evidence (I)
Surgery	Autologous Blood Re-infusion Systems	Moderately Recommended, Evidence (B)
	Cartilage Grafts, Osteochonndral Autografts, and/or Transplantation	Moderately Recommended, Evidence (B)
	Chondroplasty and Debridement for Knee Osteoarthrosis	Moderately Not Recommended, Evidence (B)
	Compression Stockings for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)
	Intra-operative Autologous Blood Transfusion	Recommended, Insufficient Evidence (I)
	Knee Arthroplasty for Bilateral Disease	Recommended, Evidence (C)

	Knee Arthroplasty for Moderate to Severe Arthritides	Strongly Recommended, Evidence (A)
	Knee Arthroscopy for Diagnosing Acute Knee Pain	Not Recommended, Insufficient Evidence (I)
	Knee Arthroscopy for Diagnosing and Treating Knee Pain with Suspicion of Meniscal Tear, Intraarticular Body, or Other Subacute or Chronic Mechanical Symptoms	Recommended, Insufficient Evidence (I)
	Knee Arthroscopy for Diagnosis or Treatment in Acute, Subacute, or Chronic Osteoarthrosis without Mechanical Symptoms and Other Remediable Mechanical Defect	Not Recommended, Insufficient Evidence (I)
	Knee Arthroscopy for Staging a Surgical Procedure	Recommended, Insufficient Evidence (I)
	Lower-Extremity Pumps for Prevention of Venous Thromboembolic Disease	Moderately Recommended, Evidence (B)
	Pre-operative Autologous Blood Donation	Recommended, Insufficient Evidence (I)
	Prevention of Venous Thromboembolic Disease	Strongly Recommended, Evidence (A)
	Surgery for ACL Reconstruction	Recommended, Insufficient Evidence (I)
	Surgery for Anterior Knee Pain	Recommended, Insufficient Evidence (I)
	Surgery for Grade III LCL Tears	Recommended, Insufficient Evidence (I)
	Surgery for Iliotibial Band Syndrome	No Recommendation, Insufficient Evidence (I)
	Surgery for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Surgery for Select Cases of Grade III MCL Tears	Recommended, Insufficient Evidence (I)
	Surgical Drainage for Knee Bursitis	Recommended, Insufficient Evidence (I)
	Surgical Resection for Chronic Knee Bursitis	Recommended, Insufficient Evidence (I)
	Unicompartmental Knee Arthroplasty for Largely Unicompartmental Disease	Recommended, Evidence (C)
Taping	Taping for Anterior Knee Pain	Not Recommended, Evidence (C)
TNF-a Blockers	Tumor Necrosis Factor-alpha Blockers for Arthroplasty Patients with Osteolysis	Not Recommended, Insufficient Evidence (I)
	Tumor Necrosis Factor-alpha Blockers for Acute, Subacute, or Chronic Knee Pain or Other Non-inflammatory Knee Disorders	Not Recommended, Insufficient Evidence (I)
	Tumor Necrosis Factor-alpha Blockers for Osteoarthrosis	Not Recommended, Insufficient Evidence (I)
Ultrasound	Ultrasound for Evaluation of Meniscal Tears	No Recommendation, Insufficient Evidence (I)
	Ultrasound for the Evaluation of Patellofemoral Joint Pain	No Recommendation, Insufficient Evidence (I)
	Phonophoresis for Iliotibial Band Syndrome	No Recommendation, Insufficient Evidence (I)
	Phonophoresis for Knee Osteoarthrosis	Not Recommended, Evidence (C)

	Ultrasound for Evaluating Other Knee Disorders including Osteonecrosis, Osteoarthrosis, Dysplasia, or Fractures	No Recommendation, Insufficient Evidence (I)
	Ultrasound for Evaluating Patellar Tendinopathy, Pes Anserine Bursitis, Hamstring Strains, Quadriceps Strains or Post-arthroplasty Chronic Pain When Peri-Articular Masses Are Suspected	Recommended, Insufficient Evidence (I)
	Ultrasound for Evaluation of Knee Sprains	No Recommendation, Insufficient Evidence (I)
	Ultrasound for the Evaluation of ACL Tears	No Recommendation, Insufficient Evidence (I)
	Ultrasound for Treatment of Knee Osteoarthrosis	No Recommendation, Insufficient Evidence (I)
Wedges	Lateral Wedges for Medial Compartment for Knee Osteoarthrosis	Moderately Not Recommended, Evidence (B)
Weight Bearing	Bed Rest and Non-weight Bearing for Patients with Acute, Subacute, or Chronic Knee Pain	Not Recommended, Insufficient Evidence (I)
	Bed Rest and/or Non-weight Bearing for Unstable Fractures	Recommended, Insufficient Evidence (I)
Wraps	Ace Wraps for Knee Sprains	Recommended, Insufficient Evidence (I)
	Ace Wraps for Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	Ace Wraps, Supports or Sleeves for Meniscal Tears	Recommended, Insufficient Evidence (I)
	Soft Knee Padding and Ace Wraps for Knee Bursitis	Recommended, Insufficient Evidence (I)
	Wraps for Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
X-ray	X-ray for Bursitis	Recommended, Insufficient Evidence (I)
	X-ray for Diagnosing Fracture	Recommended, Insufficient Evidence (I)
	X-ray for Diagnosing Osteonecrosis (aka Avascular Necrosis, AVN)	Recommended, Insufficient Evidence (I)
	X-ray for Evaluating Acute, Subacute, or Chronic Knee Pain	Recommended, Insufficient Evidence (I)
	X-ray for Evaluation of ACL Tears	Recommended, Insufficient Evidence (I)
	X-ray for Evaluation of Meniscal Tears	Recommended, Insufficient Evidence (I)
	X-ray for Evaluation of Patellofemoral Joint Pain	Recommended, Insufficient Evidence (I)
	X-ray for Severe Quadriceps, Gastrocnemius, or Soleus Strains	Recommended, Insufficient Evidence (I)
	X-rays for Evaluation of Knee Sprains	Recommended, Insufficient Evidence (I)

Evaluation and Diagnostic Issues

The knee should be carefully evaluated with a history, physical examination, and focused diagnostic testing. A complete physical exam is recommended, since pain can be referred, particularly from the back or hip to the knee joint.

The initial knee examination or consultation should focus on the detection of conditions that are remediable and “red flags” (e.g., fractures, osteonecrosis, or septic arthritis).

Initial evaluation of knee joint symptoms may require knee x-rays depending on the presentation. The threshold for additional x-rays, particularly of the back and hip, should be low and may be indicated in certain situations.

Magnetic resonance imaging is helpful for soft tissue disorders, including meniscal and cruciate tears.

Patient Education Issues

Patients should be reassured that knee pain is common. Knee arthroplasty is a major surgical procedure, but has a good prognosis. However, most knee arthrosis patients, particularly those without severe disease, do not require arthroplasty.

Osteonecrosis often requires surgery, although bisphosphonates may substantially reduce the need for surgery.

Rest and disuse of body parts are not recommended for the management of knee conditions other than fractures, as they usually cause further disability and prolong treatment and recovery.

Patients should be encouraged to maintain a high level of function, although activity modifications may be helpful in reducing stresses on the knee.

Occupational Issues

Aside from knee fracture patients in whom prolonged time away from work is often required, or stress fracture patients in whom significant restrictions to limit forceful activity and weight bearing may be recommended, patients should be encouraged to return to normal activity or work as soon as possible. Some situations might require modified duty. However, the more these activities are reduced, the greater the time generally required to rehabilitate the patient.

If knee pain is present, reduced activity may be necessary if the job physical requirements exceed the patient's capabilities.

A functional capacity evaluation (FCE) can establish appropriate physical capacity for work. However, results should be interpreted with caution, as patients' efforts might be submaximal because of pain. Testing is therefore preferably conducted by someone experienced in dealing with these types of patients. Nonphysical factors, return to work programs and participatory ergonomics should be addressed as needed. Patients should be empowered to accept responsibility for managing their recovery.

Adaptive Equipment/Assistive Devices and Other Physical Methods

Ambulatory assistive devices (e.g., canes and crutches) are often mandatory for severely affected patients until they can ambulate.[i] However, physicians should balance use against risks of accelerated muscle weakness, particularly in mildly affected patients.

Ice should be considered as a part of self-care at home, particularly in the acute pain setting, and heat or ice in the chronic setting. They can provide temporary relief of symptoms, but can also reinforce pain and illness behaviors in persons with chronic pain. Many providers believe heat is not indicated in the acute phase of strains, sprains, and some other injuries, although acute low back pain has been demonstrated to be successfully treated with heat. Quality evidence for heat and ice in knee pain is lacking.

[i]Some patients require coaching to not limp, as some continue to limp as a pain behavior.

Ice, heat, ultrasound, and other similar modalities are rarely indicated for treatment of knee pain outside the self-care setting. However, they may be considered for certain cases of patellar tendinopathy and anserine bursitis.

Insoles and knee braces are modestly helpful for patients with osteoarthrosis who are compliant with their use and can be considered if other therapeutic options are limited.

There is no evidence to support prolonged and repetitive use of allied health therapies (massage, electrical therapies, manipulation, and acupuncture). Long-term and repetitive treatment, particularly if there is no documentation of functional improvement, is not indicated in managing patients with chronic pain, including knee pain from DJD.

Exercise Issues

Graded exercises to assist in achieving a return to normal function are indicated.

Gentle exercises are useful to regain normal range of motion (ROM) in the acute pain and post-operative settings. Aggressive stretching may be contraindicated if symptoms (e.g., pain and/or swelling) are substantially aggravated. It is also important for patients to understand that, while exercises after surgery may cause some discomfort, they should not cause significant increases in pain or new onset of increased swelling.

Aerobic and strengthening exercises appear most helpful for the rehabilitation of most chronic knee pain conditions. Consultation with a physical therapist to determine the most appropriate exercises for the patient is recommended.

Medications

Initial management of most knee pain conditions should be with NSAIDs and acetaminophen.

Opioids should be avoided for most patients. Opioids may be considered for the management of selected patients with confirmed moderate to severe knee DJD.

Glucocorticoid injections are indicated for treatment of bursitis, osteoarthrosis, chondromalacia patella, and as initial therapy in degenerative meniscal tears.

Other Issues

Knee replacement surgery, osteotomy and other procedures are selectively recommended for symptoms of severe knee DJD that cannot be managed with other non-operative treatments (e.g. medications, injections).

Surgery is indicated for knee meniscal tears that are unresponsive to non-operative treatment.

Surgical treatment is generally recommended for anterior cruciate ligament tears, although non-operative treatment may be attempted particularly in older patients and in patients without clinically unstable knees.

Intra-articular fragments, such as cartilage, in the knee joint may require arthroscopic exploration and removal.

Impact

Of the many knee disorders reviewed in this guideline, few have been comprehensively studied using high-quality methods. For example, while robust prevalence, incidence, and cost estimates are available for osteoarthrosis and meniscal and cruciate ligament tears, robust data on the burden of other knee disorders is largely unavailable.

Meniscal and anterior cruciate ligament (ACL) injuries are the first and second most common knee injuries, respectively. There are as many as 250,000 ACL injuries per year in the U.S., (1, 2) amounting to 1 in 3,000 of the general population. (3) Of those 250,000 injured, at least one-third elect to have surgery (the actual number is estimated to be approximately 100,000 procedures per year). (4) With operative costs of $11,768, and non-operative costs of $2,333 per procedure, (5) the total annual costs of knee injuries is approximately $1.4 billion per year. But unlike knee replacements, the prevalence of ACL surgery is resistant to the aging of the population. The highest incidence of those suffering from an ACL injury occurs in the 15 to 25 year old age group (2) and 70% of all ACL injuries occur in the context of sport. The incidence of meniscal injuries has been estimated at 61 per 100,000 persons in the U.S., and the prevalence is 12 to 14%, with a strong relationship to age. Meniscal surgical procedures are common, comprising 10 to 20% of all orthopaedic surgeries and an estimated total of 850,000 patients per year.

Osteoarthrosis (OA) is common, increases in incidence with age, and is associated with significant morbidity and cost. OA affects 13.9% of adults aged 25 years and older and between 33.6 to 46% of adults over age 65. Nearly 66% of obese adults will develop painful knee OA over their lifetime.(6, 7) Of the arthritis-related procedures that require hospitalization, 35% are due to hip and knee replacements. Job-related costs for OA overall are $3.4 to $13.2 billion per year with an average patient out-of-pocket direct expense of $2,600 per year. Twenty-five percent of those affected with OA cannot perform major activities of daily living.(7)

Non-fatal work-related knee injuries and diseases involving days away from work have been decreasing, but physician visits for knee complaints and the incidence of certain knee surgeries has been increasing. According to the U.S. Department of Labor Statistics, number of non-fatal work-related knee injuries decreased from a peak of 130,000 in 2000, to 95,000 in 2007. Yet, total physician visits for knee complaints increased from 10,790,000 in 1998, to 14,960,000 in 2006, and the number of emergency room visits for knee complaints increased from 1,039,000 in 1998, to 1,452,000 in 2006.(8) The rate of total knee replacements for persons aged 65 years and older has been increasing, with women having more surgeries than men. Data from the National Center for Health Statistics indicate that from the period of 1980 to 2002, knee replacements increased approximately 8.1 times, from 10 per 10,000 in women to just fewer than 80 per 10,000, with similar trends observed in men.

Overview

The following knee disorders are covered in detail in this guideline. Other disorders not reviewed in this guideline in depth should be considered in the differential diagnosis of knee pain and knee symptoms. These include lumbar radiculopathy and lumbar spinal stenosis, (see Low Back Disorders guideline), osteochondritis dissecans, vascular disease, avulsion fractures, femoral mononeuritis, tumor, cancer, crystal arthropathies (e.g., gout, pseudogout, hydroxyapatite), and infections, including septic arthritis (see Basic Principles and Definitions for normal anatomy). Several of these disorders have a tenuous relationship with work, but are included for purposes of completeness (see Work-Relatedness section).

Avascular Necrosis

See Osteonecrosis below.

Anserine, Infra-Patellar and Pre-Patellar Bursitis

Bursitis occurs when the bursae become inflamed and irritated, although classic symptoms and signs of inflammation are not always present. Bursitis results in swelling and pain when muscles overlying the bursae are used. There are many bursae around the knee, and this discussion includes some of those more commonly affected. Infra-patellar bursitis involves the bursa between the patellar tendon and the skin. Pre-tibial bursitis involves the bursa between the tibial tuberosity below the knee and the overlying dermis. Pre-patellar bursitis involves the bursa between the patella and the overlying dermis. Anserine bursitis (also pes anserine bursitis) involves a deeper bursa located between the conjoined tendons of the sartorius, gracilis, semitendinosus, and the medial collateral ligaments. Treatment of bursitis has most commonly included avoidance of kneeling or other exposures, NSAIDs, glucocorticosteroid injections (with or without aspiration), and rehabilitation therapy.

Fracture of the Knee

Knee fractures include frank fractures and dislocated, hairline, and “stress” fractures. All fractures involve an application of force that is beyond the strength of the bone. In the knee, fractures can occur in the tibia (commonly as the tibial plateau), fibula, or patella. These almost invariably require surgical fixation, but treatment can range from immobilization with a knee brace to casting immobilization to surgical fixation, depending on the severity of the fracture. Stress fractures typically involve repeated applications of unaccustomed force over a relatively short interval of hours to a few days. These are usually treated with elimination of the offending exposure and observation. Physical therapy assessment to address movement system impairments, such as muscle performance and motor patterns, may assist in developing management plans to reduce forces on the affected site.

Groin Strains

See Hip and Groin Disorders guideline.

Hamstring, Calf, and Quadricep Strains, and Tears

A strain usually consists of a disruption of a myotendinous junction. The lower extremity is particularly prone to muscle strains, and strains of certain structures are more common than others. A hamstring strain involves the hamstring muscles of the thigh and can be located either distally or proximally

depending on the strained muscle-tendon units, usually in the long head of the biceps femoris muscle. Calf strains typically involve the gastrocnemius or soleus muscles in the upper calf. Quadricep strains involve one or more of the quadriceps muscles as they insert on the superior patella. Complete muscular tears usually occur in the same muscles prone to developing strains. Strains are most commonly treated by removal from high force activities, NSAIDs, and therapy for more severe cases. Immobilization is sometimes implemented. Complete tears/ruptures of the quadriceps tendon or patellar ligament commonly require surgical repair while other muscle-tendon units are usually managed non-operatively.

Iliotibial Band Syndrome

This entity is common in runners, cyclists and participants in endurance sports. Pain is in the lateral knee. Treatment is largely empiric, as quality evidence is sparse, and may consist of NSAIDs, active physical therapy, glucocorticosteroid injections, and deep friction massage.

Lumbar Radiculopathy and Lumbar Stenosis

These disorders may present as knee, thigh, and calf pain. Thus, they should be considered in the differential diagnosis of knee pain (see Low Back Disorders guideline).

Meniscal Tears

Menisci are prone to degenerative changes and tears with age. Meniscal tears frequently accompany degenerative joint disease. Younger patients tend to tear with high-force discrete trauma as a result of sporting activities such as football. Older patients tend to acquire tears over time, without any inciting event or with relatively mild trauma, during performance of usual activities (e.g., stair climbing). The type of tear may help determine whether it is more likely degenerative or traumatic in nature. The medial meniscus is 2.7-fold more likely to be torn than the lateral meniscus.(9) Pain tends to be focal – e.g., at the posteromedial joint line for a medial posterior horn meniscal tear. Joint effusions tend to occur if there is an acute, large tear. Small degenerative tears may produce no effusion. Treatment of large “bucket-handle” tears involves surgical removal. Treatment of degenerative and small tears involves NSAIDs, activity modifications to avoid aggravating activities, glucocorticoid infiltration, and therapeutic exercises. Surgery may be needed in cases where non-operative results are not satisfactory.

Osteoarthrosis Including Degenerative Joint Disease (“Osteoarthritis” and “Degenerative Arthritis”)

Degenerative joint disease (DJD) of the knee is most commonly caused by osteoarthrosis (OA). While osteoarthritis is the more common name for this entity, osteoarthrosis is more technically precise since there is no classic inflammation. Other types of arthritic disorders that cause DJD include inflammatory autoimmune disorders (e.g., rheumatoid arthritis, systemic lupus erythematosus, and psoriasis) and crystal diseases (e.g., gout, pseudogout, apatites). These latter disorders are non-occupational and are not included in this discussion. Knee OA and inflammatory knee arthritis can result in destruction of the knee joint, and these conditions may therefore be indistinguishable on x-ray. Thus, a correct interpretation of an x-ray may include DJD, but not “osteoarthritis.”

Most joints in the body have a modest female preponderance of OA and the knee is no exception with an estimate of 84% higher risk in women than men for reasons that are unclear.(10) Patients who already have OA in one or two joints may be at higher risk for developing OA in other joint groups. This

is sometimes referred to as “systemic osteoarthrosis.” Systemic osteoarthrosis likely reflects genetic or other systemic predispositions. Several genetic risk factors have been identified.(11)

OA is more common with age and is associated with thinning of cartilage on the articular surfaces of the knee joint. Thinning of the cartilage in the knee joint may lead to pain with movement and stiffness. OA is generally characterized by stiffness (and pain) after both long periods of inactivity or in association with unaccustomed increases in activity. Most cases of OA are symmetrical and appear to arise without obvious physical exposure(s). A minority of cases occur after discrete significant trauma, most commonly fractures. The disease tends to progress irrespective of physical exposures.

Osteoarthrosis: Initial Interventions/Role of Rehabilitation Therapy and Other Non-pharmacologic or Non-Invasive Interventions

Many patients with knee osteoarthrosis are able to control their pain adequately through avoidance of activities that significantly provoke symptoms and through the use of over-the-counter (OTC) medication. Topical agents, heat, and ice may be helpful self-treatments. Braces and orthotics/insoles are sometimes helpful. Patients may benefit from education about the natural history of knee OA. Regular participation in programs stressing aquatic or gentle aerobic (e.g., walking programs), or strengthening exercise may also be of benefit, although these modalities should be individualized to the patient’s diagnosis, prior activity levels, desired activity levels, and overall preferences. Weight loss also is thought to be strongly indicated for patients who are either overweight or obese.(12-33) A few recent trials have suggested that weight loss reduces pain and morbidity.(13, 24, 34-36)

Osteoarthrosis: Pharmacologic Management

Non-steroidal anti-inflammatory drugs (NSAIDs) are most commonly used for patients with OA. Chronic NSAID therapy may warrant ancillary use of proton pump inhibitors, H-2 histamine blocking agents, or misoprostol to provide prophylaxis against gastrointestinal adverse effects. The advantage of selective Cox-2 inhibitors is their lower risks of gastrointestinal side effects. Tricyclic antidepressants, dual reuptake inhibiting antidepressants (i.e., SSNRIs) and acetaminophen may be of benefit for some patients. Highly selected patients may be candidates for judicious use of low doses of opioids if this results in functional improvement. Providers should also take into consideration that many OA patients are older and have significant comorbidities, including renal impairment. Medications should therefore be carefully prescribed.

Osteoarthrosis: Role of Invasive Procedures

Invasive procedures are not indicated in the management of most osteoarthrosis patients unless the condition is unable to be satisfactorily controlled with other non-invasive treatments. In such cases, intraarticular injections with glucocorticosteroid and viscosupplementation are sometimes utilized. In advanced cases, joint replacements and other surgical procedures are often performed.

Osteochondritis Dissecans

Osteochondritis dissecans most commonly affects the knee, although the elbow, hip, and ankle are sometimes affected.(37) It is manifested by articular cartilage that dislodges or dissects from the underlying bone. Osteochondritis dissecans most commonly occurs in teenagers, although it can occur in adults. The cause of osteochondritis dissecans is unclear. However, there appears to be important genetic risks.(37, 38) Although sports activities, particularly in teenage years, also appear to be an important risk factor, there are no quality epidemiological studies of the association of osteochondritis dissecans with work. Consequently, osteochondritis dissecans will not be addressed further in this guideline.(39-51)

Osteonecrosis (Avascular Necrosis)

Osteonecrosis occurs when the tenuous blood supply to the bone is interrupted. Osteonecrosis may result from traumatic or non-traumatic factors. The condition is painless at early stages, but when it advances, patients generally present with pain and limitation of motion. Pain most commonly localizes over the affected bone. This condition most commonly affects the head of the femur, but it can affect any bone. Pain in the lower extremity is usually exacerbated by weight bearing and relieved with rest. Management of knee osteonecrosis is extrapolated from quality evidence for treatment of osteonecrosis of the head of the femur (see Hip and Groin Disorders guideline).

Patellar Dislocation and Instability

The patella is subject to instability from congenital or inherited tendencies to dislocate (52-55) as well as trauma. Pain from dislocation is usually severe and associated with an inability to use the limb. Individuals with a congenital or inherited tendency to dislocate have usually dislocated their patella prior to reaching an employable age. The patella may dislocate with lesser force or stress over time, and recurrences are quite common. Surgery to attempt to tighten the quadriceps mechanism is usually attempted. Other cases of patellar dislocation occur as a result of significant trauma (e.g., motor vehicle accident or fall). The patella may then be prone to recurrent dislocation after the initial dislocation, and a subjective feeling of instability may result. Strengthening exercises may be helpful. In most cases, particularly if recurrent, surgical repair is attempted.

Patellofemoral Joint Syndrome and Patellofemoral Joint Degenerative Arthrosis (Including Chondromalacia Patellae)

Patellofemoral joint syndrome is a diagnostic category that includes patients with pain thought to be primarily from the patellofemoral joint or the anterior aspect of the knee. Some of these patients are thought to have degenerative joint disease that is focused on that aspect of the knee joint, although they may also have degenerative changes in other parts of the knee joint. Theoretical mechanisms are controversial. Some patients may have muscle weakness that is present in one part of the quadriceps (e.g., vastus medialis), or alternatively the whole quadriceps may be judged as demonstrating weakness. When pain arises from arthrosis in the patellofemoral joint then treatment is comparable to other arthrosis reviewed above. However, when there is evidence of quadriceps muscle weakness, specific strengthening exercises for that muscle are usually prescribed.

Patellar Tendinopathy

Patellar tendinosis, which affects the patellar tendon, is sometimes referred to as “jumper’s knee.” This usually arises from high-force activities on a stereotypical basis, direct trauma, and/or as a degenerative condition. Patellar tendinosis is usually treated with NSAIDs and exercises. Knee appliances (e.g., sleeve, strap) are also sometimes used as are heat, ice, and topical treatments. Severe cases may rupture (see Patellar Tendon Tears).

Patellar Tendon Tears

Patellar tendon tears usually occur with either a high-force event or an accident, but can result from severe patellar tendinosis. They are treated with surgical repair and rehabilitation; partial tears may be treated non-operatively.

Sprains and Tears of the Cruciate Ligament (Anterior and Posterior)

Cruciate ligament sprains and tears are sprains or partial or complete tears of the ligaments connecting the femur to the tibial plateau that generally occur as the result of high-force injuries from sports, accidents, or falls. In some cases involving less trauma, rupture is believed to occur because of prior injury and weakness. Symptoms include pain and instability. A large effusion may occur with large ruptures. Partial tears are usually treated with NSAIDs, ice, and may involve physical or occupational therapy. Complete tears of the anterior cruciate ligament are usually surgically reconstructed, although non-surgical treatment with rehabilitation may be attempted. Complete tears of the posterior cruciate are usually treated with exercise, although sometimes they are treated surgically.

Sprains and Tears of the Collateral Ligaments (Medial and Lateral)

Collateral ligament sprains and tears are sprains and partial or complete tears of the ligaments connecting the lateral femur to the tibia (lateral collateral ligament) or medial femur to the tibia (medial collateral ligament). By definition, these are high force injuries and may occur during sports, accidents, trips, slips or falls. Pain is localized to the affected ligament. The medial collateral ligament may be accompanied by a medial meniscal tear due to shared fibers in these two anatomical parts. Treatments usually consist of NSAIDs and ice or heat, knee support sleeves in the acute phase, and may involve physical or occupational therapy. Isolated complete tears of the medial collateral ligament are usually treated non-operatively.

Synovitis

Synovitis refers to inflammation of a synovial membrane, although in most cases, there are no classic symptoms and signs of inflammation. Synovitis is usually painful, especially with motion. Fluctuating swelling may occur due to effusion within the synovial sac. Treatments usually consists of NSAIDs, elimination of physical exposures (especially direct pressure if thought to be problematic), and often ice or heat.

Basic Principles and Definitions

Acute, Subacute, and Chronic Pain: For the purposes of identifying interventions at different stages of diseases, acute pain is defined as pain of up to 1 month, subacute is pain from 1 to 3 months, and chronic is pain of more than 3 months duration (see Chronic Pain guideline for additional information).

Active Therapy: The term “active therapy” is commonly used to describe treatment that requires the patient to assume an active role in rehabilitative treatment. Although there is no one specific treatment defined by this term, it most commonly includes therapeutic exercises, particularly aerobic activities and muscle reconditioning (weight lifting or resistance training).(56) Some authors include active stretching and treatment with psychological, social and/or educational components requiring active participation from the patient.(57)

Active Exercise Therapy: Therapy that typically consists of cardiovascular training and muscle strengthening,(58, 59) though it may also include progressive or occasionally even active stretching, especially in those with substantially reduced ranges of motion. Active exercise therapy is used as a primary treatment for chronic pain, is frequently initiated in the course of treating subacute pain, and is a primary treatment after various surgeries. The goal of active exercise therapy is to improve function.(58) The word "active" is used to differentiate individualized exercise programs designed to address and rehabilitate specific functional, anatomic or physiologic deficits from passive treatment modalities or from forms of "exercise" that require very little effort or investment on the part of the patient or provider.

Bursae: Fluid-filled sacs within the body which provide lubrication in areas where muscles move over bony projections. Inflammation of the bursae may occur and is referred to as bursitis (see Bursitis). Commonly affected bursae include the infra-patellar, pre-patellar, suprapatellar and anserine bursae. These bursae lie in front of the tibial tuberosity, anterior to the patella, above the patella, and between the bone and adductor tendons along the medial knee, respectively.

Collateral Ligament: Ligaments connecting the lateral femur to the fibula (lateral collateral ligament) or the medial femur to the tibia (medial collateral ligament).

Cruciate Ligament: Ligament connecting the center of the distal femur to the center of the tibial plateau. There are two cruciate ligaments per knee – the anterior and posterior.

Delayed Recovery: Defined as an increase in the period of time between the onset of the injury and/or illness and the patient's return to work or usual activities relative to the expected recovery time. Expected recovery takes into account reasonable expectations, disorder severity, age, and treatments provided.

Enthesopathy: Disorder of the muscular or tendinous attachment to bone.

Functional Capacity Evaluation (FCE): A comprehensive battery of performance-based tests used to attempt to assess an individual's ability for work and do activities of daily living.(60) An FCE may be done to identify an evaluee's ability to perform specific job tasks associated with a job (job-specific FCE) or his or her ability to perform physical activities associated with any job (general FCE).

Functional Improvement: Entails tracking and recording evidence that the patient is making progress towards increasing his or her functional state. Use of validated tool(s) to track functional improvement is preferable.

Functional Restoration: A term initially used for a variant of interdisciplinary pain alleviation, or at least amelioration, characterized by objective physical function measures, intensive graded exercise and multi-modal pain/disability management with both psychological and case management features.(61-67) The term has become popular as a philosophy and an approach to medical care and rehabilitation. In that sense, functional restoration refers to a blend of various techniques (physical and psychosocial) for evaluating and treating the chronic non-malignant pain patient, particularly in the workers' compensation setting (see Chronic Pain guideline).

Iliotibial Band: Fibrous connection between the ilium of the pelvis to the tibia. The iliotibial band syndrome involves pain mostly in the lateral knee joint.

Knee Joint: The knee joint is a synovial hinge type joint based on the articulation of the distal femur and the tibia of the calf. Four ligaments hold the femur to the tibia – the medial and lateral collateral ligaments and the anterior and posterior cruciate ligaments.

Knee Pain: Pain originating from the knee is usually focally felt in the knee joint. However, some cases are experienced with pain primarily in the hip region. Anterior knee pain is commonly due to patellofemoral joint pain, patellar tendinopathy, and quadriceps strains. Medial joint pain is often caused by medial collateral ligament (MCL) sprains, medial meniscal tears, medial compartment OA, groin strains, and anserine bursitis. Lateral joint pain is frequently due to lateral collateral ligament (LCL) sprains, lateral meniscal tears, lateral joint OA, and iliotibial band syndrome. Posterior knee joint pain is commonly due to hamstring strains, calf strains, Baker's cysts, hyperextension injuries, and popliteal arterial disorders. Other patients have proximally or distally radiating pain. Pain in the knee may also be due to referred pain from cardiovascular or metastatic processes, lumbar disc herniation with nerve impingement, lumbar spinal stenosis, or arterial insufficiency.

Meniscus: A semilunar ("C-shaped") fibrocartilaginous structure which covers approximately 60% of the surface of the tibial plateau and helps distribute weight from the respective femoral condyle evenly. Each joint has a medial and lateral meniscus.

Pain Behavior: Verbal and non-verbal actions (e.g., grimacing, groaning, limping, using pain relieving or support devices, requesting pain medications, etc.) which communicate the concept of pain to others.

Passive Modality: Various types of provider-administered treatments in which the patient is passive. These treatments include medication, injection, surgery, allied health therapies (e.g., massage, acupuncture, and manipulation), and various physical modalities such as hydrotherapy (e.g., whirlpools, hot tubs, spas, etc.), ultrasound, TENS, other electrical therapies, heat and cryotherapies.

Primary Prevention: Primary prevention involves preventing the condition or risk factor from developing (e.g., physical activity programs to prevent obesity).

Rehabilitation: Rehabilitation is used in these guidelines to mean physical medicine, therapeutic and rehabilitative evaluations, and procedures. Rehabilitation services are delivered under the direction of trained and licensed individuals such as physicians, occupational therapists, and physical therapists. Sometimes mental health professionals are incorporated into the treatment team, particularly for select chronic pain patients. Jurisdictions may differ on qualifications for licensure to perform rehabilitative evaluations and interventions.

Secondary Prevention: Secondary prevention involves reduction in the exposure or risk factor after the risk factor has already developed, but before the disease has manifested (e.g., use of fall protection equipment to prevent hip fractures).

Sprain: Disruption of a joint's ligaments. Examples in the knee include sprains of the medical or lateral collateral ligaments or anterior or posterior cruciate ligaments (see Cruciate and Collateral Sprain).

Strain: Disruption of a muscle or myotendinous junction, usually from a high force or unaccustomed exertion(s). It may also occur during an accident. This term is occasionally used to describe non-specific muscle pain in the absence of knowledge of an anatomic pathophysiological correlate. In the knee region, examples include hamstring, calf, and quadriceps strains (see Hamstring, Calf, Quadriceps Strain).

Stress Fracture: Fractures that occur mainly due to unaccustomed, forceful use. Treatment is generally activity modification to preclude high force use.

Synovial Membrane: The membrane surrounding the entire knee, including the medial, lateral, and patellofemoral joints. The synovial membrane may become inflamed, leading to synovitis (see Synovitis).

Synovial Plicae: Remnants of the divisions of the knee compartments. These are thought to be involved in inflammation and irritation, termed "plicae syndrome."

Tenosynovitis: Tenosynovitis refers to inflammation of a tendon sheath, although in most cases, there are not classic symptoms and signs of inflammation. Classic inflammation may occur with arthropathies or infectious agents.

Tertiary Prevention: The amelioration of the condition after it has already developed. For example, after a patient has osteonecrosis, precluding them from diving, which may be associated with dysbaric osteonecrosis, is a method of tertiary prevention.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): Most common knee outcome measure for osteoarthrosis of the knee, other than standard and VAS pain ratings. It combines subjective ratings of pain with measures of activity levels, stiffness, physical function, social function and emotional function.(68)

Initial Assessment

The physician performing an initial evaluation of a patient with knee symptoms should aim to develop an appropriate differential diagnosis. A careful, thorough history and focused physical examination is required (see General Approach to Initial Assessment and Documentation). A review that not only focuses on the knee, but also addresses the hip, foot, spine, abdomen, and genitourinary tract, is necessary. The examination of the patient with knee symptoms should focus on the knee joint and relevant neighboring structures. Findings of the medical history and physical examination can alert the physician to other non knee-related pathology. Certain findings, referred to as "red flags," raise suspicion of serious underlying medical conditions (see Table 1). Potentially serious disorders include infections, tumors, and systemic rheumatological disorders.

Knee disorders may be classified into one of four somewhat arbitrary and overlapping categories (examples):

Potentially serious knee conditions: fractures, dislocation, infection, neurovascular compromise, tumors.

Mechanical disorders: derangements of the knee more commonly related to acute trauma, such as ligament sprains and tears, myotendinous strain, and some meniscus tears.

Degenerative disorders: mostly consequences of aging, including osteoarthrosis, tendinosis, and most meniscal tears.

Nonspecific disorders: occurring in the knee and suggesting neither internal derangement nor referred pain.

Table 1. Red Flags for Potentially Serious Conditions Associated with Knee Pain*

Disorder	Medical History	Physical Examination
Tumor and Neoplasia	Severe localized pain, often deep-seated, unrelenting bony pain History of cancer (at any point in lifetime) Age >50 years Symptom consistent with disease in a specific organ system (e.g., cough, change in bowel habit, epigastric pain, early satiety) Constitutional symptoms, such as recent unexplained weight loss, fatigue Pain that continues at night or at rest	Pallor, reduced blood pressure, diffuse weakness New mass or tenderness, including tenderness over bony landmarks New findings at a distant site relative to the original complaints, including abnormal pulmonary examination (crackles, wheezes, rhonchi, decreased breath sounds)
Infection	Constitutional symptoms, such as recent fever, chills, or unexplained weight loss Recent bacterial infection (e.g., urinary tract infection); IV drug abuse; diabetes mellitus; or immunosuppression (due to corticosteroids, transplant, or HIV) History of recurring infections treated with antibiotics (e.g., repeated urinary tract infections) Foreign travel with potential exposure to infectious agents	Fever, tachycardia, tachypnea, hypotension Elevated white blood cell count (may be decreased in elderly or immunocompromised) Shift in the WBC differential towards immature cells ("left shift") Abnormal urinalysis Abnormal body part examination (e.g., pulmonary) Tenderness over bony landmarks Joint effusion, tenderness and difficulty moving knee joint (if knee septic arthritis)
Significant or Progressive Neurologic Deficit	Severe spine or extremity pain Progressive numbness or weakness Complaints of new gait difficulty	Significant or progressive dermatomal and/or myotomal (motor) involvement Evidence of cauda equina syndrome, including urinary retention or bowel incontinence Hyper-reflexia, or other evidence of myelopathy
Compartment Syndrome	History of fracture, crush wound or other major trauma Very painful muscular compartment History of peripheral vascular disease	Tense compartment Exquisitely tender Distal neurovascular compromise (e.g., absent or decreased pulses or pale/cold extremity) if severe and/or prolonged
Rheumatologic Disease	Diffuse arthralgias Prior arthropathies, autoimmune diseases Skin changes, lesions, or ulcers Fatigue, malaise	Polyarticular joint effusions (usually with warmth) X-ray abnormalities consistent with erosive pathology Elevated sedimentation rate (ESR) or C-reactive protein (CRP) Hematuria, proteinuria Other specific abnormalities, as appropriate (e.g., ANA, RF, anti-DNA, C3, anti-Ro, anti-La, oral ulcers, pulmonary abnormalities, ophthalmological involvement, dermal abnormalities)

*The above list is not meant to be comprehensive but rather reviews many common historical and examination findings.

Medical History

The initial evaluation of patients with knee pain should include a thorough medical history. Although knee symptoms are generally more accurately attributed to the knee joint than the hip joint, some cases of knee joint pathology may present with hip pain (see Hip and Groin Disorders guideline).[ii] A complete occupational history is also necessary to assist the patient with successful accommodation and rehabilitation, as well as to determine work-relatedness. Asking the patient open-ended questions, such as those listed below, allows the clinician to gauge the need for further discussion or specific inquiries to obtain more detailed information (see also General Approach to Initial Assessment and Documentation guideline):

1. "What may I do for you today?" (This question helps focus the discussion on what the patient feels is the main purpose of the visit. It also helps ensure that the physician is able to eventually address the main purpose of the visit, which is important for patient satisfaction.)

2. What are your symptoms? (Observing how the worker acts when describing symptoms may provide insight into the diagnosis and help the physician understand the impact of symptoms on the patient.)
    - What are your symptoms?
    - When did your symptoms begin?
    - Where are the symptoms located?
    - Do you have pain or stiffness?
    - Do you have swelling, locking, or giving way? If swollen, how long after the injury did your knee become swollen? What is the pattern to your symptoms? Are they better when first getting out of bed in the morning, during the morning, mid-day, evening or while asleep? When is it worst?
    - Do you have fever, night sweats, or weight loss?
    - Do you have pain or other symptoms elsewhere?
    - Do you have numbness, tingling, or weakness? Have you lost control of your bowel or bladder? Are your symptoms worse when climbing or going down stairs or hills? (These questions are particularly important if knee pain is felt to be associated with radicular spine pain or spinal stenosis).
    - Since these symptoms began, have your symptoms changed? How?
    - How do your symptoms affect your life?
    - Can you walk on your leg?
    - Do you have difficulty sleeping? What position is most comfortable?

3. How did the condition develop?

[ii] The clinical phenomena of primary hip and pelvic region pathology referring pain to the knee is well documented (69) and appears to be particularly prevalent in the pediatric population. This may include delayed diagnoses of serious pelvic region pathology such as osteogenic sarcoma in younger soldiers. Disorders such as Legg-Calve-Perthes and slipped capital femoral epiphysis may be associated with primary complaints of knee pain. These conditions might be seen in younger workers.(70,71) Similarly many patients with a chief complaint of hip pain actually have a knee disorder that is usually osteoarthrosis. Clues to the origin of symptoms can be determined with a careful patient history as primary hip pathology typically is perceived in the buttocks, anterior inguinal region, thigh and occasionally in the foot and ankle.(69) Hip pathology presents as difficulty crossing legs, laying on the hip and restricted internal rotation, while knee pathology presents as difficulty climbing stairs, kneeling onto the knee, and bending the knee to get in and out of the car. Consequently, the hip, pelvic region and lumbar spine should be examined thoroughly in any instance of thigh or knee pain that is not clearly an isolated acute knee injury. (69-71)

Past:

- Have you had similar episodes previously?
- Have you had previous testing or treatment? What treatment? What were the results? With whom? How long did it take to get back to work? To light duty?
- Did you receive a disability or impairment rating?
- Was recovery complete? (Did you get a disability award?)

Cause:

- What do you think caused the problem? When?
- Do you think it is related to work?
- Did your symptoms begin suddenly or gradually? (It is important to distinguish between symptoms associated with a specific traumatic injury and those that represent cumulative trauma over time).
- What were you doing at the time when your symptoms began? Did you have a slip, trip, fall, or twist or strike an object? (It is important to document the circumstances surrounding the injury and any biomechanical risk factors).
- For traumatic injuries: Was the area deformed? Did you lose any blood or have an open wound? When after the injury did your symptoms begin?
- For degenerative conditions: Is there a history in your family of this problem? Does anyone else have arthritis in your family?

Job:

- What are your specific job duties?
- What are your work hours, and what is your break schedule?
- Do you rotate duties?
- How long do you spend performing each duty on a daily basis?
- How much do you lift, push, or pull at work as a maximum? Usual lift, push, or pull?
- Do you have assistance of other people or assistive (e.g. lifting) devices?
- What previous jobs have you held, and what were your job duties?
- What is the hardest part of the job for you to do with your injury? Why?
- Is modified duty available at your workplace? What type of modified duty is available?

Non-Occupational Activities:

- What other activities (e.g. hobbies, sports) do you engage in at home or elsewhere? What prior activities did you engage in?
- Describe your current daily activities. Do you do any heavy lifting, pushing, or pulling? How often?
- Could these activities have contributed to the development of your symptoms?

4. Assess treatments and determine whether responses differ from expected outcomes.
    - What treatments have you had?
    - Did anything help decrease your symptoms? What, and for how long?
    - Are you doing any exercises at home? Which ones? How often?
    - Are you taking any non-prescription medications and supplements?
5. Discuss symptom limitations.
    - Do you expect to recover? How soon?
    - How do your symptoms limit you?

- Can you perform activities of daily living (e.g., dressing, bathing, grooming, etc.) or instrumental activities of daily living (e.g., shopping, food preparation, housekeeping, etc.)?
- How long can you sit, stand, walk, and bend?
- How much weight can you lift (use items such as gallons of milk, groceries, etc. as examples)?
- How much can you push or pull?
- If these symptoms limit you, how long have your activities been limited?

6. Do you have other medical problems? For example:
   - Osteoarthrosis, rheumatoid arthritis, gout, pseudogout, or other arthritides?
   - Fractures or lower extremity surgeries?
   - Cardiovascular disease?
   - Pulmonary disease?
   - Gastrointestinal disease?
   - Diabetes mellitus?
   - Neurological disorders (including radiculopathies, headaches)?
   - Psychophysiologic disorders (e.g. irritable bowel syndrome, chronic fatigue syndrome, or fibromyalgia)?

7. Do you have a history of mental health disorders or alcohol, tobacco, or other substance use?
   - Have you ever had a substance use problem? Have you ever been charged with driving under the influence (DUI)? Have you ever been in a detoxification program? Have you ever had an alcohol problem? (CAGE or MAST screening should be performed in the case of suspected osteonecrosis, as alcohol use is associated with a higher risk of osteonecrosis)
   - Do you or have you ever used tobacco (assess pack-years)?
   - Do you or have you ever used any other drugs?

8. What do you think about your job (psychosocial context)?
   - Do you like your job?
   - Do you have control over your job? Partial control?
   - Do you feel your job demands are reasonable?
   - What is your relationship with your co-workers and supervisor? How do they treat you?

9. Assess whether there are problems at home or in the social life? Is there support?
   - How do you get along with your family members? Do they help and support you?
   - Does your family treat you differently now that you are in pain? Have your roles at home changed because of your injury? Do your friends treat you differently?
   - Are your symptoms worse when you are dealing with problems with your family and friends?

10. Are there advocagenic (litigious) influences?

11. Do you have a workers' compensation claim for this injury?

12. Do you have a lawsuit or other legal action involving this problem?

Physical Examination

Objectives of the physical examination of the knee include defining physical abnormalities, narrowing diagnostic considerations, and developing and focusing an effective, specific treatment plan. In order to align an intervention strategy with deficits such as impaired strength, or movement balance, the examination should first reveal the impairments. Examination of knee includes active and passive ranges of motion and accessory movements. Muscle strength and flexibility should be revealed through valid testing. Coordination, balance, and fall risk should also be assessed. Special tests for specific pathologies are often only a small aspect of the examination and may be overall less important to nonsurgical management of the knee disorder. Special tests are more helpful when there is clear evidence that the pathology revealed is better managed by a process other than restoring normal movement, strength, flexibility, and coordination to the knee.

Physical examination data, including vital signs, should be reviewed for potential inferences about infectious or neoplastic etiologies of knee symptoms. The physical examination should begin the moment the physician sees the patient. Observing how the patient sits, walks, and moves is extremely important. It is also helpful to have the patient demonstrate what positions caused or seem to provoke the symptoms.

Guided by the medical history, the physical examination includes:

- general observation of the patient, including stance and gait, and how the patient changes positions (monitoring for pain behavior during range of motion (ROM) and posture changes often offers a clue to the origin of the problem);
- regional examination of the knee and testing for specific knee disorders;
- examination of organ systems related to appropriate differential diagnoses, including a neurological examination.

Much of the knee examination is not purely objective. There is an element of patient cooperation when determining strength or active range of motion, and most maneuvers require a subjective statement of pain to be considered positive. It is often helpful to assess patients' capabilities in the clinic to follow in subsequent clinic visits. These may include:

- walking distance and ability to climb stairs (observe, if possible, and inquire about any progress);
- repeated toe raises (number able to perform), heel walking (distance), and squats (number);
- sensory examination findings (e.g. pin prick, using monofilaments).

The use of validated functional assessment tools is recommended, if possible, to assess capabilities. Active involvement of the provider in evaluating patients' function is believed to be helpful in facilitating patients' recoveries.(72)

Physical Examination for Specific Diagnoses

Physical examination findings vary based on the acuity and severity of the disorder. In general, conditions that arise acutely present with more pronounced physical examination findings. Patients with long-standing conditions may have less prominent physical examination findings. The most commonly used physical examination maneuvers are described below. In addition, there are other examination maneuvers and techniques, including performance of maneuvers under anesthesia.(73-91) It is suggested that the examiner become familiar with a specific set of maneuvers rather than an entire battery.

Pes Anserine Bursitis
Tenderness over the pes anserine bursa is usually present.(92, 93) In contrast with other bursidities, there is usually no palpable swelling or warmth.(92, 94, 95)

Bursitis (Infrapatellar, Prepatellar, Suprapatellar)
Swelling in the affected bursa(e) is present.(96-98) The affected bursa may be slightly warm, but is generally minimally tender or non-tender. Moderate or severe pain or tenderness, overlying warmth, and erythema raise the probability of septic bursitis.(98, 99) Crystal arthropathies may affect the bursae, but are rare, particularly in the infrapatellar or prepatellar bursae.

Collateral Ligament Sprains and Tears (MCL and LCL)
Collateral ligament sprains present with focal tenderness over the specific ligament.(100, 101) Increased pain with stressing the ligament (i.e., valgus stressing for the medial collateral ligament and varus stressing for the lateral collateral ligament) is consistent with a ligamentous sprain.(102, 103) Patients with complete tears have tenderness over the normal location of the ligament, and valgus or varus stressing reveals widening of the joint line.(100, 102-104)

Cruciate Ligament Tears and Sprains
Cruciate ligament tears generally have effusions that may be sizable, particularly if acute.(105-108) Joint tenderness may be present. Joint laxity is the major clinical finding and may be detected with Lachman's maneuver which is performed recumbent, with the knee flexed 20° and the examiner pulling the shin forward. If an ACL tear is present, there is greater movement than normal and compared with the other knee and with a soft endpoint.(85, 102, 109-112) The anterior drawer sign is performed with the knee flexed 90° and shin pulled forward, with greater movement than normal and compared with the other knee indicating an anterior cruciate ligament tear. The posterior drawer sign is performed with the knee flexed 90° and shin pushed backwards, with greater movement than normal indicating a posterior cruciate ligament tear.(111, 113, 114) Sprains without complete tears may present with some laxity in the drawer signs, but generally with hard endpoints. There is conflicting evidence on the utility of the most commonly used physical examination signs (see Table 2). For example, there is disagreement about the utility of the pivot shift test.(73, 83) This test may only be adequately performed under anesthesia.(115) However, there is general consensus that the Lachman's test is the most sensitive physical examination maneuver for detecting ACL tears.(84, 111, 115-122)

Table 2. Operant Characteristics of Physical Examination Signs of Anterior Cruciate Ligament Tears*

	Sensitivity (%)	Specificity (%)
Lachman	82-100	43-100
Anterior Drawer	22-80	74-100
Pivot shift	71-90	4-98

*Data compiled from Sandberg, Kim, Liu, Torg, Jonsson, Donaldson, Zarins, Gelb, Lee, and Katz.(84, 111, 115-122)

Hamstring, Calf, and Quadricep Strains and Tears
Complete ruptures are accompanied by an inability to use the knee, including an inability to walk.(123, 124) Moderate to severe strains also produce considerable difficulty using the limb and bearing weight. Moderate to severe strains and tears generally cause swelling and ecchymosis. Development of hematoma in the area of the strain or rupture is common.(123) Mild strains may present with some difficulty with knee use and focal tenderness.(123-125)

Iliotibial (IT) Band Syndrome
Patients with IT Band Syndrome have pain in the distal lateral thigh, which is typically worse with provocative activities, including running, cycling and other endurance sports.(126-130) Tenderness may be present along the lateral fascia from the lower thigh to the knee, particularly the lateral femoral condyle,(131) and pain may be worse at 30° of flexion,(132) otherwise, the knee joint is usually normal.

Knee Fracture
Patients with knee fractures are often unable to bear weight or walk,(133) and bony deformity and crepitus may be present. Patients with stress fractures may be able to bear weight normally but usually have focal tenderness over the fibular head, patella, or tibia.(133, 134)

Knee Dislocation
Patellofemoral dislocations are the most common knee dislocation and may be congenital or trauma associated.(135) Patients with tibiofemoral knee dislocations tend to have a history of high-impact trauma(135) which do not spontaneously reduce are unable to bear weight or walk, have deformity, and may have signs of fractures. Tears of multiple ligaments are usually present and tenderness over sprained and/or torn ligaments is present. Effusions are usually present.

Meniscal Tears
The extent of the meniscal tear usually determines the degree of physical examination abnormalities, which can range from marked findings to a normal examination. Patients with large, acute tears tend to have swelling, focal tenderness, difficulty walking, difficulty using the knee, locking, and giving out or buckling. Patients with mild, chronic degenerative tears that are symptomatic frequently have no effusion, but may have focal tenderness. Specific physical signs include joint line tenderness, McMurray's test (painful palpable click when moving knee from full flexion to 90°), Ege's test (audible and painful palpable click with squatting; feet turned outwards for medial meniscus and inwards for lateral), and Apley's test (pain on axial compression of the tibia with external rotation while patient prone and knee flexed.(75, 102, 114, 136-141) The sensitivity of these tests is generally higher for medial than lateral meniscal tears,(142, 143) and it has been suggested that the tests should be combined for increased accuracy.(144) However, there is conflicting data on the value of these physical examination signs (see Table 3), and they may not have the same operant characteristics depending on the anatomic location, e.g., with anterior tears less likely to be captured by McMurray's. Acutely locked knees have been reported to reflect meniscal tears (47.9%), ACL tears (14.6%), meniscal and ACL tears (22.9%), a loose body (4.2%), or an unidentifiable mechanical cause (10.4%).(145)

Table 3. Operant Characteristics of Physical Examination Signs of Meniscal Tears*

	Sensitivity (%)	Specificity (%)	Accuracy (%)
Joint Line Tenderness	55-92	31-97	57-96
McMurray	20-67	69-96	45-82
Apley (distraction or compression)	6-16	90	28
Ege	64-67	81-90	71-84
History of mechanical symptoms	20	94	--

*Data compiled from Kurosaka, Konan, Corea, Wadey, Fowler, Lowery, Akseki, Anderson, and Benjaminse.(74, 75, 83, 139, 142-144, 146, 147)

Osteoarthrosis
Patients with osteoarthroses usually have an antalgic or slow gait. Those with more severe disease commonly are slow to stand and initiate gait. Bony enlargement (osteophytes) develops.(148) Alignment may become abnormal. If medial joint disease is disproportionate, varus deformities can develop. Other physical signs of osteoarthrosis include crepitus on range of motion. Tenderness is usually present but poorly localized, and effusions may or may not be present. Warmth and erythema are normally absent.(149, 150)

Patellar Dislocation
Patients with a dislocated patella cannot walk or bear weight on the knee.(135) Deformity with displacement of the patella is apparent. Testing for instability can include variants of a patellar apprehension test (putting a lateral force on the patella, causing a sensation that the patella may dislocate).(52, 151) The sensitivity and specificity of apprehension testing has been reported to be 39 to 100%, and 88.4%, respectively.(52, 152)

Patellar Tendinopathy
The main finding of patellar tendinosis on physical examination is tenderness over the patellar tendon. The tendon is often affected at the junction with the patella, but the quadriceps insertion on the patella may also be affected. This condition is often seen in athletes and others with high loading of the tendon ("jumper's knee").(153-156) Unless the patellar tendon is ruptured, other associated anatomic abnormalities are infrequent.

Patellar Tendon Tears
Patellar tendon tears are relatively uncommon and present with an inability to walk.(157, 158) Deformity of the anterior knee, with clinical findings of a ruptured patellar tendon, is present. Tenderness is also present, and there is usually some proximal patellar retraction proximally, also known as patella alta.

Patellofemoral Syndrome
Patients with patellofemoral syndrome have anterior knee pain, usually with a normal gait.(159, 160) Patellar alignment may be normal, but is often lateral. Some measure the Q-angle), formed by a line drawn from the anterior superior iliac spine through the center of the patella and a line drawn from the center of the patella to the center of the tibial tubercle, is too large, although the clinical applicability of this angle appears weak.(161-163) Crepitus on range of motion (ROM) of the patella and with squatting is common. Pain with patellofemoral compression during ROM constitutes a positive grind test and may be helpful in the diagnosis of patellofemoral joint syndrome.(164) Tenderness along the edges of the patella has been reported to be78% sensitive, 37% specific, and 58% accurate for the diagnosis of patellofemoral joint syndrome,(74) although the positive likelihood ratio for this sign is under 2.5.(165)

Work-Relatedness

Acute occupational knee injuries are related to a specific acute traumatic event. The location of that event determines work-relatedness, and work-relatedness in this case is usually non-controversial. Most jurisdictions also request an opinion from the physician as to whether a disease or disorder should be considered as work-related for the purpose of a workers' compensation claim. Physicians need to remember that their role is to supply opinion, and that the "medical/scientific answer" and the "legal answer," as determined by the regulations and case law precedents in a particular jurisdiction (workers' compensation system), are different (see Work-relatedness guideline). However, there have few quality

epidemiological studies that address work-related knee disorders. Thus, aside from these specific circumstances (e.g., occupational fractures and other acute trauma, meniscal tears from acute trauma, osteonecrosis from barotrauma, prepatellar bursitis in a roofer), most opinions are speculative.

Pes Anserine Bursitis
Anserine bursitis appears to occur both in the presence and absence of trauma. There are no quality studies of occupational factors, and one study reported the only associated factor found was a valgus knee deformity.(95) In settings where significant trauma has occurred to precipitate the bursitis, work-relatedness is not controversial. In the absence of trauma, a theory may be constructed whereby physical factors such as unaccustomed forceful use of the knee may cause the condition; however, this is speculative.

Bursitis (Infrapatellar, Prepatellar, Suprapatellar)
Infrapatellar bursitis appears to occur most commonly in the setting of kneeling activities, often in workers who are unaccustomed to kneeling.(166) This diagnosis in this context is considered work-related and is not usually controversial. Similarly, prepatellar bursitis in the context of discrete trauma or kneeling is considered work-related.(167-170) However, for other cases of bursitis, including where there is no discrete trauma, there are no quality studies of occupational factors. However, a theory may be constructed whereby physical factors such as unaccustomed forceful use of the knee may cause the condition.

Collateral Ligament Sprains and Tears (MCL and LCL)
Collateral ligament sprains are thought to be consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related.

Cruciate Ligament Tears and Sprains
Cruciate tears and sprains are largely attributed to the consequences of significant trauma.(171-174) The mechanism of the trauma determines whether the condition is work-related.

Hamstring, Calf and Quadriceps Strains and Tears
Hamstring, calf, and quadriceps strains involve myotendinous strains in the respective muscle-tendon unit. Symptoms are usually acute in onset and these injuries are considered more analogous to acute injuries than diseases, although repeated, unaccustomed use may have precipitated the event. Thus, the nature of the forceful unaccustomed use determines whether the condition is work-related.

Iliotibial Band Syndrome
This entity is considered a disease, rather than an acute injury. Most case series occur in athletes, particularly in runners, weight lifters, bicyclists, and downhill skiers, and among military recruits.(127, 129, 175-197) However, quality epidemiological studies are absent and risk factors are unclear. As there are no quality epidemiological studies, the condition has not been documented as occupational.

Knee Fracture
Knee fractures are consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related.

Meniscal Tears
Meniscal tears are highly prevalent.(198-208) The mechanism of injury will determine whether the meniscal tear is considered work-related. Acute, large meniscal tears occurring with a discrete traumatic event are usually considered as being consequences of that trauma.(208) The mechanism of the trauma normally determines whether the condition is work-related. On the other end of the spectrum, there are cases of degenerative-appearing meniscal tears without a discrete traumatic event. In such cases,

these tears are diseases. There is little quality epidemiological evidence that they are work-related, although some have theorized a relationship.(208-212) There are many cases occurring between the two extremes noted above, and work-relatedness is often unclear.

Osteoarthrosis

A minority of cases of osteoarthrosis appear to arise in a knee after either fracture, removal of a meniscus,(213-219) torn meniscus,(29, 220, 221) ACL surgery,(222-224) other surgery, or major trauma or injury.(220, 225-228) The mechanism of that trauma is usually believed to be responsible for the osteoarthrosis particularly as the magnitude or risk is generally considerable,[iii] and this often determines work-relatedness. However, the majority of cases have no significant traumatic history and thus causation is often unclear. Yet, while some aspects are poorly understood or controversial, there are some aspects of the epidemiology of knee osteoarthrosis that are robust. The condition has been traditionally labeled non-inflammatory in contrast with rheumatoid arthritis and other inflammatory arthritides. Yet there are many different inflammatory mediators that are detectable in joints or systemically in affected individuals, including collagenase, tissue inhibitor of metalloproteinases, proteoglycan fragments, aggrecan, stromelysin-1, decorin, biglycan, lumican, keratocan,(229-239) and hyaluronic acid, which has predicted earlier progression of OA.(240) Weight loss has been shown to reduce those same inflammatory markers among knee osteoarthrosis patients.(25)

Age is a well documented risk factor for knee osteoarthrosis.(10, 241-255) Obesity has been shown to be an unusually robust risk factor for osteoarthrosis of the knee,(10, 31, 225, 244, 246, 250, 256-274) as it is for other joints throughout the body(244, 275-277) (see Hip and Groin Disorders and Hand, Wrist, and Forearm Disorders guidelines). That obesity is associated with osteoarthrosis of the upper extremity suggests the mechanism is at least partially unrelated to weight bearing. Additionally, weight loss appears to result in lower risk for osteoarthrosis,(258) reduces biomarkers,(25) and improves prognoses of patients with osteoarthrosis.(25, 278, 279)

Genetic factors have been reportedly strong,(260, 280-282) and the knee joint is frequently involved in generalized osteoarthrosis.(201, 203, 251, 274, 283-288) Generalized OA as well as signs of active disease including effusions predicts faster progression of OA.(289) Heberden's nodes reportedly increase risk of knee degenerative changes by 6-fold over a 12-year period,(274) hand osteoarthrosis conveys a 50% increased risk for knee OA,(10) and a specific hand-knee OA subset has been proposed.(290, 291)

Muscle weakness is thought to increase risk of knee OA(292-299) and forms a basis for one of the interventions for which there is some quality evidence of efficacy (see exercise section). Leg length discrepancy is also an apparently risk factor(300) as is knee malalignment.(274) Bone marrow edema is another reported risk.(301)

Job physical factors have not been studied in a quality epidemiological study reported to date. The proper study designs have yet to be reported, particularly either cohort studies or at least a well done case-control study with measured job physical factors and adjustments for the non-occupational factors.

Purported associated factors have included kneeling, squatting and lifting. However, results are inconsistent,(256, 257, 302) concerns about biases have been noted,(303) risks are nearly always low magnitude when positive, and nearly completely based on retrospective methods without measured job factors.(170, 220, 270, 304-313) However, some studies reported interactions of risk factors, and this

[iii] Pooled odds ratio estimated at 3.86, 95% CI 2.61-5.70.10. Blagojevic M, Jinks C, Jeffery A, Jordan KP. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. *Osteoarthritis Cartilage*. 2010;18(1):24-33.

suggests further need for study.(223, 270) Of all risks, kneeling appears to be most consistently associated with knee OA.(170, 210, 270, 306) A registry study from Sweden has suggested increased risk among farmers, construction workers, and firefighters, while risks were not elevated among numerous other occupational groups.(309, 310) Others have suggested no increased risk of knee OA among farmers.(314)

Numerous studies of runners have been performed with a basic presumption of risk due to high force use of the knees; however, nearly all studies including long duration cohort and other studies have been negative.(315-320) There also is suggestive evidence of thicker cartilage among runners(321) and in some animal models.(322) Mixed sports and power sports have reportedly led to earlier knee OA, but not endurance sports.(318) Another study found increased risks among women with high levels of physical activity, but not among men.(323)

A few other studies may also be of interest including a lack of differences in injuries between artificial turf and natural grass in a prospective cohort study of soccer players.(324) A comparative study of cartilage from the apparently unaffected side in unicompartmental OA patients found the cartilage was inferior to the cadaveric controls,(325) suggesting the cartilage of affected patients is inherently defective.

Patellar Dislocation
Patellar dislocations are, absent congenital abnormalities, consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related. In those with recurrent dislocations, there is frequently an inherited or congenital abnormality with a propensity towards recurrences. In situations where there is a congenital abnormality, dislocation may occur in the context of an “event at work” and produce a controversy regarding work-relatedness that likely will be determined largely based on the specific statutory definition of work-relatedness in the setting of pre-existing, non-occupational conditions.

Patellar Tendon Tendinosis and Tears
These are believed to be degenerative tendon conditions and tears, similar to those in the rotator cuff and are considered more analogous to diseases. However, discrete accidents may contribute to these tears. It is theorized that forceful use may contribute to the condition; thus, it is possible that they may be occupational in some circumstance(s), likely involving high-force quadriceps contraction. However, there currently are no quality epidemiological studies to identify occupational risk factors. Repeated, high force stereotypical use is believed to be a risk (i.e., “jumper’s knee”).

Patellofemoral Joint Syndrome
This is a disease for which there is not quality evidence of work-relatedness. There are reports that the condition is most common in those with high knee demands including military recruits(326) and among those kneeling.(327, 328) Chondromalacia patellae was previously thought to be a distinct entity,(329) although increasingly the term anterior knee pain has been used.

Diagnostic Criteria

Special studies are not needed to evaluate most knee symptoms (see Table 4), unless a period of conservative care and observation has failed to lead to resolution or improvement of symptoms. The American College of Radiology (ACR), in its most recent appropriateness criteria, lists the following clinical parameters as predicting the absence of significant fracture. These parameters may be used to

support the decision *not* to obtain a radiograph following knee trauma, although the decision rests with the primary treating physician who has completed a history and physical exam:

- patient is able to walk without a limp;
- patient had a twisting injury and there is no effusion.

The clinical parameters for ordering knee radiographs following trauma, as recommended by the ACR, are:

- joint effusion within 24 hours of direct blow or fall;
- palpable tenderness over fibular head or patella;
- inability to walk (4 steps) or bear weight immediately or within a week of the trauma;
- inability to flex knee to 90°.

Table 4. Ability of Various Techniques to Identify and Define Knee Pathology

Technique	Meniscus Tear	Ligament Sprain	Ligament Tear	Patello-femoral Syndrome	Tendinopathy	Prepatellar Bursitis	Regional Pain
History	+ +	+ +	+ +	+ + + +	+ + +	+ +	+ +
Physical examination	+ + + +	+ + + +	+ + + +	+ +	+ + + +	+ + + +	+ +
Laboratory studies	0	0	0	0	0	0	0
Electromyography/nerve conduction velocity (EMG/NCV) studies	0	0	0	0	0	0	0
Imaging studies							
Radiography†	0	0	0	+	0	0	0
Bone scan†	0	0	0	+	0	0	0
Arthrography†	+ + +	0	+	0	0	0	0
Computed tomography (CT)†	0	0	0	0	0	0	0
Magnetic resonance imaging (MRI)†	+ + + +	+ + +	+ + + +	+ + +	+ + +	+ + +	0

†Risk of complications (e.g., infection, radiation) highest for arthrography, less for radiography and computer tomography (CT), and lowest for bone scan and MRI.

The criteria presented in Table 5 follow the clinical thought process, from the type of illness or injury, to symptoms and signs of a particular disorder to, finally, test results (if any tests are indicated).

Table 5. Diagnostic Criteria for Non-red-flag Knee Disorders

Probable Diagnosis or Injury	Symptoms	Signs	Tests and Results
Knee Osteoarthrosis	Non-radiating knee pain. Morning stiffness or stiffness upon standing or after prolonged sitting. Sleep disturbance sometimes present as a result of pain, but mood disturbance usually not present. Other joints are often affected.	ROM generally reduced, especially knee flexion. May be normal when mild.	X-rays usually ordered to help secure diagnosis. Other diagnostic tests only if there is a potential for meaningful intervention

Patellofemoral Joint Syndrome (chondromalacia patella)	Anterior knee pain. Pain with stair climbing, other activities involving knee flexion, or sitting for a prolonged period of time.	Anterior knee tenderness. Crepitus on range of motion. Pain with patellofemoral compression	X-rays often ordered. Sunrise patella view particularly helpful. Other testing usually not necessary.
Patellar Dislocation and Instability	Inability to bear weight. Acute onset associated with forceful event or accident. Congenital or inherited variants tend to be recurrent. Instability if feeling of impending recurrence of subluxation with specific activities.	Unable to bear weight. Patella visibly displaced. Difficulty extending the knee.	Knee x-rays usually ordered. Other testing usually not necessary.
Patellar Tendinopathy	Focal patellar tendon pain. Pain increases with use including stair use and jumping.	Focal tenderness over patella. Resisted knee extension may reproduce pain.	X-rays may demonstrate calcification and osteophytes at inferior patellar pole (which also may be non-specific). Ultrasound may show small tears.
Fractures	Fall, motor vehicle accident, or other significant trauma. Severe pain.	Unable to bear weight. Angulation, deformity, point tenderness, and bony crepitus.	X-rays required. Other testing usually not necessary in the acute treatment setting.
Meniscal Tears	Non-radiating knee pain. Typically provoked with specific, predictable activities in specific position(s). May have symptoms of joint effusion, buckling, clicking, catching or locking. Pain may be worse with pivoting and walking or stair-climbing.	Variable findings depending on extent of tear(s). May have joint effusion and modest warmth. Knee pain often worse with ROM and extent of ROM may be restricted. Pain reproduced with knee rotation and flexion. Click and/or crepitus may be present on exam.	X-rays often ordered. MRI is sometimes ordered, and MR arthrography may be helpful.
Osteonecrosis	Non-radiating bony pain. History of systemic factors (e.g., diabetes mellitus, alcohol). Pain generally increases with weight-bearing.	Reduced ROM and pain with passive ROM usually present. May have pain with weight bearing. May be unable to bear weight if osseous collapse has occurred.	X-rays required. MRI and CT may be ordered for further evaluation of the necrotic region. Bone scans sometimes ordered.
Infrapatellar, Prepatellar, Suprapatellar, and Anserine Bursitis	Anserine bursitis may be painful, but without clear effusion or exertional component. Other types of bursitis frequently not painful, but do have effusion/swelling.	Tender over anserine bursa. Other bursitis often minimally or not tender. ROM usually normal.	X-rays usually not needed. X-rays sometimes ordered if questions of usual settings, including concerns for infection, osteomyelitis, and foreign body. Other testing usually not required.

Collateral Ligament Sprains and Tears (lateral and medial)	Focal knee joint line pain. Medial more prone to be accompanied by meniscal tear. If complete tear, will typically have instability.	May have antalgic gait, especially if moderate to severe sprain. Focal tenderness over collateral ligament. Usually no effusion.	X-rays usually ordered in acute setting to rule out fracture, particularly for moderate to severe injuries. MRI may be helpful in chronic setting to rule out associated meniscal tear. Other testing usually not required.
Iliotibial Band Syndrome	Non-radiating lateral knee pain.	Lateral knee pain with use, especially running, cycling. Tender over lateral fascia.	X-ray generally not necessary, but may be indicated if concerns of unusual diagnostic concerns, such as accompanying arthrosis.
Cruciate Ligament Sprains, Tears and Ruptures. (anterior, Posterior)	Sudden pain with accident or other traumatic event. May have giving out and immediate swelling after event. May be asymptomatic. Event usually involved exaggerated adduction and external rotation or abduction.	Effusion if acute tear. Joint laxity with complete tears, including positive posterior or anterior drawer signs.	X-ray usually ordered in acute setting to rule out fractures. MRI may be helpful.
Non-specific Knee Pain	Non-specific. No acute trauma	None	None
Non-specific Effusion	None. No acute trauma.	Effusion. No signs of infection or other abnormality.	X-ray often ordered, but by definition, normal other than effusion. Need evaluation for rheumatological disorder.

Adapted from AMA Guides to Impairment Rating – 6th edition and Sanders S, et al. Evidence-based clinical practice guidelines for interdisciplinary rehabilitation of chronic nonmalignant pain syndrome patients. *Pain Prac*. 2005;5(4):303-15.

Follow-up Visits

Patients with knee symptoms should have follow-up approximately every three to seven days, depending on severity of the condition, limitations, and workplace accommodation of limitations. Considerations for the initial follow-up visits include: response to treatment, further education, advice to avoid static positions, medication use, activity modification, and other concerns. The practitioner can answer questions and make these sessions interactive so that the patient is fully involved in his or her recovery. If the patient has returned to work, these interactions may be done on site or by telephone to avoid interfering with modified- or full-work activities.

Diagnostic Recommendations

Antibodies

There are numerous antibodies that are markers for specific rheumatic diseases (e.g., rheumatoid factor, anti-nuclear antibodies, anti-Sm, anti-Ro, anti-La for rheumatoid arthritis, systemic lupus erythematosus, Sjogren's, mixed connective tissue disorder, etc.). Patients with rheumatic disorders are at increased risk for degenerative joint disease of the knee.(283, 333-339)

Antibodies for Diagnosing Knee Pain with Suspicion of Chronic or Recurrent Rheumatological Disorder
Antibody levels are recommended to evaluate and diagnose patients with knee pain who have reasonable suspicion of rheumatological disorder. However, ordering of a large, diverse array of antibody levels without targeting a few specific disorders is not recommended.

Indications – Knee pain with suspicion of rheumatological disorder.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Antibodies to Confirm Specific Disorders
Antibody levels are strongly recommended to confirm specific disorders (e.g., rheumatoid arthritis).

Indications – Knee pain and presumptive diagnosis of a rheumatological disorder.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Rationale for Recommendations
Elevated antibody levels are useful for confirmation of clinical impressions of rheumatic diseases. However, routine use of these tests in knee pain patients, especially as wide-ranging, non-focused test batteries are likely to result in inaccurate diagnoses due to false positives and low pre-test probabilities. Providers should also be aware that false negative results occur. Measurement of antibody levels is recommended for focused testing of a limited number of diagnostic considerations for which there is clinical suspicion. Measuring antibody levels is minimally invasive, unlikely to have substantial adverse effects and low to moderately costly, depending on the specific test ordered.

Arthrography

This diagnostic procedure has been replaced by MRI, which is both more sensitive and specific.

Knee Arthroscopy

Arthroscopy of the knee has been increasingly utilized for treatment of knee disorders.(9, 137, 340-367) It has become the gold standard for measuring the utility of the clinical examination as well as the comparative standard for other treatments.(368) Disorders commonly treated arthroscopically include meniscal tears, cruciate tears, and chondral fractures.(353, 369-374) However, there are few high quality studies from which to determine indications for either diagnostic or therapeutic arthroscopic knee procedures.

Knee Arthroscopy for Diagnosing and Treating Knee Pain with Suspicion of Meniscal Tear, Intraarticular Body, or Other Subacute or Chronic Mechanical Symptoms
Arthroscopy is only recommended to evaluate and diagnose patients with knee pain if there is suspicion of a clinically significant meniscal tear, intraarticular body, or other subacute or chronic mechanical symptoms and an equivocal or inconclusive MRI.

Indications – Knee pain with suspicion of meniscal tear, intraarticular body, or other subacute or chronic mechanical symptoms treatable by arthroscopy.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Knee Arthroscopy for Diagnosing Acute Knee Pain
Arthroscopy for diagnosing acute knee pain, other than large meniscal tears, cruciate tears or intraarticular bodies, is not recommended.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Knee Arthroscopy for Staging a Surgical Procedure
Arthroscopy is recommended for staging a surgical procedure.

Strength of Evidence –**Recommended, Insufficient Evidence (I)**

Knee Arthroscopy for Diagnosis or Treatment in Acute, Subacute, or Chronic Osteoarthrosis without Mechanical Symptoms and Other Remediable Mechanical Defect
Arthroscopy is not recommended for diagnosis or treatment in patients with acute, subacute, or chronic osteoarthrosis in the absence of a remediable mechanical defect such as clinically significant symptomatic meniscal tear.(375)

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
Arthroscopy of the knee is widely utilized for treatment of several knee disorders, especially meniscal tears. Complications usually occur with more serious injuries and include nerve retraction, neuropraxias, infection, and complex regional pain syndrome.(376-385) Adverse effects are minimal when small-bore arthroscopes are used. Osteoarthrosis was previously thought to be treatable by arthroscopy.(369) However, arthroscopy is currently not believed to be helpful, and arthroscopy with chondroplasty has been shown not to be helpful, in the absence of remediable mechanical symptoms suggesting a clinically significant meniscal tear or intraarticular body.(375) Arthroscopy is invasive and expensive, but it is recommended for selected patients, particularly those with remediable mechanical defects such as meniscal tears.

Evidence for the Use of Arthroscopy
There is 1 low-quality RCT in Appendix 1.(386)

Bone Scans

Bone scans involve intravenous administration of a radioactive tracer medication that is preferentially concentrated in areas of metabolic activity in bone.(387, 388) The radioactivity is then detected by a large sensor and converted into images of the skeleton. There are many causes of abnormal radioactive uptake, including metastases, infection, inflammatory arthropathies, fracture or other significant bone trauma. Thus, positive bone scans are not highly specific. Bone scans have been used for the diagnosis of early osteonecrosis, which is often not apparent on x-ray.(389-392)

Bone Scanning for Select Use in Acute, Subacute, or Chronic Knee Pain
Bone scanning is recommended for select use in patients with acute, subacute, or chronic knee pain to assist in diagnosing osteonecrosis, neoplasms, or other conditions with increased polyostotic bone metabolism, particularly if more than one joint is to be evaluated.

Indications – Knee pain with suspicion of osteonecrosis, Paget's disease, neoplasm, or other increased polyostotic bone metabolism.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Routine Use of Bone Scanning for Knee Joint Evaluations
Bone scanning is not recommended for routine use in knee joint evaluations as it is generally thought to be inferior to MRI.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
Bone scanning may be a helpful diagnostic test to evaluate suspected metastases, primary bone tumors, infected bone (osteomyelitis), inflammatory arthropathies, and trauma (e.g., occult fractures). It may be helpful in those with suspected early AVN without x-ray changes. There is no indication for bone scanning in cases where the diagnosis is felt to be secure, as bone scanning does not alter management. Bone scanning is minimally invasive, has minimal potential for adverse effects (essentially equivalent to a blood test), but is costly.

Evidence for the Use of Bone Scans
There are no quality studies evaluating the use of bone scans for the evaluation of knee pain.

Computerized Tomography (CT)

Computerized tomography is a useful imaging procedure for bony anatomy, whereas MRI is superior for soft tissue abnormalities.(393, 394) CT may be useful for certain knee joint abnormalities, including complex fractures, in which advanced imaging of the bones is required. CT may be helpful for the evaluation of AVN. CT may also be useful for evaluation of the spine in patients with contraindications for MRI, including implanted metallic-ferrous device.(394)

Routine CT for Evaluating Acute, Subacute, or Chronic Knee Pain
Routine CT is not recommended for evaluating acute, subacute, or chronic knee pain.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

CT for Evaluating Patients with Osteonecrosis (AVN)
CT is recommended for evaluating patients with osteonecrosis or for those who need advanced imaging, but have contraindications for MRI.

Indications – Knee pain from osteonecrosis with suspicion of subchondral fracture(s), or increased polyostotic bone metabolism.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

CT for Evaluating Patients with Periprosthetic Osteolysis after Total Knee Arthroplasty
CT is recommended for evaluation of total knee arthroplasty patients with potential periprosthetic osteolysis.

Indications – Arthroplasty thought to have periprosthetic osteolysis.(395)

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
Computerized tomography is considered superior to MRI for imaging of most knee abnormalities where advanced imaging of calcified structures is required. CT has been used to evaluate periprosthetic

osteolysis.(395) A contrast CT study is minimally invasive, has few adverse effects, but is costly. It is recommended for select use. Helical CT scan is thought to be superior to MRI for evaluating subchondral fractures; however, a large, high-quality study comparing these modalities has not yet been published.(396)

Evidence for the Use of CT
There are no quality studies evaluating the use of CT for the evaluation of knee pain.

C-Reactive Protein, Erythrocyte Sedimentation Rate, and Other Non-Specific Inflammatory Markers

There are many markers of inflammation that may be measured serologically. These include C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), ferritin, and a total protein-albumin gap.(397-400)

Non-specific Inflammatory Markers for Screening for Inflammatory Disorders in Subacute or Chronic Knee Pain Patients
Erythrocyte sedimentation rate and other inflammatory markers are recommended to evaluate for inflammatory disorders or prosthetic sepsis when there is a reasonable suspicion of an inflammatory disorder in subacute or chronic knee pain patients. However, ordering a large, diverse array of inflammatory markers without targeting specific disorders for which there is clinical suspicion is not recommended.

Indications – Knee pain with suspicion of inflammatory disorder, including infection.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
Erythrocyte sedimentation rate is the most commonly used systemic marker for non-specific inflammation. The ESR is elevated in numerous inflammatory conditions, including rheumatological disorders, as well as with infectious diseases. C-reactive protein is a marker of systemic inflammation that has been reported to be associated with an increased risk of coronary artery disease. However, it is also a non-specific inflammatory marker. Other non-specific markers of inflammation include an elevated ferritin and protein-albumin gap. CRP and ESR measurements are minimally invasive, have low risk of adverse effects, and are relatively inexpensive. They are recommended as a reasonable component of the evaluation when there is suspicion of a systemic inflammatory condition.

Evidence for the Use of C-Reactive Protein, Erythrocyte Sedimentation Rate, and Other Non-specific Inflammatory Markers
There are no quality studies evaluating the use of C-reactive protein, erythrocyte sedimentation rate, and other non-specific inflammatory markers for knee pain.

CYTOKINES

See Chronic Pain guideline.

LOCAL ANESTHETIC INJECTIONS AND EPIDURALS

Local anesthetic injections are sometimes used for diagnostic confirmation of knee conditions (see Injections). These injections are also sometimes used to differentiate pain from a distant site, such as the hip or spine. Diagnostic injections include intraarticular injections (knee, hip, or sacroiliac), ilioinguinal, genitofemoral, and saphenous nerve blocks, and lumbar epidurals.(401-404)

Local Anesthetic Injections to Diagnose Subacute or Chronic Knee Pain
Local anesthetic injections are recommended to assist in the diagnosis of subacute or chronic knee pain.

Indications – Subacute or chronic knee pain from an unclear source; immediate and delayed results of injection(s) should be recorded.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
Local anesthetic injections may be helpful for confirming diagnostic impressions, although there are no quality studies evaluating the use of injections for these purposes. Intraarticular knee injections are often performed with anesthetic agents and glucocorticosteroids, as this generally accomplishes both diagnostic and therapeutic purposes simultaneously. These injections are minimally invasive, have minimal potential for adverse effects, and are moderately costly.

Evidence for the Use of Local Anesthetic Diagnostic Injections
There are no quality studies evaluating the use of local anesthetic diagnostic injections for knee pain.

ELECTROMYOGRAPHY (including Nerve Conduction Studies)

See the Low Back Disorders guideline for discussion regarding the use of electrodiagnostic studies for evaluation of back-related disorders that may present as knee pain. Electrodiagnostic studies have also been used to confirm diagnostic impressions of other peripheral nerve entrapments, including of the lateral cutaneous nerve of the thigh (meralgia paresthetica).(405-417)

Electromyography for Diagnosing Subacute or Chronic Peripheral Nerve Entrapments
Electrodiagnostic studies are recommended to assist in the diagnosis of subacute or chronic peripheral nerve entrapments.

Indications – Subacute or chronic paresthesias with or without pain, particularly with an unclear diagnosis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
Electrodiagnostic studies may assist in confirming peripheral nerve entrapments. These studies are minimally invasive, have minimal potential for adverse effects (essentially equivalent to a blood test), and are moderately costly.

Evidence for the Use of Electromyography
There are no quality studies evaluating the use of electrodiagnostic studies for diagnosing peripheral nerve entrapments relevant to the knee.

FUNCTIONAL CAPACITY EVALUATIONS

See Chronic Pain guideline.

MAGNETIC RESONANCE IMAGING (MRI)

Magnetic resonance imaging (MRI) has been widely used for diagnostic purposes in patients with knee pain, particularly for evaluating the menisci and cruciate ligaments.(137, 340, 341, 343, 344, 346-352, 354-358, 360-362, 365-367, 418-420) MRI is considered the gold standard for evaluating AVN.(421-429)

MRI for Knee Joint Pathology, Including Diagnosing Meniscal Tears, Cruciate Ligament Tears, Hamstring and other Muscular Tears, and for Select Patients with Post-arthroplasty Chronic Pain or Periarticular Masses

MRI is recommended for select patients with subacute or chronic knee symptoms in which mechanically disruptive internal derangement or similar soft tissue pathology is a concern. It is generally not indicated for patients with acute knee pain.

Indications – Subacute or chronic knee pain in which imaging of surrounding or intraarticular soft tissues is needed (including menisci); evaluation of moderately severe and severe cruciate ligament sprains and tears to evaluate the extent of the injury and help determine whether surgery is indicated.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

MRI for Diagnosing Osteonecrosis (AVN)
MRI is recommended for diagnosing osteonecrosis.

Indications – Subacute or chronic knee pain thought to be related to osteonecrosis (AVN), particularly if the diagnosis is unclear or if additional diagnostic evaluation and staging is needed.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

MRI for Routine Evaluation of Acute, Subacute, or Chronic Knee Joint Pathology
MRI is not recommended for routine evaluation of acute, subacute, or chronic knee joint pathology, including degenerative joint disease.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
MRI has not been evaluated in quality studies for knee joint pathology, although studies have reported accuracy estimates ranging from 82 to 96% for cruciate ligament and meniscal tears.(84, 121, 348, 356, 357, 367, 430-434) False-negative MRI interpretations are particularly likely in posterior horn meniscal tears.(368) There is concern that MRI is overutilized, particularly in cases where clinical examination is sufficient.(84, 102, 116, 435) However, most physicians believe that MRI should be performed prior to arthroscopy for meniscal or ACL tears(436) or in patients with non-specific knee pain.(437)

MRI may play a role in staging osteoarthrosis,(438) although there is no quality evidence that this practice affects prognosis or treatment. MRI can detect osteophytes(439) and is better than x-ray for identifying cartilage loss and subchondral cysts, but it is relatively poor at detecting early subchondral sclerosis.(439, 440) There are no quality studies evaluating the use of MRI for osteonecrosis of the knee joint. There is low-quality evidence that MRI may be less sensitive for detection of subchondral fractures than helical CT or plain x-rays in patients with osteonecrosis.(396) MRI is not invasive, has no adverse effects, although there may be issues related to claustrophobia or complications of concomitantly administered medications, but it is costly. MRI is not recommended for routine knee imaging, but it is recommended for selected knee joint pathology, particularly suspected soft tissue pathology.

Evidence for the Use of MRI
There are no quality studies evaluating the use of MRI for diagnosing knee pain.

MR Arthrogram

Magnetic resonance imaging with arthrography (MR arthrography) has been performed to evaluate meniscal and chondral lesions,(441, 442) for example following chondrocyte and meniscus implants.(442, 443)

MR Arthrogram for Evaluation of Select Patients Needing Advanced Meniscal and Cartilage Imaging and Following Chondrocyte Implantation

MR arthrograms are recommended for select patients who require advanced imaging of the menisci and articular cartilage or following procedures such as chondrocyte implantation.

Indications – Patients with negative or equivocal MRI imaging with ongoing suspicion of clinically significant intraarticular pathology such as meniscal tears or articular cartilage defects or following selected procedures such as chondrocyte implantation.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

MR arthrograms have not been evaluated in quality studies, but appear helpful in evaluating patients with ongoing intraarticular mechanical symptoms despite negative or inconclusive MRIs. These studies are also likely to be helpful for those with certain post-operative indications, including after chondrocyte implantation. MR arthrography is minimally invasive, has no adverse effects, although there may be issues related to claustrophobia or complications of concomitantly administered medications, but it is costly. However, it is likely the best imaging procedure available for certain select patients.

Evidence for the Use of MR Arthrogram

There are no quality studies evaluating the use of MR arthrogram.

ROENTGENOGRAMS (X-RAYS)

X-ray is the initial test for evaluation of most cases of knee pain.(283, 342, 438, 444-449) X-rays are considered the initial test of choice for evaluating patients with suspected knee osteoarthrosis. Two or three supine views are generally performed. There are no quality studies of x-ray in the evaluation of knee pain. It should be noted that the threshold for x-ray of the lumbosacral spine and/or hip joint should be low, particularly if the findings on knee x-ray are either normal or do not readily explain the degree of clinical findings. Stress radiography (x-ray taken while a stress is applied to the joint and used to demonstrate instability) has been described for evaluation of ACL tears, but is not usually necessary to establish a diagnosis.(110) In the case of osteonecrosis, plain x-ray results differ by stage of disease. Early x-rays are usually normal or have less distinct trabecular patterns, but as the disease progresses, x-rays begin to show osteoporotic areas progressing to sclerotic areas and flattening and bony collapse.(450) X-rays are also used to evaluate post-arthroplasty knees.

X-ray for Evaluating Acute, Subacute, or Chronic Knee Pain

X-ray is recommended for evaluating acute, subacute, or chronic knee pain.

Indications – In the absence of red flags, knee pain of moderate to severe intensity lasting at least a few weeks, and/or limited range of motion.

Frequency/Duration – Obtaining x-rays once is generally sufficient. For patients with chronic or progressive knee pain, it may be reasonable to obtain a second set of x-rays, months to years after the baseline x-rays to re-evaluate the patient's condition, particularly if symptoms change.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

X-ray for Diagnosing Fracture

X-ray is recommended for diagnosing fracture.

Indications – Patients thought to have fracture, particularly those with an inability to bear weight, effusion, or ecchymosis.(451)

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

X-ray for Diagnosing Osteonecrosis (aka Avascular Necrosis, AVN)

X-ray is recommended for diagnosing osteonecrosis.

Indications – Patients thought to have osteonecrosis (ON).

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations

X-ray is helpful in evaluating most knee pain, both to diagnose and to assist with narrowing the differential diagnosis. A clinical algorithm was constructed to evaluate the need for x-ray to rule out fracture, and the presence of at least one sign of fracture was deemed to be highly sensitive for fracture.(451) There are no quality studies of the use of x-ray to evaluate knee pain. There is one low-quality study suggesting x-ray has higher sensitivity than MRI for detection of subchondral fractures in patients with osteonecrosis.(396) However, x-ray has long been used to stage osteoarthrosis(283, 342, 438, 452-456) and evaluate for post-arthroplasty osteolysis.(457) X-ray is non-invasive, low to moderately costly, and has little risk of adverse effects.

Evidence for the Use of X-rays

There are no quality studies evaluating the use of x-rays for knee pain, including for diagnosing osteonecrosis.

SALINE LOAD TEST

The saline load test has been used when there is a knee laceration to determine whether there has been penetration of the joint capsule.(458-460) The test involves injection of saline into the joint to ascertain whether the solution flows thought the joint capsule and out of the trauma site.(461)

Saline Load Test for Select Knee Lacerations

A saline load test is recommended for select patients with knee lacerations that may have penetrated the joint.

Indications – Lacerations in the knee region that may have penetrated the knee joint but have not clearly done so.

Dose – At least 150 to 200mL of saline injected with an 18-g needle. Volume required varies based on size of potential laceration (more saline required for smaller lacerations) and may differ based on location of laceration. The lateral suprapatellar instillation site has been utilized.(460) Superomedial and inferomedial locations have been compared; more volume required for the superomedial location (mean 95.2 vs. 64.0mL).(459)

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality studies of the saline load test in the evaluation of joint capsule penetration. A study in 30 arthroscopy patients suggested that more than 194mL was required for the saline load test to be at least 95% sensitive.(460) Another study of knee arthroscopy patients found at least 155mL of saline must be injected to detect 95% of 1-cm inferolateral arthrotomies.(459) This procedure is minimally

invasive, has minimal potential for adverse effects, is relatively inexpensive, and is recommended for select patients.

Evidence for the Use of Saline Load Test
There are no quality studies evaluating the use of saline load test for the evaluation of knee pain.

Ultrasound

Many of the usual causes of knee pain are better imaged with modalities other than ultrasound. Diagnostic ultrasound has been used for evaluating the patellar ligament, including for "jumper's knee" and partial ruptures,(156, 462-468) effusions,(469) dysplasia,(470, 471) labral tears,(472) and occult factures.(473) Ultrasound for cruciate ligament tears has been described as technically difficult.(78) Ultrasound has also been used to guide injections in deep body structures, although the knee joint is relatively accessible. The diagnostic accuracy of ultrasound for patellar partial ligament ruptures has been reported as 100% in a modest sized case series.(462)

Ultrasound for Evaluating Patellar Tendinopathy, Pes Anserine Bursitis, Hamstring Strains, Quadriceps Strains or Post-arthroplasty Chronic Pain When Peri-Articular Masses Are Suspected
Ultrasound is recommended for evaluating patients with patellar tendinopathy, pes anserine bursitis, hamstring strains, quadriceps strains, or post-arthroplasty chronic pain, when peri-articular masses are suspected.

Indications – Patients with knee pain thought to be from these disorders.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Ultrasound for Evaluating Other Knee Disorders including Osteonecrosis, Osteoarthrosis, Dysplasia, or Fractures
There is no recommendation for or against the use of ultrasound for evaluating other knee disorders, including osteonecrosis, osteoarthrosis, dysplasia, or fractures.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
Ultrasound has been found to be helpful in evaluating tendinopathy and myotendinous strains. There is no clear indication for use of ultrasound for the evaluation of osteoarthrosis. Ultrasound is not invasive, has no adverse effects, is moderately costly, and is recommended for select use.

Evidence for the Use of Diagnostic Ultrasound
There are no quality studies evaluating the use of diagnostic ultrasound.

Management Overview

Although comfort is often a patient's first concern, the treating physician must first evaluate for remediable conditions or red flags. Nonprescription analgesics may provide sufficient pain relief for most patients with acute or subacute knee pain. If treatment response is inadequate (i.e., if symptoms and activity limitations continue) or the physician judges the condition limitations to be more significant, prescribed pharmaceuticals or physical methods can be added. Co-morbid conditions, invasiveness, adverse effects, cost, and physician and patient preferences guide the choice of recommendations. Initial care, including comfort items, may consist of non-steroidal anti-inflammatory drugs (NSAIDs),

acetaminophen, cryotherapy, heat, exercises, or education and advice on activities. Education about knee pain should begin at the first visit.

This guideline addresses the evidence for efficacy of many knee interventions. Interventions with quality evidence of proven efficacy are recommended in this guideline. Complication rates and safety profiles, if available, were considered in developing these guidelines. Interventions not supported by moderate- to high-quality studies are not recommended and are indicated as **Not Recommended, Insufficient Evidence (I)**.

Knee Pain and Osteoarthrosis

Treatment Recommendations

Physicians should develop individualized patient treatment and follow-up plans based on the severity of the condition, co-morbidities, occupational demands, psychosocial factors, and patient motivation and need for encouragement. The ability to return to work should be considered when determining the frequency of follow-up. More frequent appointments are generally required for patients whose limitations have not been accommodated. The patient should be transitioned to work, or from modified work to full work, at the earliest date possible, and should be supported during that transition and counseled about the likelihood of increased symptoms while being reassured that pain does not equate to injury.

Activities and Activity Modification

Activities and activity alterations are typically managed differently in patients with acute and chronic knee pain. Acute knee pain patients may benefit from activity limitations, while chronic knee pain patients almost never improve with activity limitations. Acute knee pain often improves with avoidance of occupational and non-occupational activities that result in *substantial* increases in pain. However, even in the acute pain setting, appropriate activity alterations are difficult to identify. For example, prolonged inactivity of any musculoskeletal pain usually results in increased pain upon movement. It is easy to erroneously conclude the activity aggravated the pain. Even in the acute setting, however, some activity is usually desirable. In general, activities causing a *significant* increase in knee symptoms should be reviewed with the patient and modifications advised when appropriate. These activities may include stair climbing, walking, lifting, and frequency of postural changes.

Chronic knee pain is managed differently. Almost invariably, rehabilitation of chronic knee pain involves gradually performing the occupational and non-occupational activities that result in increased pain in order to improve function. The same types of limitations may be reasonable, but progressive increases in activity frequency, intensity and/or durations is generally necessary to rehabilitate these problems.

Work limitations should take into account four main factors: 1) the job physical requirements; 2) the severity of the problem; 3) work organizational issues (e.g. ability to control job or tasks, overtime, work allocation, wage incentives); and 4) the patient's understanding of his or her condition. Sometimes it is necessary to write limitations or prescribe activity levels that are above what the patient feels he or she can do, particularly for patients who believe they should remain sedentary. Progressively increased activity is important, and restrictions that state "sedentary work" are *not* appropriate for most knee

patients. Physicians should recognize that a patient's expectations regarding return-to-work status are often set prior to the first appointment,(474) (Kapoor 06) and therefore education may be necessary to set realistic expectations and goals. It is best to communicate early in the treatment that limitations will be progressively reduced as the patient progresses. This should be reiterated at each successive visit so that the patient is well advised in advance of the treatment plan.

There are no quality studies of restrictions, so determining appropriate restrictions is often left to clinical judgment. Assessment of work activities and potential for modifications may be facilitated by a worksite visit and analysis by a healthcare provider with appropriate training (e.g., occupational therapist, physical therapist, physician, or ergonomist). Common limitations involve stair climbing and modifying the weight of objects lifted, frequency of lifts, and posture while taking into account the patient's capabilities. For severe cases of acute knee pain, initial modification of occupational and non-occupational activities often includes:

- frequent alternation of sitting and standing;
- no lifting more than 10 pounds;
- no prolonged or repeated knee bending (flexion);
- no prolonged or repeated crouching and squatting;
- avoidance of ambulation on slippery surfaces or uneven ground; and
- avoidance of frequent stairs.

These work and home activity guidelines are generally reassessed every week in the acute phase. Gradual increases in activity levels are recommended with a goal of returning to full duty in 6 to 12 weeks. The amount of weight handled can be progressively increased. Alternatively, patients can be returned to 1 to 2 hours a day of prior full duty work, with the remainder of the day spent at modified duty. The numbers of hours of full duty work can be increased every 1 to 2 weeks. Individualization of management plans is often necessary. For example, if prior job physical tasks involved frequent lifting of more than 100 pounds, then restricted work guidance may be substantially greater (e.g., 25 pounds of lifting and carrying at first). For workers who have control over their job tasks, assistance from someone else and alternating between sitting and standing as needed, may be included in the management plan.

It should be noted that some workplaces provide healthcare or rehabilitation therapy on-site, so brief periods of recumbent time during the day and on-site physical or occupational therapy may be possible. The physician should make it clear to patients and employers that:

- prolonged walking and/or stair climbing may aggravate symptoms;
- moderately heavy lifting, carrying, or working in awkward positions may aggravate symptoms; and
- any restrictions are intended to allow for recovery and time to build activity tolerance through structured exercise.

It is in the patent's best interest for the short- and long-term to maintain maximal levels of activity, including work activity. Written guidance on activity limitations, when applicable, communicates the status of the patient to the employer and gives the patient information on what he or she should or should not do both at work and at home.

ACTIVITY MODIFICATION

Activity Modification for Acute, Subacute, or Chronic Knee Pain

Activities that do not substantially aggravate symptoms are recommended for most patients with acute, subacute, or chronic knee pain.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality studies evaluating modification of activity for treatment of knee pain. Common post-arthroplasty limitations have included no lifting over a weight limit, no running, and no jumping. Lifting limits may commonly be 50 pounds, but are frequently based on prior weight-lifting capabilities and anticipated future abilities. While modification of activity is not invasive, it may result in increased disability through disuse, or increased cardiovascular morbidity through lack of exercise. It also may result in high costs through lost productivity. Thus, implementation of activity modifications should be carefully balanced against increased longer term morbidity and other costs. In cases where activity does not aggravate the symptoms or disease, activity modifications are not recommended – rather, activity is recommended.

Evidence for the Use of Activity Modification
There are no quality studies evaluating the use of activity modification for treatment of knee pain.

BED REST AND NON-WEIGHT-BEARING

Bed Rest and Non-weight Bearing for Patients with Acute, Subacute, or Chronic Knee Pain
Bed rest and non-weight bearing are not recommended for patients with acute, subacute, or chronic knee pain.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Bed Rest and/or Non-weight Bearing for Unstable Fractures
Bed rest and/or non-weight bearing activities are recommended for patients with clear contraindications to weight-bearing, such as an unstable fracture.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
Bed rest and/or non-weight bearing are unlikely to be beneficial and generally should be avoided for all patients other than for those with clear contraindications to weight-bearing, such as evidence of an unstable fracture.

Evidence for the Use of Bed Rest and Non-Weight Bearing
There are no quality studies evaluating the use of bed rest for treatment of knee pain.

EXERCISE

Exercises have been utilized for the prevention and treatment of osteoarthrosis, including aerobic exercise, strengthening exercise, and flexibility.(475-491) Exercise is also thought to be effective for rehabilitation after knee arthroplasty.(492) Educational programs have also been used to treat knee osteoarthrosis, often in combination with an exercise program.(6, 481, 493-499)

Arthritic patients tend not to engage in high levels of physical activity.(500) Some believe that exercise is an effective primary and secondary preventive intervention.(12) Opinions on the relative importance of aerobic versus strengthening versus flexibility conflict,(482, 484, 491, 501-512) and some endorse the belief that “exercise may be the most effective, malleable, and inexpensive modality available to achieve optimal outcomes for people with osteoarthritis.”(483)

Available research addressing exercise for knee OA consists of mostly low- to moderate-quality trials with few high-quality studies. In these recommendations, the entire body of exercise-related articles has been included, program.(279, 513-519) since several studies have included both inflammatory conditions,(501, 520-540) as well as osteoarthrosis. Most studies have combined different exercises into programs that at least partially obscure effects of a specific exercise prescription (e.g., flexibility versus aerobic versus strengthening). However, some patterns do appear. While specific to knee or hip osteoarthrosis, these recommendations also appear to apply to rheumatoid arthritis patients as well,(520, 541-543) as materially different results were not found in that population (see exercise evidence table and Hip and Groin Disorders guideline).

Aerobic Exercise for Treatment of Knee Osteoarthrosis
Aerobic exercise is strongly recommended for the treatment of knee osteoarthrosis.

Indications – All patients with knee osteoarthrosis. However, those with significant cardiac disease or significant potential for cardiovascular disease should be evaluated prior to instituting vigorous exercises (follow ACSM *Guidelines for Exercise Testing and Prescription,* 7th ed.).(544)

Frequency/Dose/Duration – Dose is somewhat unclear. A self-directed program is recommended for all patients. Supervised programs may be particularly indicated for those who require supervision to initiate a program or otherwise need assistance with motivation or concomitant fear avoidant belief training. Supervision may be for a few appointments to help initiate the program. The highest quality trial prescribed walking 40 minutes per session, 3 times a week.(508, 545-547) Another common regimen is walking at least 4 times a week at 60% of predicted maximum heart rate (220 - age = maximum heart rate). Both regimens are comparable and either is recommended.(548, 549) Nearly all patients should be encouraged to continue aerobic exercises on a long-term basis for fitness purposes, including maintaining lower extremity muscle strength.

Indications for Discontinuation – Intolerance (rarely occurs), development of other disorders.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Stretching Exercises for Treatment of Knee Osteoarthrosis
Stretching exercises are recommended for select patients with knee osteoarthrosis who have significant reductions in range of motion that are not thought to be fixed deficits.

Indications – Patients with significant reductions in range of motion that are thought to be non-fixed deficits (e.g., limitations based on stiffness or disuse rather than osteophytes).

Frequency/Duration – Generally taught as home exercises over 1 to 3 appointments.

Indications for Discontinuation – Worsening of symptoms, identification that the deficits are fixed, or achievement of exercise program goals.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Strengthening Exercises for Treatment of Knee Osteoarthrosis
Strengthening exercises are moderately recommended for treatment of knee osteoarthrosis.

Indications – Knee osteoarthrosis.

Frequency/Duration – Home program at least 2 to 3 times a week. Supervised treatment frequency and duration is dependent on symptom severity and acuity and the presence of comorbid conditions. There is moderate-quality evidence that isometric exercises are least successful.(550) May be added with aerobic exercises to an exercise program. In limited circumstances where range-of-motion deficits are considerable, but thought to not be fixed, strengthening is sometimes added after beginning flexibility

exercises. One moderate-quality trial suggests strengthening exercises are more effective for neutrally aligned knees.(551)

Indications for Discontinuation – Development of a strain or failure to improve.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Educational Sessions for Treatment of Knee Osteoarthrosis

Educational sessions are recommended to help facilitate treatment of knee osteoarthrosis.

Indications – Knee osteoarthrosis.

Frequency/Duration – One to 3 sessions over 6 weeks, primarily to facilitate an active exercise program and compliance. Content is suggested to be focused on active exercises rather than passive interventions or disease pathophysiology as this may be helpful, particularly in addition to an active exercise program when compliance is challenging or periodic encouragement and facilitation to overcome incapacity in patients with severe osteoarthrosis.

Indications for Discontinuation – Noncompliance, failure to improve.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations

There are multiple RCTs addressing hip knee and/or hip osteoarthrosis patients. Studies compare exercise to non-exercise controls,(476, 494-496, 508, 545-547, 552-566) exercise to exercise,(567-574) and exercise to other treatments(575-579) (see Exercise evidence table). As there is not a strong rationale for believing that there are major differences in efficacy for hip versus knee OA (see Hip and Groin Disorders guideline),(563) and analysis of the available evidence fails to suggest major differences, this summary assumes the outcomes are similar in both sets of patients. Most of the studies considered here combined different exercises. Some exercise programs were unstructured and some studies did not clearly describe the interventions. These limitations preclude drawing strong evidence-based conclusions regarding any single intervention. Yet, there are quality studies comparing exercise to non-exercise controls (580) that allow evidence-based conclusions to be made on the relative value of aerobic, stretching, and strengthening exercises. There also is experimental evidence that the glycosaminoglycan content in the post-meniscectomized knee is superior if exercised.

A high-quality trial of knee osteoarthrosis suggests that while both aerobic and resistance training are helpful, aerobic exercises are modestly superior to resistance training and far superior to education.(508, 545-547) A moderate-quality trial using a comparable exercise regimen also suggests that walking is beneficial.(548) These studies support the idea that weight bearing is beneficial,(581) raise questions about which specific exercises are most beneficial, and suggest that aerobic exercise may be superior for knee osteoarthrosis patients.

All quality studies which included a major component of documented compliance with increased aerobic exercise found benefits of aerobic exercise.(548, 560, 565) Strengthening exercise results appear similar. There is not clear superiority of aerobic or strengthening exercises or vice versa. The available quality evidence suggests aerobic and strengthening exercises are superior to flexibility or range-of-motion exercises.(476, 548) Some, but not all data, suggest increased exercise intensity results in superior outcomes. Some, but not all studies that have assessed inflammatory markers and joint scores among those with OA or RA have found reductions in erythrocyte sedimentation rates and lower joint scores among those exercising. Pool-based programs have been evaluated and evidence of superiority of water-based programs is lacking (see Aquatic Therapy). A Cochrane review of exercise for knee OA found platinum (highest) level evidence of modest beneficial effects on knee pain and disability, but

unclear evidence on the rate of disease progression.(582) A second Cochrane review found equal efficacy for both high- and low-intensity exercise.(583)

Problems with compliance and persistence with exercise programs after discharge are considerable. Evidence is mixed regarding whether supervised exercise programs are necessary or whether home-based programs are sufficient. Providers need to encourage ongoing compliance with these programs. Exercise programs are not invasive, have low adverse effects, and are low to moderate cost depending on numbers of supervised appointments. Programs emphasizing aerobic and strengthening exercises are recommended, as is stretching for those with considerable reductions in range of motion that do not appear fixed.

Educational programs are largely ineffective compared to exercise or other active treatments.(508, 545-547, 584) Trials have sometimes employed educational programs as a sham or control treatment. However, a few educational visits to emphasize need for exercise and to tailor exercise and other activities are recommended in concert with an exercise prescription, as educational interventions have low adverse effects and are not costly. There is moderate quality evidence a combination of exercise and weight loss is effective for osteoarthrosis, providing additional rationale for educational interventions targeted at weight loss.(24, 585, 586)

Evidence for the Use of Exercise for Knee Osteoarthrosis and Rheumatoid Arthritis
There are 5 high- and 78 moderate-quality RCTs incorporated into this analysis. There are 21 low-quality RCTs(504, 507, 511, 512, 516, 587-602) (one with two reports(603, 604)) in Appendix 1.

Aquatic Therapy (Hydrotherapy)

Aquatic therapy involves the performance of aerobic and/or flexibility and/or strengthening exercises in a pool to minimize the effects of gravity, particularly where reduced weight-bearing status is believed to be desirable.(548, 605-607) However, as per the above review of exercise, there is quality evidence that weight-bearing exercise is beneficial for treatment of knee osteoarthrosis.

Aquatic Therapy for Knee Osteoarthrosis
A trial of aquatic therapy is recommended for patients with knee osteoarthrosis who meet the referral criteria for supervised exercise therapy, have co-morbidities (e.g., extreme obesity, significant degenerative joint disease, etc.) that preclude effective participation in a weight-bearing physical activity, and are planned to transition either to a land-based program or a self-administered water-based program.

Frequency/Duration – Begin with 3 to 4 visits a week. Functional improvement should be documented within the first 2 weeks to justify additional visits. The program should include up to 4 weeks of aquatic therapy with progression towards a land-based, self-directed physical activity or self-directed aquatic therapy program by 6 weeks. For some patients with knee osteoarthrosis, aquatic exercise may be the preferred method. In these cases, the program should become self managed. If any membership to a pool is covered, coverage should be continued if it can be documented that the patient is using the facility at least 3 times a week and following the prescribed exercise program.

Indications for Discontinuation – Non-tolerance, failure to progress, or reaching conclusion of program at 4 to 6 weeks.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

Aerobic exercise is beneficial for treatment of knee osteoarthrosis compared to no program(605); however, evidence of superiority to land-based programs is lacking.(548, 606-608) Instead, the quality literature appears to document comparable efficacy between land and water-based exercise programs.(548, 606, 607) These water programs are performed in lukewarm rather than higher temperature settings to allow for aerobic exercise to be performed. Spa water has been found to be no different than tap water.(609) There may be a select minority of patients in whom it is thought to be advantageous to reduce the effects of gravity. As noted previously, other forms of exercise have been shown to be effective in the treatment of knee OA, but for a few select patients who are unable to tolerate those land-based therapies, aquatic therapy is moderate costly, not invasive, and has little potential for adverse effects.

Evidence for the Use of Aquatic Therapy for Knee Osteoarthrosis
There is 1 high-(605) and 7 moderate-quality(548, 557, 606-610) RCTs incorporated into this analysis.

Yoga

Yoga has been used successfully for treatment of low back pain patients(611-613) (see Low Back Disorders guideline).

Yoga for Chronic Knee Pain
There is no recommendation for or against the use of yoga for treatment of chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality studies of yoga for treatment of these patients. Yoga may be appropriate for highly motivated patients; however, compliance is an issue.

Ergonomic Interventions

The physician may recommend ergonomic redesign of the workplace to facilitate recovery and prevent recurrence of knee disorders.(330) Ergonomic evaluations of the workplace can be conducted on-site by a qualified professional such as an ergonomist, occupational or physical therapist, or other health safety specialist. There are no quality studies regarding ergonomic interventions to prevent knee conditions, nor are there quality studies regarding return to work and secondary prevention. Thus, suggested changes to the work environment are empiric. Knee protection for kneeling activities is recommended. Falls result in considerable knee morbidity (including fractures), and fall protection equipment has resulted in far fewer fatalities in industry over the past few decades.(331)

Knee Pads for Kneeling Activities
Knee pads are recommended for activities which require kneeling.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Fall Protection
Measures to prevent falls are recommended.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Ergonomic Interventions for Knee MSDs
There is no recommendation for or against the use ergonomic interventions for knee MSDs.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
Ergonomic interventions for spine and upper extremity disorders have been attempted in numerous occupational settings,(332) and RCTs of ergonomic interventions in these settings have been reported. However, there are no quality studies of ergonomic interventions for the lower extremity. In the upper extremity, some interventions that had been thought to be beneficial were found to be unhelpful. Thus, without quality evidence, there is no recommendation for or against ergonomic interventions for knee MSDs. Although there is no quality evidence for fall protection in preventing knee disorders, falls from heights continue to cause morbidity and deaths, and fall protection is therefore recommended.

Medications

Non-steroidal Anti-inflammatory Drugs (NSAIDs) and Acetaminophen (Including Cytoprotection)

NSAIDs are widely used for treatment of osteoarthrosis (OA) and have been considered efficacious. However, the duration of follow-up in most studies does not exceed 6 weeks.(614-616) Most quality studies have included both knee and hip OA patients; however, outcomes in these two patient populations are similar.

Nonsteroidal anti-inflammatory drugs (NSAIDs) inhibit prostaglandin synthesis, impairing inflammation. There are several classes of NSAIDS: 1) salicylates – aspirin, diflunisal, salicyl salicylate (salsalate); 2) arylalkanoic acids – diclofenac, etodolac, ketorolac, nabumetone, sulindac, tolmetin; 3) 2-arylpropionic acids – ibuprofen, fenoprofen, ketoprofen, naproxen; 4) n-arylanthranilic acids – mefenamic acid; 5) oxicams – piroxicam, meloxicam; 6) COX-2 inhibitors – celecoxib, rofecoxib, etoricoxib; and 7) sulphonanilides – nimesulide. Acetaminophen is considered an analgesic and not an anti-inflammatory agent. Acetaminophen blocks the activation of COX by another enzyme, peroxidase. Tissues with high levels of peroxidase (i.e., platelets and immune cells) are “resistant” to acetaminophen, but tissues with low levels of peroxidase (i.e., nerve and endothelial cells that participate in pain and fever) are “sensitive” to acetaminophen.(617) There have been recent suggestions that NSAIDs may reduce cartilage synthesis.(618) However, there also are many articles documenting reductions in inflammatory mediators,(619-625) thus raising the possibility that NSAIDs delay cartilage destruction.

There are two isoenzymes of cyclooxygenase, COX-1 and Cox-2. NSAIDs are COX (non)selective to different degrees. COX-2 selective agents were designed to reduce inflammation without increasing risks for gastrointestinal (GI) bleeding. It appears that certain COX-2 selective agents may increase the risk of cardiovascular events (see Hip and Groin Disorders guideline for more information).

NSAIDs for Treatment of Acute, Subacute, Chronic, or Post-operative Knee Pain
NSAIDs are recommended for treatment of acute, subacute, chronic, or post-operative knee pain. There is no consistent quality evidence that one NSAID is superior to another, thus there is **No Recommendation, Insufficient Evidence (I)**, nor is there consistent quality evidence for superiority of one dosage form(626) or enteric-coated or sustained release preparations.(627-630) Due to their inhibitory effects on platelet function, non-selective COX inhibitors should be used with caution, or avoided altogether, in the post-operative period if patients are also receiving pharmacoprophylaxis (e.g., warfarin, low molecular weight heparins) to prevent venous thromboembolic disease. Concomitant use of non-selective COX inhibitors and anti-coagulation regimens may increase the risk of hemorrhage. There is also concern that COX inhibitors, particularly COX-2 inhibitors, may inhibit bone healing. Therefore, these agents should be used with caution, or avoided altogether, in the acute post-operative

period in situations where bone healing is required, such as in fracture repair or in knee replacements where cementless components are utilized.

Acetaminophen (or the analog, paracetamol) may be a reasonable alternative for treatment of acute, subacute, chronic or post-operative knee pain,(631, 632) although quality evidence suggests that acetaminophen is less efficacious than NSAIDs.(633-639) At least two quality trials of acetaminophen compared to placebo have been negative, including one with a large sample size of 779 patients.(637, 640) Of note, a recent FDA advisory committee recommended reduction of the maximum dose of acetaminophen to 650mg, which is less than the 1gm dose used in most quality trials. Consequently, the degree of successful treatment of osteoarthrosis with lower doses of acetaminophen is somewhat unclear. There is evidence that NSAIDs are as effective for pain relief as tramadol(641, 642) and dextropropoxyphene, although slightly less efficacious than codeine.(643, 644)

Indications – Acute, subacute, chronic, or post-operative knee pain. OTC agents may suffice and be tried first.

Frequency/Duration – Per manufacturer's recommendations; essentially all NSAIDs have proven efficacious for this indication. As-needed use may be reasonable for many patients. However, nearly all trials used scheduled doses.(645) There is evidence that nocturnal dosing is superior if patient primarily has morning or nocturnal pain,(646) although this may only apply to agents with shorter half-lives, including indomethacin.(647)

Indications for Discontinuation – Resolution of knee pain, lack of efficacy, or development of adverse effects that necessitate discontinuation.

Strength of Evidence – **Strongly Recommended, Evidence (A)** – Chronic knee pain(231, 631, 637, 648-660)

Recommended, Evidence (C) – Acute flares(648, 661, 662)
Recommended, Insufficient Evidence (I) – Acute, subacute, post-operative knee pain(663)

NSAIDs for Patients at Risk for GI Adverse Effects

Concomitant prescriptions of cytoprotective medications are recommended for patients at substantially increased risk for gastrointestinal (GI) bleeding. There are four commonly used cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers (famotidine, ranitidine, cimetidine, etc.), and proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole). It is generally thought that there is no significant difference in efficacy between these classes for the prevention of GI bleeding.(664) However, evidence suggests that histamine-2 blockers are less effective for protection of the gastric mucosa and sucralfate is weaker than proton pump inhibitors. There also are combination products of NSAIDs/misoprostol that have documented reductions in the risk of endoscopic lesions.

Indications – Patients with high GI risk factor profiles who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is planned. At-risk patients include those with a history of prior GI bleeding, elderly patients, diabetics, and cigarette smokers. Providers are cautioned that H2 blockers might not protect from gastric ulcers.(665-667)

Frequency/Dose/Duration – Proton pump inhibitors, misoprostol, sucralfate, and H2 blockers recommended. Dose and frequency as recommended by manufacturer for duration of NSAID therapy or permanently for those with recurrent bleeds or other complications.

Indications for Discontinuation – Intolerance, development of adverse effects, or discontinuation of NSAID.

Strength of Evidence – **Strongly Recommended, Evidence (A)** – Proton pump inhibitors, misoprostol
Moderately Recommended, Evidence (B) – Sucralfate
Recommended, Evidence (C) – H2 blockers

NSAIDs for Patients at Risk for Cardiovascular Adverse Effects
Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should be counseled about the risks and benefits of NSAID therapy.(668)

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Acetaminophen or aspirin should be considered as the first-line therapy for these patients with cardiovascular disease risk factors.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin to minimize the potential for the NSAID to counteract the beneficial effects of aspirin.(669)

Acetaminophen for Treatment of Acute, Subacute, Chronic or Post-operative Knee Pain
Acetaminophen is recommended for treatment of acute, subacute, chronic or post-operative knee pain, particularly for those with contraindications for NSAIDs.

Indications – All patients with knee pain, including acute, subacute, chronic and post-operative.

Dose/Frequency – Per manufacturer's recommendations; may be utilized on an as needed basis. It has been suggested that 1gm doses are more effective than 650mg doses, particularly in post-operative patients.(670, 671) However, this dose is now above the maximum dose recommended by an FDA advisory committee of 650mg, as evidence of hepatic toxicity has been reported at 4gms per day, particularly among those consuming excessive alcohol. There is no quality evidence for superiority of 1gm dosing for treatment of osteoarthrosis.

Discontinuation – Resolution of pain, adverse effects or intolerance.

Strength of Evidence **– Recommended, Evidence (C)**

Rationale for Recommendations
There is abundant quality evidence that NSAIDs improve pain and function among chronic knee pain patients, particularly those with osteoarthrosis or rheumatoid arthritis. There are a few studies of NSAID use for osteoarthrosis flares that consistently document benefits. There are no quality studies of NSAID use for acute, subacute or post-operative knee pain. However, by analogy to other MSDs including LBP (see Low Back Disorders guideline), successful treatment of knee pain with NSAIDs may be reasonably anticipated. Results are similar for non-selective or COX-2 (selective) NSAIDs, although the magnitude of benefit is generally not large for any given medication. There are many quality trials comparing various NSAIDs,(68, 631, 638, 639, 648, 654, 658, 659, 661, 672-722) and there is no consistent quality evidence suggesting superiority of one over another or of one class over another class. Most studies have not found cyclooxygenase-2 selective medications to be superior to other NSAIDs for pain control.(614, 615, 723) However, there is quality evidence that COX-2 selective NSAIDs reduce the risk of gastrointestinal adverse effects.(614, 615, 723) In terms of the timing of NSAID dosing, there is one quality study suggesting that evening dosing of indomethacin resulted in better pain control.(646) There is no similar result with the longer-acting agent celecoxib.(647) There is quality evidence that NSAIDs are less

impairing than opioids, yet efficacy is comparable (see Chronic Pain and Low Back Disorders guidelines). For most patients, generic ibuprofen, naproxen or other older generation NSAIDs are generally recommended as first-line medications. Second-line medications should generally include other generic medications.

There are several quality studies of acetaminophen and a few of paracetamol, a close analog.(724) All trials that compared acetaminophen with NSAIDs found either that NSAID significantly reduced pain more than acetaminophen or that differences were not statistically significant but favored NSAIDs.(633, 634, 636-639, 724-726) There is superior symptom relief at 2 hours with ibuprofen compared to paracetamol. These findings are consistent with quality evidence for the treatment of low back pain (see Low Back Disorders guideline). Subanalyses have suggested that NSAIDs are particularly more efficacious for those with more severe osteoarthrosis. However, evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and lower overall adverse effects profiles for acetaminophen.

A systematic review and meta-analysis of observational studies of NSAIDs found that the risk for serious cardiovascular events was elevated in combined analyses for some NSAIDs, but not for others.(727) Many of the studies supporting these estimates were based on large pharmaceutical databases that were adequately powered to detect effects, but had limited ability to control for potential confounding. There is one reported study of NSAIDs and myocardial infarctions that controlled for two major confounders – aspirin and body mass index.(728) Summary estimates from that study for non-selective NSAIDs suggested that they are protective against cardiovascular events. Study weaknesses included a 50% participation rate and reliance on recall. However, the American Heart Association has cautioned against the use of NSAIDs, especially COX-2 inhibitors.(669) Thus, current evidence is unclear if there is increased risk, no risk, or reduced risk of cardiovascular events from the use of any NSAIDs other than rofecoxib, which appears to have a modestly elevated relative risk.(727) It is recommended that risks of NSAIDs be discussed with patients, particularly patients with cardiovascular risk factors.

Risks of gastrointestinal events should be assessed, including prior history of gastrointestinal bleeding and source, length of treatment, age, smoking, diabetes mellitus, and other medical factors. Treatment with either acetaminophen, NSAIDs plus misoprostol, proton pump inhibitors (see below) or a COX-2 selective agent should be considered in those at high risk for gastrointestinal complications.(231, 614, 615, 650, 683, 723, 729-733)

Gastrointestinal adverse events are generally considered the most significant of the risks of NSAIDs. A large volume of high and moderate quality evidence has consistently shown that proton pump inhibitors are effective for prevention and or treatment of gastric and duodenal ulcers and erosions.(734-748) Different proton pump inhibitors are probably equally effective. There is one quality head-to-head trial, and it found no difference in efficacy between pantoprazole and omeprazole.(735) Misoprostol has also been consistently shown to be effective compared with placebo.(749-759) Relatively fewer studies have shown sucralfate to be effective compared with placebo.(760) H2 blockers appear more effective for treatment of duodenal than gastric mucosa.(665-667) There are relatively few quality trials comparing efficacy of the different classes of agents. Pantoprazole but not lansoprazole has been reported to be modestly superior to misoprostol.(761, 762) No difference was found between famotidine and lansoprazole.(763) Misoprostol has been reported superior to placebo(764) and ranitidine,(765, 766) cimetidine(756) and sucralfate.(755, 767) In short, while the evidence is not definitive, available quality evidence suggests proton pump inhibitors and misoprostol appear superior to H-2 blockers and sucralfate. While COX-2 selective agents have generally been recommended as either third- or fourth-line medications for routine use in osteoarthrosis patients, they are often preferred when there is a risk

of gastrointestinal complications. For patients at high risk of gastrointestinal bleeding, there is evidence that a combination of proton pump inhibitor plus COX-2 selective agent is efficacious.(768) There is consistent quality evidence that NSAIDs prevent heterotopic bone formation in post-arthroplasty patients.(769-773) but there is no quality evidence that prophylactic treatment with NSAIDs results in improved functional outcomes.(769)

NSAIDs are not invasive, have low side effect profiles in a healthy working patient population, and are low cost when generic medications are used. The potential for NSAIDs to increase the risk of cardiovascular events needs to be carefully considered

Evidence for the Use of NSAIDs and Acetaminophen
There are 26 high and 114 moderate-quality RCTs and randomized crossover trials incorporated in this analysis. *Note: Trials are aggregated within these categories to provide some structure. However, while many of these could be listed in multiple categories, they are listed only once to conserve space.*

OPIOIDS – Oral, Transdermal, and Parenteral (Includes Tramadol)

Opioids are addressed in a separate guideline. The treatment recommendations are summarized below. (See Opioids guideline for all supporting evidence.)

Acute Pain (Up to 4 Weeks)

Routine Use of Opioids for Treatment of Non-Severe Acute Pain
Routine opioid use is strongly not recommended for treatment of non-severe acute pain (e.g., low back pain [LBP], sprains, or minor injury without signs of tissue damage).

Harms – May inadequately treat acute, severe pain.

Benefits – Faster recovery, less debility, reduced accidents risks, risks of dependency or addiction.
Strength of Evidence **– Strongly Not Recommended, Evidence (A)**
Level of Confidence – High

Opioids for Treatment of Acute, Severe Pain
Opioids are recommended for treatment of acute, severe pain (e.g., crush injuries, large burns, severe fractures, injury with significant tissue damage) uncontrolled by other agents and/or with functional deficits caused by pain. A brief course of opiods may also be indicated at the initial visit for anticipated pain accompanying severe injuries (i.e., failure of other treatment is not mandatory). A Schedule IV[iv] opioid may be indicated if there is a true allergy to NSAIDs and acetaminophen, other contraindication to an alternative medication, or insufficient pain relief with an alternative. Recommend to taper off opioid use in 1 to 2 weeks.

Indications **–** Patients should meet all of the following:

[iv]USA classifies controlled substances that includes a classification system, ranging from Class 1 to Class V corresponding to lower risks of abuse and dependence. Class I includes substances with a high potential for abuse and without a recognized medical use (e.g., heroin, marijuana, LSD). Class II includes most opiates, amphetamines and cocaine. Class III includes buprenorphine, dihydrocodeiene, hydrocodone/codeiene when compounded with an NSAID, Marinol. Class IV includes tramadol (in some states), carisoprodol, benzodiazepines, and long-activing barbiturates. Class V includes small amounts of codeine (e.g., 30mg, 60mg).

Severe injury with a clear rationale for use (objective functional limitations due to pain resulting from the medical problem, e.g., extensive trauma such as forearm crush injury, large burns, severe radiculopathy).[v]
Other more efficacious treatments should have been instituted,[vi] and either:

a) failed and/or

b) have reasonable expectations of the immediate need for an opioid to obtain sleep the evening after the injury.

1) Where available, prescription databases (usually referred to as a Prescription Drug Monitoring Program [PDMP]) should be checked and not show evidence for conflicting opioid prescriptions from other providers or evidence of misreporting.[vii]
2) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) absent contraindication(s) should nearly always be the primary treatment and accompany an opioid prescription.
3) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
4) Dispensing quantities should be only what is needed to treat the pain. Short-acting opioids are recommended for treatment of acute pain. Long-acting opioids are not recommended.
5) Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines; ii) anti-histamines (H_1-blockers); and/or iii) illicit substances.(774-777) Patients should not receive opioids if they use illicit substances unless there is objective evidence of significant trauma or moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.(774, 775) Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, untreated sleep disorders, substance abuse history, current alcohol use or current tobacco use, attention deficit hyperactivity disorder (ADHD), post-traumatic stress disorder (PTSD), suicidal risk, impulse control problems, thought disorders, psychotropic medication use, chronic obstructive pulmonary disease (COPD), asthma, or recurrent pneumonia.(774, 778-798) Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,(799) as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, asthma, recurrent pneumonia, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, human immunodeficiency virus (HIV), ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids guideline).

Frequency/Duration – Generally, opioids should be prescribed at night or while not working.(800) Lowest effective, short-acting opioid doses are preferable as they tend to have the better safety profiles, less risk of escalation,(801) less risk of lost time from work,(802) and faster return to work.(803) Short-

[v]Other indications beyond the scope of this guideline include acute myocardial infarction or agitation interfering with acute trauma management.
[vi]Treatments to have tried generally include NSAIDs and acetaminophen. For LBP patients, additional considerations include muscle relaxants, progressive aerobic exercise, and directional exercise.
[vii]Exceptions such as acute, severe trauma should be documented.

acting opioids are recommended for treatment of acute pain and long-acting opioids are not recommended. Recommend opioid use as required by pain, rather than in regularly scheduled dosing.

If parenteral administration is required, ketorolac has demonstrated superior efficacy compared with opioids for acute severe pain,(804, 805) although ketorolac's risk profile may limit use for some patients. Parenteral opioid administration outside of obvious acute trauma or surgical emergency conditions is almost never required, and requests for such treatment are clinically viewed as red flags for potential substance abuse.

Indications for Discontinuation – Resolution of pain, sufficient improvement in pain, intolerance or adverse effects, non-compliance, surreptitious medication use, consumption of medications or substances advised to not take concomitantly (e.g., sedating medications, alcohol, benzodiazepines), or use beyond 2 weeks.
Harms – Adverse effects are many (see section below on "Opioids Benefits and Harms").
Benefits – Improved short-term pain control.

Strength of Evidence **– Recommended, Evidence (C)**
Level of Confidence – High

Screening Patients Prior to Initiation of Opioids
Initial screening of patients is recommended with more detailed screening for: i) requiring continuation of opioids beyond 2 weeks for those with an acute severe injury; and ii) at consideration of initiation for severe pain but no objective evidence. Screening should include history(ies) of depression, anxiety, personality disorder, other psychiatric disorder, substance abuse, sedating medication use (e.g., anti-histamine/anti-H_1 blocker(774)), benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (may include psychological evaluation); ii) consideration of consultation and examination(s) for complicating conditions and/or appropriateness of opioids, and iii) if opioids are prescribed, more frequent assessments for compliance, achievement of functional gains,(775, 806, 807) adverse effects, and symptoms and signs of aberrancy.

Harms – Negligible. If a consultation is needed, there are additional costs that are incurred.
Benefits – Improved identification of more appropriate candidates for opioids. Identification of patients at increased risk of adverse effects. In cases where someone has elevated, but potentially acceptable risk, may alert the provider to improve surveillance for complications and aberrant behaviors.
Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – High

Opioid Dose Limits in Acute Pain
Dispense only that which is required. The maximum daily oral dose recommended for opioid-naïve, acute pain patients based on risk of overdose/death is 50mg morphine equivalent dose (MED)[viii](808). In rare cases with documented functional improvement (see Appendix 1 of Opioids guideline), higher doses may be considered, however, risks are substantially higher and greater monitoring is also recommended (see Subacute/Chronic Opioid recommendations below). Lower doses should be used for

[viii]Statistical significance present for acute and chronic pain at and above 50 mg per day of oral morphine equivalent dose.

patients at higher risk of dependency, addiction and other adverse effects. Monitoring is also recommended and consultation may be considered for those patients on higher doses.
Harms – Theoretical potential to undertreat pain in some patients with increased pain sensitivity.
Benefits – Reduced risk for adverse physical and cognitive effects, dependency, addiction and opioid-related overdoses and deaths.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – Moderate

Post-Operative Pain Up to 4 Weeks (After 4 weeks, see Subacute Pain)

Oral opioids are commonly prescribed after sinus surgery,(809) major noncardiac surgical procedures,(810) mastectomy and immediate breast reconstruction (IBR),(811, 812) coronary artery bypass graft surgery,(813) major abdominal surgery (abdominal laparoscopic, abdominal hysterectomy, bowel resection or radical hysterectomy),(814-817) orthopedic surgery,(818) and molar extraction.(819)

Limited Use of Opioids for Post-operative Pain
Limited use of opioids is recommended for post-operative pain management as an adjunctive therapy to more effective treatments.

Indications – For post-operative pain management, a brief prescription of short-acting opioids as an adjunct to more efficacious treatments (especially Cox-2 NSAIDs such as celecoxib, non-selective NSAIDs after risk of bleeding is no longer a concern).[ix] A brief course of opioids is often needed for minor surgical procedures. However, minor wound laceration repairs often require no opioids. Evidence suggests perioperative pregabalin for 14 days and/or continuous femoral nerve catheter analgesia instead of solely using oral opioids results in superior knee arthroplasty functional outcomes with less venous thromboses.(820) Additional considerations include:

1) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) should nearly always be the primary treatment and accompany an opioid prescription. Computerized programs may also assist in optimal management.(821)
2) The lowest effective dose of a short-acting opioid should be used,(801) as well as weaker opioids if possible.(802, 803)
3) Short-acting opioids are recommended for treatment of acute pain.
4) Dispensing should be only what is needed to treat the pain.[x]
5) Long-acting opioids are not recommended.
6) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
7) Where available, prescription databases (usually referred to as Prescription Drug Monitoring Program (PDMP)) should be checked for other opioid prescriptions. Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines; ii) anti-histamines (H_1-blockers); and/or iii) illicit substances.(774-777) Patients should not receive opioids if they use illicit substances unless there is objective evidence of significant trauma or

[ix] More efficaciouos treatments also include therapeutic exercises, e.g., progressive ambulation especially for moderate to extensive procedures (e.g., arthroplasty, fusion).
[x] Generally, this should be sufficient to cover two weeks of treatment. Prescriptions of 90-day supplies in the post-operative setting are not recommended.

moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.(774, 775)

Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, ADHD, PTSD, suicidal risk, impulse control problems, thought disorders, psychotropic medication use, substance abuse history, current alcohol use or current tobacco use, untreated sleep disorders, COPD, asthma, or recurrent pneumonia.(774, 778-798, 822) Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,(799) as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, HIV, ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids guideline). Inpatient management may moderate these recommendations provided there is careful monitoring, although these same management issues then apply post-discharge.

8) For patients taking opioids chronically prior to surgery, consultations with anesthesiology and/or pain management are generally needed as post-operative dosing may be very high and management is often challenging.
9) Ongoing prescriptions of opioids after the immediate post-operative period should generally be for patients who have undergone a major surgery or have other condition(s) necessitating opioids. Most patients should be making progress towards functional restoration, pain reduction and weaning off the opioids. Patients who have not progressed should be carefully evaluated for physical complications or psychiatric comorbidity, adherence to active treatments, and pending development of addiction or dependency.

Frequency/Duration – For moderate and major surgeries, opioids are generally needed on a scheduled basis in the immediate post-operative period. Other post-operative situations may be sufficiently managed with an as needed opioid prescription schedule. Provision of opioids sufficient to participate in therapeutic exercise (e.g., progressive ambulation) and allow sleep may be needed. However, high dose use at night is not recommended due to respiratory depression and disruption of sleep architecture. Weaning should begin as soon as function is recovering and pain is subsiding. Subsequent weaning to as needed opioid use is recommended.

Indications for Discontinuation – The physician should discontinue the use of opioids based on sufficient recovery, expected resolution of pain, lack of efficacy, intolerance or adverse effects, non-compliance, surreptitious medication use, self-escalation of dose, or use beyond 3-5 days for minor procedures, and 2-3 weeks for moderate/less extensive procedures. Use for up to 3 months may occasionally be necessary during recovery from more extensive surgical procedures (e.g., spine fusion surgery). However, with rare exceptions, only nocturnal use is recommended in months 2-3 plus institution of management as discussed in the subacute/chronic guidelines below. For those requiring opioid use beyond 1 month, subacute/chronic opioid use recommendations below apply.
Harms – Adverse effects are many (see section on “Opioids Benefits and Harms”).
Benefits – Improved short-term, post-operative pain control. Some studies suggest this may modestly improve functional outcomes in the post-operative population.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – High

Screening Patients Prior to Continuation of Opioids

Screening of patients is recommended for those requiring continuation of opioids beyond the second post-operative week. Screening should include history(ies) of: depression, anxiety, personality disorder, pain disorder, other psychiatric disorder, substance abuse history, sedating medication use (e.g., anti-histamine/anti-H_1 blocker), benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, and other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (e.g., may include psychological and/or pain evaluation); ii) compliance with active therapies (e.g., ambulation and other exercise after arthroplasty); iii) consider consultation examination(s) for complicating conditions and/or appropriateness of opioids; and iv) if ongoing opioids are prescribed, ensure more frequent assessments for treatment compliance, achievement of functional gains, (775, 806, 807) and symptoms and signs of aberrancy.

Harms – Negligible. If a consultation is needed, there are additional costs that are incurred.

Benefits – Identification of patients at increased risk of adverse effects. Improved identification of more appropriate and safe candidates for opioids compared with attempting post-operative pain control with non-opioids. This should reduce adverse effects. In cases where someone has elevated, but potentially acceptable risk, this may alert the provider to improve surveillance for complications and aberrant behaviors.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – High

Opioid Dose Limits in Post-operative Pain

The maximum daily oral dose recommended for opioid-naïve, acute pain patients based on risk of overdose/death is 50mg morphine equivalent dose (MED)[xi](808). Post-operative patients particularly require individualization due to factors such as the severity of the operative procedure, response to treatment(s) and variability in response. Higher doses beyond 50mg MED may be particularly needed for major surgeries in the first 2 post-operative weeks to achieve sufficient pain relief; however, greater caution and monitoring are warranted and reductions below 50mg MED at the earliest opportunity should be sought. Lower doses should be used for patients at higher risk of dependency, addiction and other adverse effects. In rare cases with documented functional improvement, ongoing use of higher doses may be considered, however, risks are substantially higher and greater monitoring is also recommended (see Subacute/Chronic Opioid recommendations below).

Harms – Theoretical potential to undertreat pain, which could modestly delay functional recovery.
Benefits – Reduced risk for adverse effects, dependency, addiction and opioid-related deaths.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Subacute (1-3 Months) and Chronic Pain (>3 Months)

Routine Use of Opioids for Subacute and Chronic Non-malignant Pain

[xi]Statistical significance present for acute and chronic pain at and above 50 mg per day of morphine equivalent dose.

Opioid use is moderately not recommended for treatment of subacute and chronic non-malignant pain. Opioid prescription should be patient specific and limited to cases in which other treatments are insufficient and criteria for opioid use are met (see below).

Harms – May inadequately treat severe subacute or chronic pain.
Benefits – Less debility, fewer adverse effects, reduced accident risks, lower risks of dependency, addiction, overdoses, and deaths.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**
Level of Confidence – High

Opioids for Treatment of Subacute or Chronic Severe Pain
The use of an opioid trial is recommended if other evidence-based approaches for functional restorative pain therapy have been used with inadequate improvement in function.(823, 824) **Opioids are then recommended for treatment of function impaired by subacute or chronic severe pain (e.g., inability to work due to any of the following: chronic severe radiculopathy, chronic severe peripheral neuropathies, complex regional pain syndrome (CRPS), and severe arthroses)**(806) **(see Appendix 1 of Opioids guideline).**

Indications **–** Patients should meet all of the following:

1) Reduced function is attributable to the pain. Pain or pain scales alone are insufficient reasons.(775, 806, 825-836)
2) A severe disorder warranting potential opioid treatment is present [e.g., CRPS, severe radiculopathy, advanced degenerative joint disease (DJD).(827)
3) Other more efficacious treatments have been documented to have failed.(827) Other approaches that should have been first utilized include physical restorative approaches, behavioral interventions, self-applied modalities, non-opioid medications (including NSAIDs, acetaminophen, topical agents, norepinephrine adrenergic reuptake blocking antidepressants or dual reuptake inhibitors; also antiepileptic medications particularly for neuropathic pain) and functional restoration. For LBP patients, this also includes[xii] fear avoidant belief training and ongoing progressive aerobic exercise, and strengthening exercises. For CRPS patients, this includes progressive strengthening exercise. For DJD, this includes NSAIDs, weight loss, aerobic and strengthening exercises.
4) An ongoing active exercise program is prescribed and complied with.
5) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) absent a contraindication should nearly always be the primary pain medication and accompany an opioid prescription. Other medications to consider include topical agents, norepinephrine adrenergic reuptake blocking antidepressants or dual reuptake inhibitors; also antiepileptic medications particularly for neuropathic pain).
6) The lowest effective dose should be used.(801) Weaker opioids should be used whenever possible.(802, 803) Meperidine is not recommended for chronic pain due to bioaccumulation and adverse effects.
7) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
8) Dispensing should be only what is needed to treat the pain.[xiii]

[xii] A previous trial of a muscle relaxant is generally recommended. However, if an opioid trial is contemplated, cessation of all depressant medications including muscle relaxants is advisable.
[xiii] Generally, this should be sufficient to cover one week of treatment at a time during the trial phase. If a trial is successful at improving function, prescriptions for up to 90-day supplies are recommended.

9) Extended-release/long-acting opioids are recommended to be used on a scheduled basis, rather than as needed.(827) As needed opioids should generally be avoided for treatment of chronic pain, although limited use for an acute painful event (e.g., fracture, sprain) is reasonable. Sublingual fentanyl is not recommended for treatment of subacute or chronic pain. Caution is warranted with fentanyl patches due to unpredictable absorption.
10) Where available, prescription databases (usually referred to as a Prescription Drug Monitoring Program [PDMP]) should be checked for conflicting opioid prescriptions from other providers or evidence of misreporting.
11) Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines; ii) anti-histamines (H_1-blockers); and/or iii) illicit substances.(774-777) Patients should not receive opioids if they use illicit substances unless there is objective evidence of significant trauma or moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.(774, 775)

Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, untreated sleep disorders, substance abuse history, current alcohol use or current tobacco use, ADHD, PTSD, suicidal risk, impulse control problems, thought disorders, psychotropic medication use, COPD, asthma, recurrent pneumonia.(774, 778-798, 822) Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,(799) as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, asthma, recurrent pneumonia, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, HIV, ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids guideline).

Frequency/Duration – Opioids use is generally initiated as a "trial" to ascertain whether the selected opioid produces functional improvement (see Appendix 1 of Opioids guideline). Opioid use is generally prescribed on a regular basis,(837) at night or when not at work.(800) Only one opioid is recommended to be prescribed in a trial. More than one opioid should rarely be used. Lower opioid doses are preferable as they tend to have the better safety profiles, less risk of dose escalation,(801) less work loss,(802) and faster return to work.(803) Patients should have ongoing visits to monitor efficacy, adverse effects, compliance and surreptitious medication use. Opioid prescriptions should be shorter rather than longer duration.(838)

Indications for Discontinuation – Opioids should be discontinued based on lack of functional benefit(824) (see Appendix 1), resolution of pain, improvement to the point of not requiring opioids, intolerance or adverse effects, non-compliance, surreptitious medication use, medication misuse (including self-escalation and sharing medication), aberrant drug screening results, diversion, consumption of medications or substances advised to not take concomitantly (e.g., sedating medications, alcohol, benzodiazepines).

Harms – Adverse effects are many (see section on "Opioids Benefits and Harms"). May initiate path to opioid dependency.

Benefits – Improved short-term pain ratings. Theoretical potential to improve short-term function impaired by a painful condition.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Screening Patients Prior to Initiation of Opioids
Screening of patients is recommended prior to consideration of initiating a trial of opioids for treatment of subacute or chronic pain. Screening should include history(ies) of depression, anxiety, personality disorder and personality profile,(803, 839, 840) other psychiatric disorder, substance abuse history, sedating medication use (e.g., anti-histamine/anti-H_1 blocker),(781) benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, and other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (may include psychological and/or psychiatric evaluation(s) to help assure opioids are not being used instead of appropriate mental health care); ii) consideration of consultation and examination(s) for complicating conditions and/or appropriateness of opioids; and iii) if opioids are prescribed, more frequent assessments for compliance, achievement of functional gains and symptoms and signs of aberrant use.

Harms – Negligible. If a consultation is needed, there are additional costs that are incurred.
Benefits – Identification of patients at increased risk of adverse effects. Improved identification of more appropriate and safe candidates for treatment with opioids. This should reduce adverse effects. In cases where someone has elevated, but potentially acceptable risk, this may alert the provider to improve surveillance for complications and aberrant behaviors.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – High

Opioid Dose Limits in Subacute and Chronic Pain
The maximum daily oral dose recommended for subacute or chronic pain patients based on risk of overdose/death is 50mg Morphine Equivalent Dose (MED).(782, 808) In rare cases with documented functional improvements occurring with use above 50mg MED, subsequent doses up to 100mg may be considered, however, risks of death are much greater and more intensive monitoring is then also recommended. Lower doses should be considered in high risk patients. Caution appears warranted in all patients as there is evidence the risk of dose escalation is present even among patients enrolled in a "hold the line (stable dose) prescribing strategy" treatment arm.(841)

For those whose daily consumption is more than 50mg MED, greater monitoring is recommended to include: i) at least monthly to not more than quarterly appointments with greater frequencies during trial, dose adjustments and with greater co-morbid risk factors and conditions; ii) at least semiannual attempts to wean below 50mg MED if not off the opioid; iii) at least semiannual documentation of persistence of functional benefit; iv) at least quarterly urine drug screening (see drug screening section); and v) at least semiannual review of medications, particularly to assure no sedating medication use (e.g., benzodiazepine, sedating anti-histamines).

Harms – None in a short-term trial. For chronic pain patients, theoretical potential to undertreat pain and thus impair function. However, there is no quality literature currently available to support that position.
Benefits – Reduced risk for adverse effects, dependency, addiction, and opioid-related deaths.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Use of an Opioid Treatment Agreement (Opioid Contract, Doctor/Patient Agreement, Informed Consent)
The use of an opioid treatment agreement (opioid contract, doctor/patient agreement, or informed consent) is recommended to document patient understanding, acknowledgement of potential adverse effects, and agreement with the expectations of opioid use (see Appendix 1 of Opioids guideline). (823, 842-853) **If consent is obtained, it is recommended that appropriate family members be involved in this agreement.**
Harms – Negligible.
Benefits – Educates the patient and significant others that these medications are high risk, with numerous adverse effects. It allows for a more informed choice. It provides a framework for initiation of a trial, monitoring, treatment goals, compliance requirement, treatment expectations, and conditions for opioid cessation. It should reduce risk of adverse events and opioid-related deaths, although that remains unproven to date.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Moderate

Urine Drug Screening
Baseline and random urine drug screening, qualitative and quantitative, is recommended for patients prescribed opioids for the treatment of subacute or chronic pain to evaluate presence or absence of the drug, its metabolites, and other substance(s) use. In certain situations, other screenings (e.g., hair particularly for information regarding remote use(854-859) **or blood (for acute toxicity) may be appropriate.**

Indications – All patients on opioids for subacute or chronic pain.

Frequency – Screening is recommended at baseline, randomly at least twice and up to 4 times a year and at termination. More intensive screening is recommended for those consuming more than 50mg MED (see above). Federal guidelines recommend at least 8 tests a year among those utilizing opioid treatment programs.(860) Screening should also be performed "for cause" (e.g., provider suspicion of substance misuse including over-sedating, drug intoxication, motor vehicle crash, other accidents and injuries, driving while intoxicated, premature prescription renewals, self-directed dose changes, lost or stolen prescriptions, using more than one provider for prescriptions, non-pain use of medication, using alcohol for pain treatment or excessive alcohol use, missed appointments, hoarding of medications, and selling medications). Standard urine drug/toxicology screening processes should be followed (consult a qualified medical review officer).(861-863) If there is an aberrant drug screen result (either positive for unexpected drugs or unexpected metabolites or unexpectedly negative results), there should be a careful evaluation of whether there is a plausible explanation (e.g., drug not tested, drug metabolite not tested, laboratory cutpoint and dosing interval would not capture the drug/metabolite, laboratory error). In the absence of a plausible explanation, those patients with aberrant test results should have the opioid discontinued or weaned.(824)

Harms – No adverse clinical effects if properly interpreted.
Benefits – Identifies aberrant medication(s) and substance(s) use. Such uses are high-risk for opioid events including fatalities (see tables below). It provides objective evidence to cease an opioid trial or ongoing treatment. Identifies patients who may be diverting medication (those screening negative for prescribed medication).

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Evidence for Use of Opioids
There are 2 high-(864, 865) and 21 moderate-quality(642, 866-885) RCTs incorporated in this analysis (see Opioids guidelines for additional evidence).

SKELETAL MUSCLE RELAXANTS

Skeletal muscle relaxants comprise a diverse set of pharmaceuticals designed to produce muscle relaxation through different mechanisms of action, including central nervous system (CNS) mechanisms.(886, 887) These medications are widely used in primary care to treat painful conditions, including LBP,(888-894) muscle spasms,(895) and myalgias. They are generally not used for treatment of knee disorders.

Muscle Relaxants for Acute and Subacute Knee Pain with Significant Muscle Spasm
There is no recommendation for or against the use of muscle relaxants for treatment of acute or subacute, moderate to severe knee pain from muscle spasm that is unrelieved by NSAIDs, avoidance of exacerbating exposures, or other conservative measures (generally not indicated for chronic knee pain).

Indications – Moderate to severe chronic pain syndromes and radicular pain syndromes thought to be musculoskeletal in nature.

Frequency/Dose – Initial dose in evening (not during workdays or if patient operates a motor vehicle, though daytime use is acceptable if CNS-sedating effects are minimal). Duration for exacerbations of chronic pain is limited to a couple weeks. Longer term treatment is generally not indicated.

Indications for Discontinuation – Resolution of pain, non-tolerance, significant sedating effects that carry over into the daytime, other adverse effects.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality studies of these agents for treatment of patients with knee pain. Skeletal muscle relaxants have been evaluated in quality studies evaluating acute LBP and also chronic back and neck pain(896-899) (see Chronic Pain and Low Back Disorders guidelines). The quality of the studies comparing these agents to placebo is limited due to probable unblinding from adverse effects. The adverse effect profile is concerning,(900) with CNS sedation rates ranging from approximately 25 to 50% and a low but definite risk of abuse.(901, 902) Thus, prescriptions for skeletal muscle relaxants for daytime use should be carefully weighed against the need to drive vehicles, operate machinery, or otherwise engage in occupations where mistakes in judgment may have serious consequences (e.g., crane operators, air traffic controllers, operators of motorized vehicles, construction workers, etc.). Skeletal muscle relaxants have beneficial uses, particularly for nocturnal administration to normalize sleep patterns disrupted by skeletal muscle pain, as well as for daytime use among the few patients who do not suffer from the CNS depressant effects. They are low cost if generic medications are prescribed. Skeletal muscle relaxants are not recommended for continuous management of subacute or chronic knee pain, although they may be reasonable options for selected patients with acute pain exacerbations or for a limited trial as a third- or fourth-line agent in more severely affected patients in whom NSAIDs and exercise have failed to control symptoms.

Evidence for the Use of Skeletal Muscle Relaxants
There are no quality studies evaluating the use of skeletal muscle relaxants for treatment of patients with knee pain.

ANTI-DEPRESSANTS

Antidepressants have been used for treatment of chronic pain disorders.

Norepinephrine Reuptake Inhibiting Anti-depressants for Knee Osteoarthrosis or Subacute or Chronic Knee Pain
There is no recommendation for or against the use of norepinephrine reuptake inhibiting anti-depressants for treatment of knee osteoarthrosis, subacute or chronic knee pain (see Chronic Pain guideline).

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Norepinephrine Reuptake Inhibiting Anti-depressants for Acute Knee Pain
Norepinephrine reuptake inhibiting anti-depressants are not recommended for treatment of acute knee pain.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Selective Serotonin Reuptake Inhibitors for Acute, Subacute, or Chronic Knee Pain
Selective serotonin reuptake inhibitors (SSRIs) are not recommended for treatment of acute, subacute, or chronic knee pain as there is strong evidence of their lack of efficacy in treating chronic low back pain, thus they appear unlikely to be successful in treating acute, subacute, or chronic knee pain.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Selective Serotonin Reuptake Inhibitors, SSRIs, or Tricyclic Anti-depressants for Chronic Knee Pain in Patients with Co-morbid Depression
Selective serotonin reuptake inhibitors (SSNRIs), SSRI, and/or tricyclic anti-depressants are recommended for patients with chronic knee pain and co-morbid depression.

Indications – Patients with diagnosed depression of at least moderate severity and with chronic pain, in conjunction with a behavioral program focusing on function with chronic pain.(903)

Duration – Therapy for up to 12 months.(903)

Indications for Discontinuation – No response to medication after 3 months; adverse effects or unwillingness or incapable of participating in behavioral therapy program.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendations
Norepinephrine reuptake inhibiting anti-depressants (e.g., amitriptyline, doxepin, imipramine, desipramine, nortriptyline, protriptyline, maprotiline, and clomipramine) and mixed norepinephrine and serotonin inhibitors (SNRIs) have evidence of efficacy for treatment of chronic low back pain and some other chronic pain conditions (see Low Back Disorders guideline). However, there is no quality, placebo-controlled evidence evaluating these medications for treatment of knee osteoarthrosis or other knee pain. There also are no clear analogous disorders for which evidence-based guidance may be reliably derived. There is one moderate-quality study evaluating SNRI, SSRI and tricyclic antidepressants in patients with chronic low back, hip and knee pain. This study reported a significant improvement in depression severity and pain in patients taking antidepressant medications in conjunction with

education focused on how to function with chronic pain compared to usual care controls.(903) A moderate-quality study evaluated amitriptyline 50mg a day for 3 days post-operatively and reported no benefits for pain control.(904) Thus, there is not enough quality evidence of efficacy to warrant a recommendation.

Evidence for the Use of Anti-depressants for Knee Pain and Osteoarthrosis
There is 1 high-quality RCT (with two reports) and 1 moderate-quality RCT incorporated into this analysis.

ANTI-CONVULSANT AGENTS (including Gabapentin and Pregabalin)

Anti-convulsant agents have been utilized off-label for some chronic pain syndromes since the 1960s.(905) They have been particularly used for treating neuropathic pain.(906) Anti-convulsants are thought to have analgesic properties. Several have been used to manage chronic pain conditions include carbamazepine, valproic acid, gabapentin, phenytoin, clonazepam, lamotrigine, tiagabine, pregabalin, topiramate, levetiracetam, oxcarbazepine, and zonisamide.

Topiramate for Knee Osteoarthrosis or Subacute or Chronic Knee Pain
There is no recommendation for or against the use of topiramate for treatment of knee osteoarthrosis or other subacute or chronic knee pain (see Chronic Pain guideline).

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Topiramate for Acute Knee Pain
Topiramate is not recommended for treatment of acute knee pain.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Gabapentin for Knee Osteoarthrosis or Subacute or Chronic Knee Pain
There is no recommendation for or against the use of gabapentin for treatment of knee osteoarthrosis or subacute or chronic knee pain (see Chronic Pain guideline).

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Gabapentin for Acute Knee Pain
Gabapentin is not recommended for the treatment of acute knee pain.

Strength of Evidence **– Not Recommended, Insufficient Evidence (I)**

Gabapentin for Peri-Operative Pain
Gabapentin is recommended for the peri-operative management of pain to reduce the need for opioids, particularly in those with adverse effects from opioids.

Indications **–** Peri-operative pain management.

Frequency/Dose – Limit to immediate peri-operative period, usually a few days.

Indications for Discontinuation – Resolution, intolerance.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
There are no quality studies involving knee pain patients, and quality evidence suggests that topiramate is weakly effective for treatment of low back pain patients and gabapentin is not helpful. However, there is quality evidence that gabapentin reduces the need for opioids when administered as part of

perioperative pain management for other patients, thus by inference, gabapentin is recommended for knee surgery patients.(907-910)

Evidence for the Use of Anti-convulsant Agents
There are no quality studies evaluating the use of topiramate or gabapentin for knee osteoarthrosis or other knee pain. There are 4 high-quality RCTs incorporated in this analysis for peri-operative pain that are described in the Chronic Pain guideline. (907-910)

TUMOR NECROSIS FACTOR-ALPHA BLOCKERS

A variety of tumor necrosis factor (TNF) alpha blockers, including infliximab (a chimeric monoclonal antibody directed against TNF-alpha), etanercept (a recombinant molecule comprising part of the TNF receptor plus the constant region of human immunoglobulin G1 that binds to TNF-alpha) and adalimumab (an IgG1 monoclonal antibody that binds to TNF-alpha) are in widespread use for rheumatologic and other inflammatory disorders. There may be indications for treatment of some patients with these agents in the setting of inflammatory rheumatologic disorders. However, this is beyond the scope of this guideline.

Tumor Necrosis Factor-alpha Blockers for Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain or Other Non-inflammatory Knee Disorders
Tumor necrosis factor-alpha blockers are not recommended for the treatment of osteoarthrosis or acute, subacute, or chronic knee pain, including other non-inflammatory knee disorders.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Tumor Necrosis Factor-alpha Blockers for Arthroplasty Patients with Osteolysis
Tumor necrosis factor-alpha blockers are not recommended for the treatment of arthroplasty patients with osteolysis.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
One quality study has reported evaluating etanercept for attempted treatment of periacetabular osteolysis in arthroplasty patients, but found a lack of efficacy.(911)

Evidence for the Use of Tumor Necrosis Factor-alpha Blockers for Knee Pain
There is 1 moderate-quality RCT incorporated in this analysis.

Glucosamine, Chondroitin, and Methylsulfonylmethane (MSM)

Glucosamine, chondroitin, and methylsulfonylmethane (MSM) are over-the-counter nutraceuticals(912) that have been advocated as safe and effective treatment alternatives to NSAIDs for the management of osteoarthrosis. These supplements have also gained additional interest as agents that may potentially modify or slow the progression of osteoarthrosis.

Glucosamine is an amino acid monosaccharide that occurs naturally in the human body, and is one of the principle substrates in the biosynthesis of cartilaginous glycosaminoglycans, proteoglycans, and hyaluronic acid.(913) Although the specific cause of osteoarthrosis is unknown, turnover of the cartilage matrix is mediated by a multitude of complex autocrine and paracrine anabolic and catabolic factors, leading to loss of articular cartilage, subchondral bone remodeling, and low-level inflammation of the synovial membrane.(914) Glucosamine supplementation is hypothesized to beneficially affect the

imbalance between rates of synthesis and degradation of cartilage proteoglycans.(913, 915) Glucosamine reportedly has anti-inflammatory properties.(916, 917) Glucosamine preparations come in two forms, glucosamine sulfate (pill and crystalline powder) or glucosamine hydrochloride,(918, 919) and are often combined with chondroitin sulfate and sometimes combined with methylsulfonylmethane. Most studies have utilized glucosamine sulfate rather than glucosamine hydrochloride, although there are no quality comparative head-to-head trials. Glucosamine sulfate is also available in suspension for intramuscular and intra-articular injection.(920-922)

Glucosamine generally has few adverse effects with safety profiles comparable to placebo in the reviewed trials. However, there are two hypothetical risks that may suggest select patient groups to avoid these supplements. First, there is debate as to whether or not glucosamine, which is an aminoglycan, promotes insulin resistance.(923-925) However, no adverse effects have been found in patients who have well-controlled diabetes mellitus or even in persons with glucose intolerance.(926, 927) Second, glucosamine preparations are commonly produced from the shells of shrimp and crabs (chitin) – seaweed and shark cartilage has also been used,(928, 929) leading to concerns for potential allergic responses in persons with shellfish allergies. In a trial sponsored by the U.S. National Institutes of Health (NIH) of 15 patients with known systemic allergies to shrimp, administration of glucosamine sulfate was not found to result in any immediate hypersensitivity reactions.(930) Glucosamine products in the U.S. are now also commonly synthesized from grains, providing an alternate source for persons concerned with shellfish allergies. Therefore, these hypothetical risks appear to be low. The most common glucosamine dose is 1500mg per day in single or divided doses.

Chondroitin, a sulfated glycosaminoglycan matrix, provides structural elasticity. Chondroitin is thought to work via anti-inflammatory activity, stimulation of proteoglycans and hyaluronic acid synthesis, and decrease chondrocytic catabolic activity, although the exact mechanisms are unclear.(931) As with glucosamine, there are few reported adverse effects from chondroitin sulfate though some patients have GI tract effects.(932) This supplement is produced from animal cartilage such as bovine trachea, porcine and sharks. The most common dose is 1,200mg per day in single or divided dosages. Chondroitin is most commonly combined with glucosamine in commercial preparations, sometimes additionally including MSM.

Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Knee Osteoarthrosis

There is no recommendation for or against the use of glucosamine sulfate 1,500mg daily (single or divided dose), chondroitin sulfate, or methylsulfonylmethane for the treatment of knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Glucosamine Sulfate Intra-Muscular Injections for Knee Osteoarthrosis

There is no recommendation for or against the use of glucosamine sulfate intra-muscular injections for the treatment of knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Glucosamine Sulfate Intraarticular Injections for Knee Osteoarthrosis

There is no recommendation for or against the use of glucosamine sulfate intraarticular injections for the treatment of knee osteoarthrosis.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Glucosamine Sulfate, Chondroitin Sulfate, or Methylsulfonylmethane for Osteoarthrosis Prevention

There is no recommendation for or against the use of glucosamine sulfate, chondroitin sulfate, or methylsulfonylmethane for prevention of osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**
Level of Confidence – **Low**

Rationale for Recommendations
There has been considerable debate over the efficacy of these preparations in reducing pain, improving function, and slowing the progression of the joint space narrowing in osteoarthrosis. Ten quality studies have followed knee joint spaces using either MRI (2416-2418) or x-rays (933-938, 2419) to measure the joint space and one has objectively followed the hip joint (939). Six trials utilized glucosamine sulfate (936-939, 2417, 2418), four utilized chondroitin sulfate (933-935, 2416) and one used a combination (2419). One of the 3 MRI studies (33% of the studies) suggested *improvements* in the cartilage on MRI (2416), while the only sizable study of the 3 studies using MRI was negative (2417). Overall, six of the x-ray or MRI imaging studies (60% of the studies) demonstrated preservation of joint spaces compared with placebo, including multiple studies reporting either no or reduced joint space narrowing in the active treatment group over 2 years, (933, 934, 936, 937, 2419) and one reported increased cartilage volume over 2 years (2416) . Thus, the studies that utilized x-rays or MRI generally suggested benefits from the treatment of knee osteoarthrosis with either glucosamine sulfate or chondroitin sulfate; however, quality evidence of consistent, objective benefit utilizing x-rays of glucosamine or chondroitin for the treatment of OA is not unequivocally present. Most of the placebo-controlled studies of glucosamine and/or chondroitin report improvements in pain and/or function (506, 940-944, 933-935, 944-950). Few studies assessed MSM and some reported benefits (951, 952).

Studies compared these treatments with traditional NSAIDs (938, 945, 953-957) or acetaminophen (958, 959). Glucosamine hydrochloride, chondroitin sulfate and the combination were not superior to celecoxib 200mg per day or diclofenac 50mg TID (938, 945, 954, 2420); however, the combination was successful for treatment of moderate to severe osteoarthrosis compared with placebo (945) and chondroitin sulfate had longer lasting pain relief compared to diclofenac (954). Three studies found glucosamine sulfate comparable to ibuprofen 1200mg per day (953, 955, 956). Acetaminophen was found to be inferior to glucosamine sulfate (958).

Glucosamine and chondroitin, alone or in combination, are not invasive, appear relatively safe, do not result in gastrointestinal erosions or the other common side effects of NSAIDS, are relatively inexpensive, and may provide some modest relief of knee osteoarthrosis pain, particularly in patients with more advanced pain. A majority of the imaging studies suggest these medications may modify or slow the progression of knee OA as measured by slowing of cartilage destruction and joint narrowing.(938)

One major limitation of these studies is that different glucosamine formulations (hydrochloride versus sulfate), different frequencies and dosage strengths, and different durations and severities of disease of

the study populations are present in different studies.(960) The dose is not standardized and reportedly ranges widely in available preparations. There is some evidence that a single daily dose of chondroitin sulfate may be as or more effective than divided doses.(949). Thus, although there is evidence suggesting potential efficacy with 60% of the imaging-based studies reporting efficacy, and they have very low adverse effect profiles, the lack of standardized dosing prevents the formulation of an evidence-based recommendation in support of these agents. Involving the patient in a discussion for his/her personal decision-making regarding potentially self-administering these over-the-counter agents is advised.

Evidence

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Knee Pain and Osteoarthritis controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 42 in Scopus, 87 in CINAHL, 141 in Cochrane Library, 1280 in Google Scholar, and 38 from other sources. We considered for inclusion 3 from PubMed, 0 from Scopus, 9 from CINAHL, 9 from Cochrane Library, 0 from Google Scholar, and 38 from other sources. Of the 59 articles considered for inclusion, 52 randomized trials and 5 systematic reviews met the inclusion criteria.

COMPLEMENTARY/ALTERNATIVE TREATMENTS AND DIETARY SUPPLEMENTS

Many treatments have been attempted to treat chronic pain conditions, including knee pain. Some of these interventions might be classified as dietary supplements or as complementary or alternative treatments.(962-965) These include homeopathic treatments, naturopathic treatments, vitamins, herbal remedies (certain exceptions discussed below), spiritual healing, touch for healing, craniosacral therapy, aromatherapy, energy healing, and neural therapy. Most of these do not have any quality evidence of efficacy. Some controversy surrounds the issue of the value of placebo effects in healing.(966) There are many interventions shown to be efficacious for the treatment of acute, subacute, and/or chronic pain and it is strongly recommended that patients be treated with therapies proven to be efficacious, whether the intervention is considered complementary.

Complementary or Alternative Treatments, Dietary Supplements, Etc., for Acute, Subacute, or Chronic Knee Pain

Complementary and alternative treatments and dietary supplements, etc., are not recommended for treatment of acute, subacute, or chronic knee pain, as they have not been shown to produce meaningful benefits or improvements in functional outcomes.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

As there is no evidence of their efficacy, complementary and alternative treatments including dietary supplements, etc., are not recommended.

Evidence for the Use of Complementary or Alternative Treatments Dietary Supplements, Etc.

There is 1 high-(967) and 4 moderate-quality(968-971) RCTs incorporated into this analysis. There are 2 low-quality RCTs in Appendix 1.(972, 973)

HERBAL AND OTHER PREPARATIONS

Many complementary and alternative treatments, including herbal treatments, have been used to treat chronic knee pain, especially pain due to osteoarthrosis.(974) Most of these treatments do not have any quality evidence of efficacy.(975) However, there are some remedies which may be efficacious in the management of acute LBP and osteoarthrosis. White willow bark (Salix) extract has been studied in LBP. A principal ingredient is salicin, with salicylic acid as the principal metabolite. Daily doses of 240mg salicin, approximately equivalent to 50mg of acetylsalicylate (which was sufficiently low as to suggest that this may not be the sole reason for its analgesic effect), have been shown to be more effective than placebo in alleviating pain and improving physical impairment scores in patients with acute LBP, with gastrointestinal complaints occurring no more frequently than with placebo. Topical copper salicylates have also been used for treatment of arthrosis.(976, 977) Extract of *Harpagophytum procumbens* (devil's claw root) has been used in Europe to treat musculoskeletal symptoms, and there is some evidence that it may relieve acute LBP, acute episodes of chronic LBP, and osteoarthrosis more effectively than placebo in doses that have consisted of the equivalent of 50 to 100mg of harpagoside daily. Mild gastrointestinal upset has been reported at higher doses. Other treatments include ginger extract(978-986) , rose hips,(987-996) s-adenosylmethionine,(997-1007) Camphora molmol, Maleluca alternifolia, Angelica sinensis, Aloe vera, Thymus officinalis, Menthe peperita, Arnica Montana,(1008) Curcuma longa, Tancaetum parthenium, avocado soybean unsaponifiables,(912, 1009-1019) oral enzymes,(1020-1025) and others.(1026-1029)

Willow Bark (Salix), Ginger Extract, Rose Hips, Camphora Molmol, Maleluca Alternifolia, Angelica Sinensis, Aloe Vera, Thymus Officinalis, Menthe Peperita, Arnica Montana, Curcuma Longa, Tancaetum Parthenium, and Zingiber Officinicalis, Avocado Soybean Unsaponifiables, Oral Enzymes, Topical Copper Salicylate, S-Adenosylmethionine, and Diacerein Harpagoside for Acute, Subacute, or Chronic Knee Pain
There is no recommendation for or against use of willow bark (Salix), ginger extract, rose hips, camphora molmol, maleluca alternifolia, angelica sinensis, aloe vera, thymus officinalis, menthe peperita, arnica montana, curcuma longa, tancaetum parthenium, and zingiber officinicalis, avocado soybean unsaponifiables, oral enzymes, topical copper salicylate, S-Adenosylmethionine, or diacerein harpagoside for treatment of acute, subacute, or chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
Most of these agents have no quality evidence available (e.g., Camphora molmol, Maleluca alternifolia, Angelica sinensis, Aloe vera, Thymus officinalis, Menthe peperita, Arnica Montana, Curcuma longa, Tancaetum parthenium, Harpagoside) for acute, subacute, or chronic knee pain. Some have conflicting results, e.g., willow bark (Salix),(1030, 1031) rose hips, avocado soybean unsaponifiables, and ginger extract. Still others have no quality studies comparing the active ingredient with placebo (e.g., S-Adenosylmethionine, harpagoside, oral enzymes), and one agent appears ineffective (copper salicylate).

None of these agents has had a standardized dose, resulting in a lack of clarity of patient dosing. All of the studies comparing the agent to a standard NSAID dose found the NSAID superior. Only those studies with lower doses of NSAIDs found evidence suggesting equivalency (see herbal and other preparations evidence table). These agents are not invasive, have unclear adverse effect profiles, and over time are moderate to highly costly. There is no recommendation for or against use of these agents.

Evidence for the Use of Herbal and Other Preparations
There are 12 high- and 14 moderate-quality RCTs or crossover trials incorporated into this analysis. There are 4 low-quality RCTs in Appendix 1.(986, 993, 1025, 1032)

DIACEREIN (Diacerhein)

Diacerein is an alternative pharmaceutical therapy developed for the treatment of osteoarthrosis and purported to have inhibitory action on interleukin-1, metalloproteases and other inflammatory mediators involved in cartilage destruction in in vivo and animal models, including of inflammatory arthropathies.(1033-1041) It also stimulates prostaglandin E_2 synthesis without affecting phospholipase A_2, cyclooxygenase (COX), or lipoxygenase, and thus does not affect the gastric mucosa.(1042) Diacerein has been used as a disease modifying agent in patients with moderately progressive joint narrowing.(1043-1046) It is available by prescription in only a few countries in Asia and Europe, and it is not currently available in the U.S. The adverse effect profile is generally significantly higher than placebo, mostly due to higher incidence of diarrhea(1034, 1047) and darkening of the urine, and the magnitude of its effects on pain are small.(1035) Diacerein is not widely available and may not be a treatment option for most patients. Optimal dose has been suggested to be 50mg twice daily.(1034) It may be an alternative to NSAIDs as a second- or third-line treatment, particularly for patients with a history of upper gastrointestinal bleeding, as it appears to be potentially associated with lower rates of gastric lesions.(1042) However, one quality study suggests NSAIDs are superior to diacerein for relief of pain.(1047) There are a few quality studies of diacerein in knee or combinations of hip and knee osteoarthrosis patients in this analysis.(1034, 1048-1057)

Diacerein for Treatment of Osteoarthrosis
There is no recommendation for or against the use of diacerein for the treatment of knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
Of the eight high- or moderate-quality studies evaluating diacerein, all five that compared it against placebo demonstrated modest pain relief from diacerein.(1034, 1043, 1048) A study to establish dose-response showed statistically significant improvement of symptoms with 50, 100, and 150mg daily dose, but with fewest side effects and best efficacy with the 100mg per day group.(1034) There is evidence suggesting that the effects of diacerein last weeks to months after cessation of therapy,(1047, 1048) which is not the case for NSAIDs.(1047) In addition to the symptomatic relief reported, there is one high-quality study of the hip that demonstrated a significant difference in joint space narrowing versus placebo.(1043) A 2x2 factorial study of the hip comparing diacerein, tenoxicam, diacerein with tenoxicam and placebo demonstrated early efficacy of tenoxicam. However, after 4 weeks, the diacerein plus placebo group also reached statistically significantly better symptomatic relief than placebo alone.(1047) There was no added synergistic effect; diacerein plus tenoxicam was no better or worse than each alone.

Examination of diacerein efficacy in two studies that used diacerein as one of the control arms rather than the main active research arm were not as conclusively in favor of diacerein. A comparison of diacerein to hyaluronic acid intra-articular injections over 1 year did not demonstrate diacerein to be more effective than an oral placebo, but the study had significant methodological weaknesses including a possible placebo effect of intra-articular injection masking the effect of oral diacerein treatment.(1058) Two studies comparing diacerein to Harpagophytum procumbens (Devil's Claw Root)

demonstrated both to be effective in improving pain and functional scores over baseline, but there was no placebo group for comparison.(1059, 1060)

Evidence for the Use of Diacerein
There are 6 high- and 4 moderate-quality RCTs or randomized crossover trials incorporated in this analysis.

Devices

Some patients with knee pain might benefit from limited use of devices, particularly as an assistive aid while improved or full function is sought. These aids include crutches, walkers, canes, motorized scooters, heel wedges and insoles, and functional braces.(1061-1075) However, aids might also be detrimental, as they may discourage therapeutic physical activity. In general, a device is **Recommended, Insufficient Evidence (I)** when it is either part of a plan to regain better or normal function or it is essential to achieve the maximum function possible within the limits of fixed defects (see diagnostic sections for devices used for specific disorders).

BRACING/SLEEVES/LATERAL WEDGES

Knee bracing has been used for some cases of knee osteoarthrosis.(1076, 1077) Braces include unloader or off-loader braces designed to reduce force on one tibiofemoral compartment.(1078-1085) Most commonly, an "off-loader" brace has been utilized to attempt to reduce force on the medial compartment in cases of medial or largely medial joint OA. They also have been utilized to prevent sports injuries, especially in football athletes,(1086-1091) although there are concerns that the use of a brace leads to reduced performance.(1090) Knee sleeves and other appliances have also been utilized. Foot orthotics, most commonly lateral wedges, have been used to attempt to redirect force from the medial compartment to the lateral compartment in patients with primarily medial compartment disease.(1092-1094)

Off-loader Braces for Knee Osteoarthrosis
Off-loader braces are recommended for treatment of select patients with medial joint osteoarthrosis.

Indications **–** Patients should generally have attempted other non-operative treatments, including NSAIDs, analgesics, weight loss, exercise and glucocorticosteroid injections. Additionally, patients must be highly motivated to be compliant with the device.

Strength of Evidence – **Recommended, Evidence (C)**

Knee Braces for Moderate to Severe Chronic Knee Osteoarthrosis
Knee braces (e.g., unloader braces) are recommended for treatment of moderate to severe chronic knee pain due to osteoarthrosis (medial or lateral joint OA) that is largely or totally unicompartmental.

Indications – Moderate to severe chronic unicompartmental (e.g., medial) knee osteoarthrosis, particularly if other treatments have failed and device is used in an attempt to delay surgical treatment.(1062, 1095, 1096) Patient must be motivated to comply with brace use.

Strength of Evidence **– Recommended, Evidence (C)**

Knee Braces for All Other Osteoarthrosis
There is no recommendation for or against the use of knee braces (e.g., unloader braces) for treatment of all other osteoarthrosis including symmetrical OA.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Sleeves for Knee Osteoarthrosis

Sleeves are moderately not recommended for the treatment of knee osteoarthrosis.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Neoprene Knee Sleeves for Moderate to Severe Chronic Knee Osteoarthrosis

There is no recommendation for or against use of neoprene knee sleeves for treatment of knee osteoarthrosis.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Lateral Wedges for Medial Compartment for Knee Osteoarthrosis

Lateral wedges are moderately not recommended for treatment of medial compartment knee osteoarthrosis.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Post-operative Braces for Knee Arthroplasty Patients

Post-operative knee braces are moderately not recommended for knee arthroplasty patients.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Rationale for Recommendations

There are a few moderate-quality trials that have addressed bracing for unicompartmental osteoarthrosis. Two trials comparing bracing with no bracing or usual care found bracing to be superior,(1095, 1096) while another trial comparing bracing with usual care and usual-care-only found bracing beneficial.(1062) One trial suggested bracing to be superior to neoprene sleeves.(1095) Another crossover trial suggested a valgus brace was superior to a simple hinged brace.(1097) Thus, there is moderate-quality evidence that unloader bracing is helpful in the short- to intermediate-term. There is no recommendation for or against the use of neoprene sleeves as there is moderate-quality evidence braces are superior(1095) and the evidence for neoprene sleeves compared to no treatment or another treatment is sparse. Thus, the evidence from moderate quality trials suggests these devices have modest benefits. They are not invasive and have low adverse effects, although compliance and ability to tolerate them are problematic. Thus, they are recommended for recommended for select patients with moderate to severe osteoarthrosis that is either largely in the medial or lateral compartments. Patients must be willing to comply with treatment.

Knee sleeves have been evaluated in moderate quality trials and have not been found to produce clinically meaningful benefits.(1095, 1098, 1099) Thus, knee sleeves are not recommended. One trial attempted blinding of shoes with wedges and suggested no differences with lateral wedging.(1092) One trial compared lateral wedges to knee braces and found comparable results,(1094) while another trial was negative.(1093) Thus, the quality trials suggest a lack of efficacy.

Two moderate-quality trials both suggested a lack of benefit from post-arthroplasty bracing.(1100, 1101) Thus, post-operative bracing is not recommended.

Evidence for the Use of Knee Braces, Sleeves and Lateral Wedges for Knee Osteoarthrosis

There are 12 moderate-quality RCTs or crossover trials incorporated into this analysis.

ORTHOSES (including wedged insoles)

Orthoses have been used for treatment of knee osteoarthrosis.(1063, 1067, 1070, 1092, 1102-1115)

Orthoses for Moderate to Severe Chronic Knee Osteoarthrosis

Orthoses (lateral wedges for medial joint disease) are moderately not recommended for treatment of moderate to severe chronic knee pain due to osteoarthrosis.

Strength of Evidence **– Moderately Not Recommended, Evidence (B)**

Rationale for Recommendation

There are eight moderate-quality trials of orthoses in osteoarthrosis.(1092, 1093, 1114, 1116-1120) The highest quality trial was a randomized crossover trial that reported a lack of benefit from lateral wedging.(1116) The next highest quality studies included two reports and a 2-year follow-up report that found no meaningful benefit of orthoses.(1093, 1117) There are no trials comparing braces and orthoses. Lateral edge insoles and similar devices are not invasive, have few adverse effects, are low cost, but are not effective and thus are not recommended.

Evidence for the Use of Orthoses for Osteoarthrosis

There are 8 moderate-quality RCTs or randomized crossover trials incorporated into this analysis. There are 6 low-quality RCTs in Appendix 1.

CANES AND CRUTCHES

Canes and Crutches for Moderate to Severe Acute, Subacute, or Chronic Knee Pain

Canes and crutches are recommended for treatment of moderate to severe acute knee pain or subacute and chronic knee pain when the device is used to advance the activity level.

Indications – Moderate to severe acute knee pain or subacute or chronic knee pain, particularly when the device is utilized to increase activity level.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

Crutches and canes may be helpful for treating acute injuries during the recovery phase. They also may be helpful during the rehabilitative phase to increase functional status (e.g., from wheelchair to walker to cane). However, for chronic knee pain, crutches may paradoxically increase disability through debility. In those circumstances, institution or maintenance of advice for crutch or cane use should be carefully considered against potential risks.

Evidence for the Use of Canes and Crutches

There are no quality studies evaluating the use of canes and crutches for knee pain.

MOTORIZED SCOOTERS

Motorized scooters have been used for treatment of severe knee arthrosis.(1121)

Motorized Scooters for Severe Chronic Knee Osteoarthrosis

Motorized scooters are recommended for highly select patients who have severe chronic knee pain due to osteoarthrosis.

Indications – Severe chronic knee osteoarthrosis accompanied by major impairment in mobility that has either not responded well to arthroplasty and/or other significant impairments are present that

necessitate use of a motorized scooter. Patients should also have had inadequate response to multiple other treatments including at least 2 different NSAIDs, aerobic exercise, strengthening exercise, weight loss, and aquatic therapy program.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There is one moderate-quality trial of intermittent motorized scooter use in knee osteoarthrosis patients.(1121) The trial reported no meaningful increases in manual activity and long-term effects, including deconditioning, are unclear. Scooters are costly; thus, they are recommended for highly select use.

Evidence for the Use of Motorized Scooters for Knee Osteoarthrosis
There is 1 moderate-quality RCT incorporated into this analysis.

MAGNETS AND MAGNETIC STIMULATION

High intensity magnetic stimulation purportedly causes depolarization of nerves and has been found to result in an antinociceptive effect in rats.(1122) Electromagnetic fields have also been reported to increase osteoblastic activity.(1123) Therefore, proponents of magnet therapy believe that magnetic fields have value in the treatment of musculoskeletal disorders. Many studies of magnet therapy have been negative, although several studies have reported benefits.(1124, 1125) Magnets have been studied in rheumatoid arthritis,(1126) which is beyond the scope of this guideline.

Magnets and Magnetic Stimulation for Osteoarthrosis, Acute, Subacute and Chronic Knee Pain
There is no recommendation for or against the use of magnets and magnetic stimulation for treatment of osteoarthrosis or acute, subacute and chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are quality sham-controlled trials that evaluate the use magnets for treatment of knee osteoarthrosis. However, it cannot be assumed that subjects in these trials were successfully blinded.(1127-1131) One trial reported that most of the subjects accidentally or purposefully were unblinded to the intervention,(1127) and other trials did not report on the success of blinding. Therefore, the evidence base is limited. One trial that included a sham control (active magnets that were shielded from the skin) did not find meaningful outcomes at follow-up.(1127) While magnets are not invasive, have no adverse effects, and are relatively inexpensive, there is no quality evidence of their intermediate- or long-term efficacy and other treatments have proven efficacy; thus, there is no recommendation for or against their use.

Evidence for the Use of Magnets and Magnetic Stimulation
There is 1 high- and 4 moderate-quality RCTs incorporated into this analysis.

Pulsed Electromagnetic Fields

High-intensity magnetic stimulation purportedly causes depolarization of nerves and has been found to result in an antinociceptive effect in rats.(1122, 1132) Electromagnetic fields have been known to increase osteoblastic activity. Therefore, proponents believe that magnetic fields have therapeutic value in the treatment of musculoskeletal disorders.

Pulsed Electromagnetic Fields for Osteoarthrosis and Acute, Subacute, or Chronic Knee Pain
There is no recommendation regarding pulsed electromagnetic fields for the treatment of osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of Evidence- **No Recommendation, Insufficient Evidence (I)**
Level of Confidence – **Low**

Rationale for Recommendation
There are multiple trials of magnetic fields and the evidence substantially conflicts regarding efficacy.(1133-1139) One trial for knee OA suggested benefits in VAS and WOMAC scores (2469). A moderate-quality study using PEMF after ACL reconstruction found significant recovery compared to placebo.(1140) A moderate-quality study evaluated PEMF after arthroscopic surgery and reported improved recovery at 3 years and decreased NSAID use 45 days post-operatively.(1141) These results require replication. Magnetic field treatments are not invasive, have no adverse effects, but as they are moderately costly and multiple studies suggest no benefit, there is no recommendation.

Evidence
A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: pulsed electromagnetic field; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 19 articles in PubMed, 268 in Scopus, 15 in CINAHL, 20 in Cochrane Library, 1,640 in Google Scholar, and 0 from other sources. We considered for inclusion 7 from PubMed, 2 from Scopus, 2 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 9 from other sources. Of the 11 articles considered for inclusion, 16 randomized trials and 4 systematic reviews met the inclusion criteria.

Physical Methods

HOT AND COLD THERAPIES

It has been proposed that cold and heat have actual therapeutic benefits to modify the disease processes (e.g., cold to allegedly reduce acute inflammation and swelling and heat to speed healing through increased blood supply).(1142, 1143) However, it has been proposed that these various modalities are distractants that apparently do not materially alter the clinical course.(1144) Still, it is postulated that the distractants allow increased activity levels.(1145) Many patients with chronic pain report a temporary soothing effect from the application of heat or the use of ice packs in the home setting. Cryotherapies have also been utilized in peri- and post-operative patients to speed healing and attempt to reduce opioids requirements.(1146-1155)

Cryotherapies

Cold or cryotherapies involve application of cold or cooling devices to the skin. They have been used for treatment of non-operative pain and post-operative pain.(1156)

Home Use of Cryotherapies for Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain
Cryotherapies are recommended for home use if efficacious for the temporary relief of osteoarthrosis or acute, subacute, or chronic knee pain.

Frequency/Duration – Education regarding home cryotherapy application may be part of the treatment if cold is effective in reducing pain.

Indications for Discontinuation – Non-tolerance, including exacerbation of knee pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Cryotherapy for Treatment of Knee Arthroplasty and Arthroscopy and Other Surgery Patients
Cryotherapy is recommended for select treatment of knee arthroplasty and surgery patients.

Frequency/Duration – Pain relief with cold therapy for the first several post-operative days with duration commensurate with extent of surgery. Some devices may be helpful for select patients, particularly if they are unable or unwilling to tolerate other measures to manage pain.

Indications for Discontinuation – Non-tolerance, adverse effects.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
There is one trial in non-operative patients, but it is difficult to develop evidence-based guidance as that trial is likely biased in favor of cryotherapy.(1157) While cryotherapy is generally not helpful in patients with osteoarthrosis, a small minority may find benefit. Thus, cryotherapy is recommended as a potential distractant or counter-irritant and is recommended for self-application.

There are many post-operative studies, although few are moderate in quality with significant methodological limitations. The available studies confirm that there is no effect of cryotherapy on swelling. Nearly all studies also show that cryotherapy has no significant impact on blood loss. The available quality trials conflict with two suggesting no benefit (one compared cold therapy with lukewarm water(1146)) and one suggesting benefits, including opioid sparing (compared cold therapy with traditional post-operative regimens not including epidural anesthesia(1152)).

Self applications of cryotherapies using ice bags, towels or reusable devices are non-invasive, minimally costly, and without complications. Other forms of cryotherapy are moderately costly and may be reasonable for selected patients who are unwilling to undergo epidural anesthesia or have other indications for these devices.(1152)

Evidence for the Use of Cryotherapies
There are 5 moderate-quality RCTs incorporated into this analysis. There are 7 low-quality RCTs in Appendix 1. requirements.(596, 1147-1149, 1151, 1154, 1158)

Heat Therapies

Many forms of heat therapy have been used to treat musculoskeletal pain including hot packs, moist hot packs, sauna, warm baths, infrared, diathermy, and ultrasound. The depth of penetration of some heating agents is minimal since transmission is via conduction or convection, but other modalities have deeper penetration.(1159) A particular methodological problem with most studies of heat therapy is that, despite occasional attempts at, and claims of, successful blinding, it is impossible to blind the patient to these interventions, as they produce noticeable, perceptible tissue warming. Not surprisingly, some of these heat-related modalities have been shown to reduce pain ratings more than placebo for patients with low back pain. It is less clear whether there are meaningful, long-term benefits. Heat therapies are passive treatments. In chronic pain settings, use of heat should be minimized to self-treatments of flare-ups with primary emphasis on functional restoration elements (e.g., exercises).

Self-application of Heat Therapy for Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain
Self-application of low-tech heat therapy is recommended for treatment of osteoarthrosis or acute, subacute, or chronic knee pain.

Indications – Applications may be periodic or continuous and should be home-based, as there is no evidence for efficacy of provider-based heat treatments. Primary emphasis should generally be on functional restoration program elements, rather than on passive treatments in patients with chronic pain.

Frequency/Duration – Self-applications may be periodic. Education regarding home heat application should be part of the treatment plan if heat has been effective for reducing pain.

Indications for Discontinuation – Intolerance, increased pain, development of a burn, other adverse event.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
Self-application of heat using towels or reusable devices is non-invasive, minimally costly, and without complications. There is one trial with heat administered by a sleeve that failed to find evidence of efficacy.(1160) Another trial evaluated heat and cold as an adjunctive treatment for stretching along with a prior treatment with heat and found cold to be superior.(1157) A third trial compared ice water to lukewarm water to crushed ice, but found no benefit in the early post-operative stage due to decreased knee temperature.(1146) While they are generally not helpful in patients with osteoarthrosis, heat therapy may be helpful in a small minority, and thus is recommended as self-treatment as potential distractant or counter-irritant. It may also be helpful for purposes of stretching when there is a limited range of motion. Some forms of heat can be considerably more expensive, including chemicals, and are not recommended.

Evidence for the Use of Heat Therapy
There are 3 moderate-quality RCTs incorporated into this analysis.

ULTRASOUND

There are many commercial modalities that deliver heat; these generally differ on how deeply the heat is felt. None of these modalities have demonstrated major efficacy for any disorder, however there have been limited uses for treatment of specific disorders with a specific intervention (see Hand, Wrist, and Forearm Disorders, Elbow Disorders, Low Back Disorders, and Chronic Pain guidelines). There are more trials that include ultrasound to treat the knee than the hip.(1161)

Ultrasound for Treatment of Knee Osteoarthrosis

There is no recommendation for or against the use of ultrasound therapy for knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

The highest quality trial comparing ultrasound with sham treatment found a lack of benefit.(1162) The moderate quality trials conflict – some suggest benefits,(577, 1163, 1164) while others suggest a lack of benefit.(575, 1165) Given that results conflict, there is no recommendation for or against ultrasound for treatment of knee OA.

Evidence for the Use of Ultrasound for Knee Osteoarthrosis

There is 1 high- and 5 moderate-quality RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 1.(1166)

PHONOPHORESIS

Phonophoresis for Knee Osteoarthrosis

Phonophoresis is not recommended for knee osteoarthrosis.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation

There is one moderate-quality study evaluating phonophoresis with ibuprofen compared to ultrasound and found no difference between the two therapies. The authors reported that both groups were improved over the 2 weeks of therapy.(1167) Thus, as there is not evidence of efficacy, phonophoresis is not recommended.

Evidence for the Use of Phonophoresis for Knee Osteoarthrosis

There is 1 moderate-quality RCT incorporated into this analysis.

MASSAGE

Massage is a commonly used treatment for chronic muscular pain and usually administered by multiple health care providers as well as family or friends. It is most typically used for treatment of spine and torso pain (see Chronic Pain and Low Back Disorders guidelines), although it has been used for the treatment of knee pain.(1168, 1169)

Massage for Knee Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain

There is no recommendation for or against the use of massage for knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
Massage is a commonly used treatment for musculoskeletal pain, but few studies evaluated disorders other than LBP.(1170-1172) There is one moderate-quality trial for treatment of knee OA. However, significant limitations of the study include randomization failure and use of wait-listed controls, thus biasing the study in favor of massage. While massage is not invasive and has few adverse effects, it is moderately to highly costly (when professionally administered), depending on the number of treatments. Also, other treatments with documented efficacy are available.

Evidence for the Use of Massage
There are 2 moderate-quality RCTs incorporated into this analysis.

REFLEXOLOGY

Reflexology is a complementary or alternative treatment. It entails the physical act of applying pressure to the feet and hands with specific thumb, finger, and hand techniques without the use of oil or lotion. Reflexology is based on a system of zones and reflex areas that reflect an image of the body on the feet and hands. Work on the feet and hands are thought to effect physical changes to the body.

Reflexology for Knee Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain
Reflexology is not recommended for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality studies of reflexology for knee pain. It also has not been shown to be efficacious for the treatment of chronic LBP in a moderate-quality study.(1173) Other treatments have been shown to be efficacious.

Evidence for the Use of Reflexology
There are no quality studies evaluating the use of reflexology for knee osteoarthrosis or acute, subacute, or chronic knee pain.

Acupuncture

Acupuncture has been used to treat many musculoskeletal conditions including hip(1174) and spine pain and osteoarthrosis, particularly of the knee,(486, 1175) and there is some evidence that patients seek this treatment if they have more severe pain.(1176) Multiple techniques have been used, including manual needle stimulation, electrical needle stimulation(1177-1179) (electroacupuncture), superficial dry needling, and deep dry needling.(1180, 1181) Acupuncture administration may involve moxibustion and cupping.(1182) Moxibustion is a traditional Chinese therapy involving burning of an herb (mugwort) to stimulate blood flow and balance “Qi.” Cupping is another ancient Chinese practice involving placement of a cup on the skin with negative pressure induced either through heat or suction with tension placed on the underlying tissue. Besides traditional acupuncture, there are many other types of acupuncture that have arisen, including accessing non-traditional acupuncture points.(1183) Quality evidence has documented that use of traditional acupuncture locations is not necessary to derive equivalent benefits from treatment of low back pain (see Chronic Pain and Low Back Disorders guidelines).(1184-1186)

Acupuncture for Chronic Osteoarthrosis of the Knee

Acupuncture is moderately recommended for select use for treatment of chronic osteoarthrosis of the knee as an adjunct to more efficacious treatments.

Indications – Moderate to severe chronic osteoarthrosis of the knee. Prior treatments should include NSAIDs, weight loss, and exercise, including a graded walking program and strengthening exercises. Should be considered as an adjunct to a conditioning program that has resulted in insufficient clinical response.

Frequency/Duration – A limited course of 6 appointments(1187) with clear objective and functional goals to be achieved. Additional appointments would require documented functional benefits, lack of plateau in measures and probability of obtaining further benefits. There is quality evidence suggesting traditional acupuncture needle placement may be unnecessary(1188) and that superficial needling is as successful as deep needling.(1189, 1190) There is evidence suggesting it is not necessary to perform bilateral needling,(1191) although that result has not been replicated.

Indications for Discontinuation – Resolution, intolerance, and non-compliance, including non-compliance with aerobic and strengthening exercises.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Acupuncture for Acute or Subacute Knee Pain

There is no recommendation for or against the use of acupuncture for the treatment of acute or subacute knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

There are several high- and moderate-quality studies that evaluated acupuncture for the treatment of knee osteoarthrosis.(1190, 1192-1204) Trials of auricular acupuncture suggests efficacy in reducing analgesia requirements peri-operative,(1205) intra-operative,(1206) and post-operative.(1174) Some have concluded that the evidence suggests that there is no effect of acupuncture on pain.(1012) Some trials have combined acupuncture with electrical currents, others have applied electrical currents to acupuncture sites,(1201, 1207, 1208) and one involved periosteal stimulation.(1209) There are no quality studies to show clear benefit of electroacupuncture over needling. There continue to be some questions about efficacy of acupuncture,(1210, 1211) with concerns about biases, e.g., attention and expectation bias in these study designs as well as the adequacy of placebo acupuncture treatments.(1212, 1213) One trial demonstrated acupuncturist behaviors to set positive expectations had a significant impact on outcomes from acupuncture.(1214)

Studies reporting results after the cessation of acupuncture have nearly all found lasting benefits,(1187, 1192, 1215) although there are no long-term follow-up reports. Although not all studies have been positive,(1216) acupuncture has been found to be superior to no acupuncture ,(1192, 1217) superior to more of the same medication,(1202) superior to usual care,(1218-1221) and also an additive benefit to an NSAID.(1198) Results of three trials involving shams have indicated the sham was approximately equivalent to acupuncture,(1189, 1190, 1222) but acupuncture(1196) and electroacupuncture(1207) were superior to sham in two other trials. High-quality studies with sizable populations and long follow-up periods are needed for all of these potential indications. Acupuncture when performed by experienced professionals is minimally invasive, has minimal adverse effects, and is moderately costly. Despite significant reservations regarding its true mechanism of action, a limited course of acupuncture may be recommended for treatment of knee osteoarthrosis as an adjunct to a conditioning and weight loss program. Acupuncture is recommended to assist in increasing functional activity levels more

rapidly. Primary attention should remain on the conditioning program. Acupuncture is not recommended for those not involved in a conditioning program or who are non-compliant with graded increases in activity levels.

Evidence for the Use of Acupuncture
There are 8 high- and 16 moderate-quality RCTs incorporated into this analysis. There are 4 low-quality RCTs in Appendix 1.

MANIPULATION AND MOBILIZATION

Manipulation and mobilization are two types of manual therapy. Manipulation has been used to treat knee disorders.(571, 1223-1243) It has been particularly utilized for post-operative patients with inadequate range of motion that affects function that is sometimes termed arthrofibrosis.(1223, 1229, 1232, 1244, 1245) There is quality evidence of efficacy of manipulation particularly for treatment of acute low back pain and neck pain (see Low Back Disorders, and Cervical and Thoracic Spine Disorders guidelines).

Manipulation or Mobilization for Acute Knee Pain, Knee Osteoarthrosis, or Surgical or Knee Fracture Patients
There is no recommendation for or against the use of manipulation or mobilization for treatment of acute knee pain, knee osteoarthrosis, or for surgical or knee fracture patients.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Manipulation or Mobilization for Subacute or Chronic Knee Pain
Manipulation or mobilization is recommended for patients with subacute or chronic knee pain.

Strength of Evidence – **Recommended, Evidence (C)**

Manipulation or Mobilization for Post-operative Patients with Significantly Reduced Range of Motion
Manipulation or mobilization is recommended for select post-operative patients with significantly reduced range of motion.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
There are no quality trials of manipulation or mobilization compared with sham or incorporating a clinical prediction rule that demonstrate efficacy. There is quality evidence of efficacy for manipulation or mobilization in treating knee osteoarthrosis,(571, 1226, 1246) but further quality studies are needed, as it is difficult to separate out the effect of other interventions included such as exercise. There is one high-quality study of manipulation in hospitalized knee and hip patients that found a lack of efficacy.(1247) However, this study did not include treatment to the hip or knee. Despite these study weaknesses, the orthopaedic manual physical therapy (OMPT)[xiv] approach(571, 1226) is believed to provide clinically important benefit for patients with knee OA. This treatment approach has been suggested to reduce the need for medication and total knee replacement. However, from the design of these pragmatic trials it cannot be determined what aspect of the OMPT approach is most responsible

[xiv]OMPT is a formalized type of physical therapy based on skills developed with entry level professional programs through advanced fellowship training. OMPT generally includes: 1) a manual examination to identify impairments to movement, strength, coordination, and balance, and to identify symptom producing structures; 2) manual interventions to determine techniques and movements to reduce symptoms and improve function; 3) exercise prescription that reinforces movement from manual treatment and provides the appropriate dose of strengthening and/or balance exercises.

for the improvement. Manipulation is not invasive, has low adverse effects, but is moderately costly depending on the number of treatments. There is no recommendation for or against use in these patients, with the exception of patients with subacute or chronic knee pain or select post-operative patients.

Evidence for the Use of Manipulation or Mobilization
There are 1 high- and 8 moderate-quality RCTs incorporated in this analysis. There are 2 low-quality RCTs in Appendix 1.

MANIPULATION UNDER ANESTHESIA (MUA)

Manipulation under Anesthesia for Post-operative Patients with Significantly Reduced Range of Motion
Manipulation under anesthesia is recommended for select post-operative patients with significantly reduced range of motion. This may be performed selectively under general or regional anesthesia typically by the operating orthopedist.(1245)

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There is no quality evidence of efficacy of manipulation of the knee, typically performed under anesthesia but also commonly performed by physical therapists, for post-arthroplasty patients with insufficient range of motion.(1225, 1228, 1230, 1248, 1249) One low-quality trial suggested significantly improved range of motion immediately after MUA in the manipulated group compared with the group that declined manipulation with differences persisting for 2 years.(1228) For patients with insufficient range of motion, manipulation under anesthesia is modestly invasive, has adverse effects, and is moderately costly, but it appears helpful for some patients to improve range of motion. Thus, it is a viable option for selected use.

LOW-LEVEL LASER THERAPY

Low-level laser treatment (LLLT) usually involves laser energy that does not induce significant heating. Low-level laser exposures are theorized to induce photoactivation of the oxidative chain.(1250-1252) LLLT is low risk and without significant reported side effects.(1253)

Low-level Laser Therapy for Knee Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain
The use of low-level laser therapy is not recommended for treatment of osteoarthrosis and acute, subacute, or chronic knee pain.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation
There are several moderate-quality trials that evaluated use of low level laser therapy for treatment of knee pain and osteoarthrosis,(1252, 1254-1258) and while they conflict on efficacy to some extent,(1259) most trials with sham are negative.(1260, 1261) LLLT is not invasive, has low adverse effects, is moderately to highly costly based on the number of treatments required, has mostly negative results in quality trials for the treatment of the knee, and other effective treatment options exist. Thus, LLLT is not recommended for treatment of knee pain or osteoarthrosis.

Evidence for the Use of Low-Level Laser Therapy for Knee Pain or Osteoarthrosis
There is 1 high- and 7 moderate-quality RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 1.

Electrical Therapies

There are multiple forms of electrical therapies used to treat musculoskeletal pain. These include electrical stimulation therapies, iontophoresis, interferential therapy (IFT or IT), microcurrent therapy, percutaneous electrical nerve stimulation (PENS), and transcutaneous electrical stimulation (TENS).(1138, 1262-1268) The mechanism(s) of action, if any, are unclear.

ELECTRICAL STIMULATION THERAPIES

Neuromuscular electrical stimulation has been used particularly to strengthen the quadriceps femoris.(1269-1272) Many studies using electrical stimulation have been reported both for treating patients with osteoarthrosis,(1273) patellofemoral pain,(1274) post-surgical knee patients,(1275-1279), as well as in healthy athletes to attempt to improve performance.(1280-1289)

Electrical Stimulation Therapies for Treatment of Knee Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain

There is no recommendation for or against the use of electrical stimulation therapies outside of research settings for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There are is one moderate-quality trial of electrical stimulation in in knee osteoarthrosis patients; however, the results are inconsistent.(1273) There are numerous low-quality trials attempting to address utility of electrical stimulation either alone or as an adjunct to exercise (see Appendix 1). The overall findings in those studies are exercise outperforms electrical stimulation. There are some suggestions electrical stimulation may have modest efficacy in comparison with control. Electrical stimulation is non-invasive, has low adverse effects, but is moderate to high cost with prolonged treatment. Other treatments shown to be effective are available. There is no recommendation for or against the use of these therapies.

Evidence for the Use of Electrical Stimulation Therapies

There is 1 moderate-quality study evaluating the use of electrical stimulation for knee osteoarthrosis and none for acute, subacute, or chronic knee pain. There are 16 low-quality trials in Appendix 1.

IONTOPHORESIS

Iontophoresis for Knee Osteoarthrosis

There is no recommendation for or against the use of iontophoresis for the treatment of knee osteoarthrosis or acute, subacute or chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

There are no quality studies for any of these therapies in occupational populations with knee osteoarthrosis. There is one quality study suggesting efficacy of iontophoresis with morphine for post-operative knee and hip patients(1265); however, applicability to outpatient knee osteoarthrosis populations and others is unclear. Some of these types of electrical therapies are thought to be of greater benefit for certain types of disorders such as iontophoresis with glucocorticosteroid for rheumatoid arthritis knee patients.(1268) These therapies are mostly non-invasive with low adverse effects but are moderately to highly costly when examined in aggregate. Other treatments shown to be

effective are available. There is no recommendation for or against the use of these therapies for knee osteoarthrosis.

Evidence for the Use of Iontophoresis
There are 2 moderate-quality RCTs incorporated into this analysis.

INTERFERENTIAL THERAPY

Interferential Therapy for Post-Operative Knee Patients
Interferential therapy for post-operative ACL reconstruction, meniscectomy, and knee chondroplasty is recommended immediately post-operatively in an elderly population. Patients should be engaged in an appropriate post-operative rehabilitation program in combination with interferential therapy.

Indications – Elderly patients, post-operative from ACL reconstruction, meniscectomy, or knee chondroplasty.(1267)

Duration – At home, 3 times a day for up to 9 weeks.(1267)

Indications for Discontinuation – Unable to participate in active rehabilitation program; no response after 1 to 3 treatments.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendation
There is one moderate-quality placebo-controlled trial among elderly residence home patients reporting improved pain, range of motion, and post-operative edema up to 9 weeks compared to placebo therapy.(1267) (Interferential therapy is not invasive, has few adverse effects, and is moderately costly. As there is evidence of efficacy, it is recommended.

Evidence for the Use of Interferential Therapy
There is 1 moderate-quality RCT incorporated into this analysis.

MICROCURRENT THERAPY

Microcurrent Therapy for Post-Operative Total Knee Arthroplasty Patients
There is no recommendation for or against the use of microcurrent therapy for total knee arthroplasty post-operative pain control.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There is one moderate-quality pilot study reporting improvement in post-operative pain and pain medication use and wound healing and decreased wound drain volumes.(1266) However, that trial was not sham controlled and therefore likely biased in favor of treatment. A single pilot study with these flaws is unable to be used for development of evidence-based guidance. Therefore, there is no recommendation.

Evidence for the Use of Microcurrent Therapy
There is 1 moderate-quality RCT incorporated into this analysis.

PERCUTANEOUS ELECTRIC THERAPY

Percutaneous Electric Therapy for Knee Osteoarthrosis or Other Knee Pain

Percutaneous electric therapy is recommended for assistance with pain control for knee osteoarthrosis or other knee pain.

Indications – As part of an active rehabilitation and exercise program.(1138, 1263, 1264)

Duration – Up to 3 times a week as part of a rehabilitation program.(575, 1290, 1291)

Indications for Discontinuation – Patient unable to participate in active rehabilitation program. No response after first treatment.(1263)

Strength of Evidence – **Recommended, Evidence (C)** (Knee OA)
Recommended, Insufficient Evidence (I) (Other knee pain)

Rationale for Recommendation

Two moderate quality sham-controlled trials evaluated patients with knee osteoarthrosis reporting greater pain control compared to placebo.(1263, 1264) (A low-quality study evaluated PENS in post-operative patients and reported less muscle atrophy in the PENS group.(1292)) A moderate-quality study reported improved patient and physician rated outcomes in the active treatment group after 4 weeks of daily treatment.(1138) Percutaneous Electric Therapy is not invasive, has few adverse effects, is moderately to highly costly, depending on duration of use, and has evidence of efficacy. Thus, it is recommended.

Evidence for the Use of Percutaneous Electric Therapy

There are 2 moderate-quality RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 1.

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

TENS is a modality to control pain through electrical stimulation delivered by pads placed on the surface of the skin. TENS is used for the treatment of many painful conditions, including both non-inflammatory and inflammatory disorders; although it has more typically been used for spine disorders(1293-1299) (see Chronic Pain and Low Back Disorders guidelines).

TENS for Knee Osteoarthrosis or Acute, Subacute, or Chronic Knee Pain

There is no recommendation for or against the use of TENS for knee osteoarthrosis or acute, subacute or chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There are many moderate-quality trials, and one of high-quality(1300) that evalualted TENS for knee pain. Some low-quality trials have suggested modest benefits from TENS,(1301-1304) while others have suggested no benefits.(1305-1308) Seven of the moderate-quality studies did not find any significant improvement with the use of TENS,(575, 1290, 1291, 1309-1312) while nine reported some benefit compared to control.(1177, 1178, 1313-1319) TENS is not invasive, has few adverse effects, and is moderately costly. However, as there are many conflicts in the literature, there is no recommendation for or against its use to treat knee OA or pain.

Evidence for the Use of TENS for Knee Osteoarthrosis and Knee Pain

There is 1 high- and 16 moderate-quality RCTs incorporated into this analysis. There are 8 low-quality RCTs in Appendix 1.

Injection Therapies

There are several types of injections that have been used for patients with knee pain using different approaches. These include intra-articular glucocorticosteroid injections,(1320-1326) viscosupplementation,(922) arthroscopic and non-arthroscopic joint lavage, and prolotherapy injections.(1320) Percutaneous needle tenotomy has been attempted for chronic tendinoses.(1327-1330) Tidal volume irrigation of the knee has been utilized for treatment of both inflammatory arthritides as well as osteoarthroses.(1331-1335) Additionally, radiation synovectomy has been utilized for treatment of patients with undifferentiated arthritis and rheumatoid arthritis.(1336, 1337)

Glucocorticosteroid injections, which have been used for the treatment of rheumatoid arthritis and juvenile idiopathic arthritits, are beyond the scope of this guideline.(1338) Intra-articular methotrexate and orgotein, which have been used for treatment of rheumatoid arthritis, psoriatic arthritis, and other arthritides(1339-1342) and oral methotrexate and leflunomide, which have been used for treatment of rheumatoid arthritis, are also beyond the scope of this guideline.(1343)

Transcranial magnetic stimulation has been used to attempt to make rehabilitation more effective. One small crossover trial with 1 hour follow-up suggested it may make rehabilitation more effective.(1344)

Platelet-Rich Plasma, Plasma Rich in Growth Factor, and Autologous Blood Injections

Autologous blood injections have been used to treat osteoarthritis.(1345-1350) Autologous growth factors can be injected with autologous whole blood or platelet-rich plasma (PRP).(1351) These injections have been evaluated in studies of plantar foot pain, lateral epicondylalgia, and several other disorders.(1351, 1352)

Intraarticular Platelet-Rich Plasma and Plasma Rich in Growth Factor, and Injections for Moderate to Severe Knee Osteoarthrosis

Intraarticular platelet-rich plasma and plasma rich in growth factor are neither recommended nor not recommended for treatment of moderate to severe knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**
Level of Confidence – Low

Autologous Blood Injections for Moderate to Severe Knee Osteoarthorosis

There is no recommendation for or against the use of autologous blood injections for moderate to severe knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**
Level of Confidence – Low

Indications – Re. PRP injections, moderately to severe knee osteoarthrosis with insufficient responses to NSAID/acetaminophen, and exercise. Generally, should also have attempted weight loss. Glucocorticosteroid should generally also be trialed first as there is moderate quality evidence suggesting comparable efficacy (2421, 2422).

Benefits – Improved pain and function, with somewhat conflicting evidence on duration of the benefit being 6- vs. 12+ months (2423,2424).

Harms – Hypertension, proteinuria, diarrhea, constipation, rare infections (2425)

Frequency/Dose/Duration – One injection should be evaluated to ascertain whether it is effective. Although a series of injections has been trialed, there is no clear superiority of a series of injections compared with a single injection (2423, 2424, 2426).

Rationale – There is one quality trial of injections of PRP vs. Hyaluronic acid vs. NSAID and used MRI imaging, and while the symptoms reportedly improved, there was not evidence of efficacy based on MRI results at one year (2427). One trial without placebo-control suggested MRI improvements in the PRP group compared with the HA group, with 48% vs. 8% improving at least one OA grade over 12 months (2418). Several moderate-quality placebo-controlled trials suggest modest benefits of PRP compared with placebo (2423-2424, 2427, 2429-2432); e.g., one trial suggested comparable benefits with either one or two injections at 6 months but superiority compared with placebo yet benefits waned after that point for either 1- or 2-injections (1349); another trial suggested durable benefits at 12 months of a series of three (3) PRP injections compared to placebo (2424); and one trial suggested PRP improved pain and disability (2433). Two moderate-quality trials suggested comparable efficacy to glucocorticoid injection (2421, 2422), with one of those trials suggesting longer duration of the PRP (2422).

There are many moderate- to high-quality trials (1346-1348, 1353, 2434), mostly comparisons against viscosupplementation. Thus, the body of evidence tends to suggest PRP injections tend to be superior to viscosupplementation injections, which appear superior to glucocorticosteroids (see below). With limited and somewhat conflicting placebo-controlled trials, the evidence was considered too limited by the panel for evidence-based recommendations.

PRP injections have also been trialed for preventing post-operative blood loss and have been suggested to improve function in knee arthroplasty patients (2435, 2436). The duration of the benefit was gone at 6 months in one trial (2435), but lasted 12 months in the other trial (2436). PRP has also been trialed with stem cells in a small-sized RCT (2437).

PRP injections are invasive and have a low risk of adverse effects but are high cost. A majority of the Evidence-based Practice Knee concluded that there should be no recommendation for platelet rich plasma injections for moderate to severe knee osteoarthrosis based on the relative lack of, and conflicts among the quality placebo-controlled trials. In addition, the Evidence-base Practice Knee Panel concluded there is insufficient evidence to conclude either for or against a recommendation (57% agreed with no recommendation, 15% thought it should be not recommended and 29% felt it should be recommended) for moderate to severe knee osteoarthrosis based on the lack of quality trials regarding the overall efficacy of these injections. Indications are provided above as a potential appeals process.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Knee Pain, Patellofemoral Pain Syndrome, Knee arthritis, Knee Osteoarthritis, Knee Arthrosis, knee degenerative joint disease, PRP, platelet rich plasma injections, autologous blood injections, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 136 articles in PubMed, 753 in Scopus, 78 in CINAHL, 51 in Cochrane Library, 1920 in Google Scholar, and 4 from other sources. We considered for inclusion 19 from PubMed, 8 from Scopus, 6 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 4 from other

sources. Of the 39 articles considered for inclusion, 35 randomized trials and 4 systematic reviews met the inclusion criteria.

Stem Cell Therapy

Stem cell therapy has been used for treatment of knee osteoarthrosis (2438-2441).

Stem Cell Therapy for Moderate to Severe Knee Osteoarthrosis

Stem cell therapy is not recommended for the treatment of moderate to severe knee osteoarthrosis.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Rationale – There are no sizable placebo- or sham-controlled trials of stem cells. There are only a few small trials that have been reported (2438-2441). Stem cell therpies are invasive, have some adverse effects, are costly, lack clear evidence of efficacy and thus as costs are extremely high, stem cell therapy is not recommended. Most of the panel (57%) felt the recommendation should be not recommended while 43% felt there should be no recommendation.

Evidence – A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2108 using the following terms: stem cells, adult stem cells, mesenchymal stem cells; knee pain, patellofemoral pain syndrome, knee arthritis, knee osteoarthritis, knee arthrosis, knee degenerative joint disease controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 22 articles in PubMed, 1949 in Scopus, 43 in CINAHL, 9 in Cochrane Library, 5530 in Google Scholar, and 5 from other sources. We considered for inclusion 8 from PubMed, 9 from Scopus, 2 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 5 from other sources. Of the 24 articles considered for inclusion, 18 randomized trials and 6 systematic studies met the inclusion criteria.

Viscosupplementation

Viscosupplementation has been used for knee osteoarthrosis (15, 1350, 1355-1372) and to treat pain after arthroscopy and meniscectomy.(1373, 1374, 2442-2446).

Intraarticular Knee Viscosupplementation Injections for Moderate to Severe Knee Osteoarthrosis

Intraarticular knee viscosupplementation injections are neither recommended nor not recommended for treatment of moderate to severe knee osteoarthrosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – Low

Indications – Moderately to severe knee osteoarthrosis with insufficient responses to NSAID/acetaminophen, and exercise. Generally, should also have attempted weight loss.

Glucocorticosteroid should generally also be trialed first as there is moderate quality evidence suggesting comparable efficacy (2421,2422).

Benefits – Improved pain and function, with somewhat conflicting evidence on duration of the benefit.

Harms – Allergic reactions, increased pain, intolerance, rare infections.

Frequency/Dose/Duration – One injection should be evaluated to ascertain whether it is effective. While a series of injections has been trialed, there is no clear superiority of a series of injections compared with a single injection.

Rationale – There are no placebo-controlled trials that used imaging as an objective outcome measure. There is one quality trial of injections of PRP vs. Hyaluronic acid vs. NSAID and used MRI imaging, and while the symptoms reportedly improved, there was not evidence of efficacy based on MRI results at one year (2427). One trial without placebo-control suggested MRI improvements in the PRP group compared with the HA group, with 48% vs. 8% improving at least one OA grade over 12 months (2428).

There are numerous moderate-quality trials comparing injections with viscosupplementation with placebo (see evidence table) (1058, 1375-1383, 2432, 2430, 2447-2449). Most trials show pain reductions from 2-weeks to 6 months and most trials suggesting superiority at approximately 3 months after injection. Yet, multiple high- and moderate-quality trials also suggest a lack of efficacy (1058, 1380, 1382, 1398, 1417, 1422, 1423, 1425, 2447, 2448).

There are many trials comparing injections with viscosupplementation with glucocorticosteroid. Most of these trials comparing viscosupplementation with glucocortoid injection suggested glucocorticosteroid injections are inferior for the knee (1384-1390); however, for the hip the reverse may be true (1383). None of the knee trials reported superior results with glucocorticosteroid. One high-quality trial suggested comparable results until 26 weeks at which point the glucocorticoid appeared to be losing benefit while the benefits of the viscosupplementation had greater persistence.(1389) The next highest quality trial suggested comparable efficacy over 3 months.(1383, 1389)

A moderate-quality, blinded trial reported that viscosupplementation improved articular cartilage appearance significantly compared with glucocorticosteroids,(1386) but those results have not been replicated. One quality trial also documented these injections provide additive benefit over appropriate care (1391) and usual NSAID therapy.(1392)

Sparse quality placebo/sham-controlled treatment trials with follow-up beyond 1 year have been published, with one follow-up trial suggesting lack of durable efficacy (2441). There is one moderate-quality trial reporting a lack of synergism with combined glucocorticoid injection.(1393) There is no clear preponderance of evidence that high or low molecular weight preparations are superior, although one trial suggested hyaluronan tended to be superior(1394). Both resulted in approximately 40% reductions in pain ratings with benefits lasting 6 months. Various combinations of injections have not shown one regimen to be clearly superior.(1395)

Thus, the body of evidence tends to suggest PRP injections tend to be superior to viscosupplementation injections, which appear superior to glucocorticosteroids (see below).

Hyaluronic acid injections are invasive, have moderate adverse effects, are high cost, have mixed efficacy against placebo injections, have lack of durable efficacy, and have evidence suggesting PRP injections may be superior to hyaluronic acid injections. With limited and somewhat conflicting placebo-controlled trials, the evidence was considered too limited by the panel for evidence-based recommendations. The Evidence-based Practice Knee Panel has downgraded the evidence from "C" to "I" and came to a limited conclusion that these injections should be neither recommended nor not recommended for moderate to severe knee osteoarthrosis based on the current understanding of the peer-reviewed literature, the adverse effects, and the overall efficacy of viscosupplementation injections. A minority of panel members (14%) felt these injections should be recommended and others (29%) felt they should be not recommended. Indications are provided for a potential appeals process.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: viscosupplementation, hyaluronic acid, hyaluronan; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 252 articles in PubMed, 8,381 in Scopus, 162 in CINAHL, 200 in Cochrane Library, 2,370 in Google Scholar, and 87 from other sources. We considered for inclusion 46 from PubMed, 16 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 87 from other sources. Of the 149 articles considered for inclusion, 138 randomized trials and 6 systematic studies met the inclusion criteria.

Intraarticular Glucocorticosteroid Injections

Intraarticular glucocorticosteroid injections are frequently performed to attempt to deliver anti-inflammatory medication to the joint with minimal systemic effects.(1336, 1337, 1383, 1390, 1436, 1476-1484) Their usual purpose is to gain sufficient relief to either resume conservative medical management or to delay operative intervention. These injections are generally performed without fluoroscopic or ultrasound guidance. Intraarticular injections have also been utilized intraoperatively at the close of procedures, including meniscectomy (1485) and arthroscopy.(1486, 1487) Periarticular injections have been used in arthroplasty patients(1488) in an attempt to facilitate recovery.

Intraarticular Glucocorticosteroid Injections for Knee Osteoarthrosis
Intraarticular glucocorticosteroid injections are recommended for the treatment of knee osteoarthrosis, especially for short-term control of symptoms.

> *Strength of Evidence* – **Recommended, Evidence (C)Recommended, Evidence (C)**
> *Level of Confidence* – **Moderate**

Indications – Pain from osteoarthrosis sufficient that control with NSAID(s), acetaminophen, weight loss or exercise is unsatisfactory.(1320, 1321, 1332, 1333)

Benefits – Improved pain and function. Most evidence suggests a duration of benefit of approximately 3 months.

Harms – Rare infections, short-term poorer control of diabetes. One trial found steroid injections were associated with greater cartilage loss over 2-years on MRI scans compared with saline injections (2450).

Frequency/Dose/Duration – Only 1 injection should be scheduled to start, rather than a series of three. Medications used in RCTs include triamcinolone acetonide 40mg, 80mg, triamcinolone hexacetonide 20mg, betamethasone 6mg, hydrocortisone 25mg, and methylprednisolone 80mg and 120mg).(1320, 1321, 1333) One trial used cortivazol 3.75mg.(1332) There was no benefit of 80mg triamcinolone acetonide vs. 40mg (2472). Extended-release preparations have been suggested to produce a modestly more durable benefit (2473, 2474). Anesthetics have most often been bupivacaine or lidocaine. Whether aspiration should be performed for effusions in osteoarthrosis patients is unknown; however, there is quality evidence that aspiration of effusions prior to injection results in greater effectiveness for rheumatoid arthritis patients.(1489) Many trials included aspiration prior to injection. There is moderate evidence that a superomedial or superolateral approach is superior to a lateral approach.(1434) Bed rest has been used after treatment in rheumatoid arthritis patients to theoretically reduce speed of systemic absorption; however, a moderate-quality trial demonstrated no difference and there is no reason to believe the results would be different in osteoarthrosis patients.(1323, 1324) Thus, post-injection bed rest is not recommended. There is no evidence to suggest limiting the number of injections, and a high-quality trial found both evidence of efficacy of glucocorticoid injections compared to placebo and no evidence of accelerated osteoarthrosis when injected 4 times a year for 2 years.(1320) Multiple doses have been utilized in trials with no head-to-head comparisons of dosing regimens. Comparative trials have suggested methylprednisolone acetate 40mg is superior to triamcinolone hexacetonide 20mg, which is superior to betamethasone 6mg.(1490, 1491) However, those results have not been replicated. Another comparative clinical trial found greater efficacy for methylprednisolone 80mg over 40mg for the hip joint.(1482)

Indications for Discontinuation – A 2nd glucocorticosteroid injection is not recommended if the 1st has resulted in significant reduction or resolution of symptoms. If there has been no response to a 1st injection, there is less indication for a second. If it is believed that the medication was not well placed and/or if the underlying condition is so severe that 1 steroid bolus could not be expected to adequately treat the condition, a 2nd injection may be indicated. In patients who demonstrates a pharmacologically appropriate response consisting of several weeks of temporary, partial relief of pain, but who then have worsening pain and function and who are not (yet) interested in surgical intervention, a repeat steroid injection is an option. Benefits beyond approximately 4 injections per year are not thought to exist.(1320) Patients requesting more injections should have reassessment of conservative management measures and be evaluated for irrigation/lavage and surgical intervention.

Rationale– There are high- and moderate-quality RCTs evaluating efficacy of glucocorticosteroid injections compared to placebo for treatment of knee OA(1341, 1492-1496). These have uniformly found efficacy (however, the magnitude and duration of benefits is modest thus the reduction in the evidence based rating to “C”).(1320, 1321, 1325, 1332) There is moderate-quality evidence that tidal irrigation appears more effective for treatment of osteoarthrosis in every trial that has compared these procedures(1331-1333) and there is evidence a that combination of tidal irrigation plus glucocorticosteroid injection is superior to either alone.(1332, 1333) Moderate-quality evidence suggests intraarticular injection is more effective for treatment of rheumatoid arthritis than intramuscular injection,(1322) although there is not quality evidence for osteoarthrosis patients. Thus,

there is no recommendation for intramuscular injections for osteoarthrosis patients. Three moderate-quality trials have suggested viscosupplementation is superior to glucocorticoid injection (1384, 1386, 1388), although the degree of benefits do not appear large.

Intraarticular glucocorticosteroid injections are invasive, have a low risk of adverse effects, are moderately costly, have evidence of short- to intermediate-term efficacy, and are recommended for treatment of moderate-to severe osteoarthrosis patients, particularly after inadequate results from NSAIDs, acetaminophen, exercise, or other non-invasive interventions. As there is quality evidence of progression of the loss of articular cartlage compared with saline injections, these should generally be reserved for advanced cases (2450).

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: intra articular glucocorticoids, intraarticular glucocorticoids, intra articular glucocorticosteroid, intraarticular glucocorticosteroid; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 59 articles in PubMed, 284 in Scopus, 22 in CINAHL, 34 in Cochrane Library, 7,080 in Google Scholar, and 0 from other sources. We considered for inclusion 16 from PubMed, 2 from Scopus, 0 from CINAHL, 2 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 20 articles considered for inclusion, 15 randomized trials and 5 systematic reviews met the inclusion criteria.

Tidal Knee Joint Irrigation

Large-volume irrigation of the knee joint has been used for treatment of knee osteoarthrosis.(1331-1333) Intraarticular glucocorticosteroid injections are frequently given simultaneously. This procedure may be performed in conjunction with arthroscopy, although it has also been performed without arthroscopy.

Tidal Knee Joint Irrigation for Knee Osteoarthrosis
Tidal knee joint irrigation is not recommended for the treatment of knee osteoarthrosis.

> *Strength of Evidence* – **Not Recommended, Insufficient Evidence (I)**
> *Level of Confidence* – **Low**

Rationale – One sham-controlled trial suggested no evidence of efficacy, although the randomization process failed and they attempted statistical adjustment (2475). There are three moderate-quality RCTs comparing the efficacy of tidal irrigation to glucocorticosteroid injection for treatment of knee OA, with all 3 trials finding evidence of superiority of irrigation to injection.(1331-1333) Two of the trials comparing the two procedures found superiority for patients undergoing irrigation followed by glucocorticoid injection(1332, 1333). One trial suggested superiority compared with conservative medical management (Ike 92). These procedures are invasive, have adverse effects, are moderate to high cost, the single sham-controlled trial suggests a lack of efficacy, and therefore, tidal irrigation is not recommended.

Adjunctive treatment with glucocorticosteroids after lavage has been assessed in many studies with mixed results. Both the highest quality study(1334) and the largest trial(1335) were largely negative.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Tidal Knee Joint Irrigation; Knee Pain and Osteoarthritis**;** controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 3735 in Scopus, 10 in CINAHL, 3 in Cochrane Library, 2 in Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 7 randomized trials and 0 systematic reviews met the inclusion criteria.

Radiation Synovectomy

Radiation synovectomy has been used for treatment of patients with knee arthritis, although mostly among those thought to have an inflammatory component or undifferentiated arthritis.(1336, 1337)

Radiation Synovectomy for Knee Osteoarthrosis
Radiation synovectomy is not recommended for the treatment of knee osteoarthrosis.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation
There is one moderate quality trial comparing radiation synovectomy with glucocorticoid injection with a radiation sham plus glucocorticoid that suggested radiation synovectomy was ineffective for treatment of undifferentiated arthritis and rheumatoid arthritis.(1336, 1337) Radiation synovectomy is invasive, has adverse effects, is moderately costly, appears ineffective, and is not recommended.

Evidence for the Use of Radiation Synovectomy
There are 2 moderate-quality RCTs incorporated into this analysis.

Prolotherapy Injections

Prolotherapy injections attempt to address a theoretical cause or mechanism for chronic pain. This therapy involves repeated injections of irritating, osmotic, and chemotactic agents (e.g., dextrose, glucose, glycerin, zinc sulphate, phenol, guaiacol, tannic acid, pumice flour, sodium morrhuate) combined with an injectable anesthetic agent to reduce pain, into knee structures, especially knee and other ligaments, with the theoretical construct that it will strengthen these tissues.

Prolotherapy Injections for Acute, Subacute, or Chronic Knee Pain
Prolotherapy injections are not recommended for treatment of acute, subacute, or chronic knee pain.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation

There are no quality studies of prolotherapy injections compared to placebo for treatment of patients with knee OA.(1497) The data from one trial are largely negative. A second trial suggests inferiority to PRP injections (2470). Prolotherapy injections are invasive, have adverse effects, moderately to highly costly, depending on numbers of injections, lack quality evidence of efficacy, and thus they are not recommended.

Evidence for the Use of Prolotherapy Injections
There are 2 moderate-quality RCTs incorporated into this analysis.

Botulinum Injections

Botulinum injections have antinociceptive properties and have been used to produce muscle paresis.(1498-1501) These injections have primarily been used for non-occupational conditions such as cervical dystonia,(1502) strabismus, blepharospasm,(1503) and severe primary axillary hyperhidrosis.(1503, 1504) In the lower extremities, there are treatments that have been used mainly for children with spasticity due to cerebral palsy.(1505-1507) These injections are thought to directly treat a taut muscle band and to have analgesic properties.(1499-1501)

Botulinum Injections for Knee Osteoarthrosis or Other Knee Disorders
There is no recommendation for or against the use of botulinum injections for knee osteoarthrosis or other knee disorders.

> *Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**
> *Level of Confidence* – **Low**

Rationale – There are multiple randomized trials and conflicting evidence of efficacy (2450-2454). The highest quality study suggests lack of efficacy (2450). One trial was attempted in patients with refractory painful knee after arthroplasty (2455); however, baseline differences and some non-significant results make interpretation challenging. One small trial attempted to treat refractory anterior knee pain, reported significant baseline differences, and suggested some limited improvements (2456). Botulinum injections are invasive, have adverse effects including deaths (1508), are costly, lack clear evidence of efficacy and thus there is no recommendation. A minority of the panel (43%) felt these injections should be not recommended compared with 57% no recommendation.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Botulinum Injections, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 10 articles in PubMed, 204 in Scopus, 9 in CINAHL, 38 in Cochrane Library, 5320 in Google Scholar, and 0 from other sources. We considered for inclusion 5 from PubMed, 6 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 11 articles considered for inclusion, 7 randomized trials and 4 systematic reviews met the inclusion criteria.

Autologous Blood Donation and Blood Transfusion

Autologous blood donation has been used to attempt to reduce risks of bloodborne pathogen transmission in the event a blood transfusion is required.(1509-1519)

Pre-operative Autologous Blood Donation

Selective use of pre-operative autologous blood donation is recommended.

Indications – Particularly consider in those older and in more fragile health for whom the threshold for transfusion (tolerable hemoglobin loss) is lower. Also to be considered among those with procedures anticipated to be more difficult and/or resulting in greater blood loss (e.g., revisions), and difficult to transfuse patients (e.g., many prior transfusions resulting in many antibodies).

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Intra-operative Autologous Blood Transfusion

Selective use of intraoperative autologous blood transfusion is recommended.

Indications – Particularly to be considered in those older and in more fragile health for whom the threshold for transfusion (tolerable hemoglobin loss) is lower. Also to be considered among those with procedures anticipated to be more difficult and/or resulting in greater blood loss (e.g., revisions), and difficult to transfuse patients (e.g., many prior transfusions resulting in many antibodies).

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Rationale for Recommendations

There are two moderate-quality trials that provide different approaches to the need for post-operative transfusions. One suggests pre-operative autologous blood donation is ineffective for hip arthroplasty.(1511) The other suggests intraoperative blood salvage is effective to reduce transfusion needs for knee arthroplasty.(1520) More transfusions are required for those who have donated blood pre-operatively and the costs are higher without measurable benefits. However, there are certain clinical scenarios in which pre-operative autologous blood donation may be beneficial, and the patient's age and health status needs to be considered. Therefore, pre-operative autologous blood donation is recommended for selective use.

There is one moderate-quality trial indicating that intra-operative autologous blood transfusion is associated with less need for blood transfusion,(1520) and thus is recommended.

Evidence for Autologous Blood Donation and Blood Transfusion

There are 2 moderate-quality RCTs incorporated in this analysis. There is 1 low-quality RCT in Appendix 1.(1521)

Interleukin-1 Receptor Antagonists

Interleukin-1 receptor antagonists have been used to treat rheumatoid arthritis. They have been investigated for treatment of osteoarthrosis.(1522, 1523)

Interleukin-1 Receptor Antagonists for Knee Osteoarthrosis
Interleukin-1 receptor antagonists are not recommended for treatment of osteoarthrosis.

> *Strength of Evidence* – **Not Recommended, Insufficient Evidence (I)**
> *Level of Confidence* – **LowLow**

Rationale – There are two high-quality RCTs that somewhat conflict. One suggests slight benefits in some secondary outcome measures(1522) while the other suggests no benefits.(1523) Taken together, these results suggest additional studies are warranted. Meanwhile, the treatment is associated with significant adverse effects and there are other treatments with documented efficacy, thus interleukin-1 receptor antagonists are not recommended without consistent evidence of efficacy and clear indications.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Interleukin-1 Receptor Antagonists, IL-1RA; Knee Pain, Patellofemoral Pain Syndrome, Knee Arthritis, Knee Osteoarthritis, Knee Arthrosis controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 12 articles in PubMed, 403 in Scopus, 7 in CINAHL, 18 in Cochrane Library, 1,100 in Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 5 articles considered for inclusion, 4 randomized trials and 0 systematic reviews met the inclusion criteria.

Surgical Considerations

Chondroplasty and Debridement

Chondroplasty and debridement have been used to treat knee osteoarthrosis.(1441, 1524, 1525)

Chondroplasty and debridement are moderately not recommended for treatment of knee osteoarthrosis.

> *Strength of Evidence* – **Moderately Not Recommended, Evidence (B)**
> *Level of Confidence* – **Moderate**

Rationale – A high-quality, sham-controlled trial suggested there is no benefit of chondroplasty and debridement for treatment of knee osteoarthrosis.(375) A second trial suggested debridement was not helpful in comparison with joint lavage.(1526) One substantially lower quality trial provided conflicting evidence regarding how debridement compared with lavage.(1527) Other trials evaluating

electrocautery and radiofrequency treatments suggest no benefits.(1528, 1529) Thus, the higher quality trials and balance of evidence indicate that chondroplasty and debridement are ineffective and are not recommended for treatment of knee osteoarthrosis. However, there are lesions that are thought to be mechanical in nature and require debridement, typically in the context of arthroscopic evaluation of meniscal tears with mechanical symptoms.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Chondroplasty, Debridement; Knee Pain, Patellofemoral Pain Syndrome, Knee arthritis, Knee Osteoarthritis, Knee Arthrosis controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 27 articles in PubMed, 93 in Scopus, 11 in CINAHL, 33 in Cochrane Library, 207 in Google Scholar, and 8 from other sources. We considered for inclusion 5 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 7 from other sources. Of the 14 articles considered for inclusion, 8 randomized trials and 6 systematic reviews met the inclusion criteria.

CARTILAGE GRAFTS, OSTEOCHONDRAL AUTOGRAFTS, AND/OR TRANSPLANTATION

Cartilage grafts and/or transplantations for osteochondral defects are used for treatment of articular cartilaginous defects.(349, 581, 1530-1564) These procedures are technically difficult and require specific physician expertise. They are thought to be effective in select patients generally less than 40 years old with active lifestyles having a traumatically induced, modest sized cartilage defect. These procedures are believed to delay or possibly prevent the development of osteoarthrosis. However, a Cochrane review concluded there was insufficient evidence, opining that long-term studies are needed.(1530, 1565)

Cartilage Grafts, Osteochonndral Autografts, and/or Transplantation

Cartilage grafting, osteochondral autografts, and/or transplantation is moderately recommended for select patients.

Indications – Select patients less than 40 years old with active lifestyles with a single, traumatically caused Grade III or IV femoral condyle deficit. Deficit diameter recommended not to exceed 20mm for osteochondral autograft transplants, although criteria up to 4cm^2 has been used. Grafts and transplants not recommended for those with obesity, inflammatory conditions or osteoarthrosis, other chondral defects, associated ligamentous or meniscus pathology, or who are older than 55 years of age.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Rationale for Recommendation

There are no sham-controlled trials. However, there are quality trials that have compared different management approaches for these cartilaginous defects.(1566-1570) One trial with multiple reports suggests that at up to 10 years, autologous osteochondral transplantation is superior to microfracture in competitive athletes(349, 1540, 1571) and another trial by the same author also found superiority when performed in conjunction with ACL reconstruction.(1572)

Trials have included rigorous enrollment criteria that have on at least one occasion only included conditioned athletes.(349) As most trials have excluded obesity, it appears likely that at least 50% of the potential population would be excluded solely by that criterion. Thus, it is unclear how few patients would actually be eligible for these procedures. There are increasing numbers of longer term studies that have followed treated patients from 3-10 years(349, 1531, 1540, 1546, 1571, 1572) that have reported persistent benefits.Although, further studies with long follow-ups and larger sample sizes are needed. Cartilage grafts and/or transplants are invasive, have potential for adverse effects, and are high cost. These procedures have evidence of efficacy and are recommended for select patients.

Evidence for the Use of Cartilage Grafts and/or Transplantation
There is 1 high-(1571) and 4 moderate-quality(349, 1540, 1572, 1573) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: autografts, osteochondral autograft transplant system, OATS, mosaicplasty, knee pain , patellar tendonitis, patellar tendinitis, patellar tendinopathy, knee arthritis, knee osteoarthritis, degenerative joint disease, meniscal tears, meniscus tear controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 12 articles, and considered 2 for inclusion. In Scopus, we found and reviewed 155 articles, and considered zero for inclusion. In CINAHL, we found and reviewed 13 articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 4 articles, and considered zero for inclusion. We also considered for inclusion one article from other sources. Of the 6 articles considered for inclusion, 2 randomized trials and 4 systematic studies met the inclusion criteria.*

Knee Arthroplasty

Knee arthroplasty has been long used for treatment of end-stage knee degenerative joint disease. Outcomes have generally been excellent with 5 to 10 year survival rates of 95 to 99%.(1574-1585) A modestly worse prognosis including higher infection rates has been reported in rheumatoid arthritis patients.(1585, 1586) Unicompartmental arthroplasty has been used for medial joint arthrosis. However, patellar resurfacing is controversial.(1587)

Pain and functional loss have been shown to be predictors of arthroplasties(1588, 1589) ($p < 0.0001$), as have visual analog scale ratings. Primary reasons for surgical failure are loosening, as well as infected, prostheses. Other predictors of suboptimal results include presence of effusion,(1590) older age(1591) more pre-operative debility,(1591, 1592) longer duration of disease,(1590) depressive symptoms,(1593) helplessness(1594) and catastrophizing.(1593, 1595, 1596) Similar to all arthroplasties, the literature has advanced more slowly than the technology resulting in challenges in analyzing the literature for purposes of evidence-based guidance.

Knee Arthroplasty for Moderate to Severe Arthritides
Knee arthroplasty is strongly recommended for severe arthritides.

Indications – All of the following present: 1) severe knee degenerative joint disease that is unresponsive to non-operative treatment (rare cases may include osteonecrosis of the distal femur or tibial plateau with collapse or lack of response to non-operative treatment); 2) sufficient symptoms and functional

limitations, such as impairments of activities of daily living or occupational tasks, and 3) failure to successfully manage symptoms after a prolonged period of a conservative management plan that included NSAIDs, exercise, physical or occupational therapy, and where appropriate, weight reduction, intraarticular viscosupplementation, and corticosteroids. Carefully selected patients may be candidates for bilateral arthroplastic procedures. However, particular attention should be paid to pre-operative medical fitness and psychological fortitude.

Strength of Evidence **– Strongly Recommended, Evidence (A)**

Unicompartmental Knee Arthroplasty for Largely Unicompartmental Disease
Unicompartmental arthroplasty is recommended for largely unicompartmental disease.(1597, 1598)

Strength of Evidence – **Recommended, Evidence (C)**

Knee Arthroplasty for Bilateral Disease
For bilateral disease, carefully selected patients may safely undergo simultaneous bilateral knee replacement.

Strength of Evidence – **Recommended, Evidence (C)**

Autologous Blood Re-infusion Systems
Autologous blood re-infusion systems are moderately recommended for arthroplasty patients.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Rationale for Recommendations
There are numerous trials that have been performed of arthroplasty.(1599-1682) There are no trials that have compared arthroplasty or other surgical procedures with non-operative management. However, all quality trials have reported marked improvements in all surgical arms of the trials, thus arthroplasty is strongly recommended for select patients who fail non-operative management.

For largely unicompartmental disease, one moderate-quality trial has reported 5 and 15 year follow-ups and found better range of motion and “excellent” results with unicompartmental arthroplasty compared with total joint arthroplasty.(1597, 1598) Thus, unicompartmental arthroplasty is recommended for that select group of patients. One trial has compared high tibial osteotomy with unicompartmental arthroplasty and found that arthroplasty resulted in a longer time to failure, as defined as total joint arthroplasty, but most results were reasonably comparable.(1683)

There are several trials of surgical approaches, but data somewhat conflict. A quadriceps sparing or subvastus approach has been found to result in superior short-term results or trends towards superiority in most(1684-1687) but not all trials.(1688) Two older trials were negative.(1689, 1690) A mini-incision medial parapatellar approach has also been found to be associated with a shorter hospital stay in one trial,(1691) but was not found to be superior to a quadriceps sparing approach in another trial.(1692) As there are minimal differences in outcomes, there is no recommendation, although the subvastus approach has some evidence of very short-term superiority.

Computer navigation systems have been reported in many studies and quality trials.(1672, 1693-1705) Short-term results include better function,(1699) worse function,(1706) and no differences in fat emboli.(1705) All trials that have reported on alignment found superior anatomic alignment with those systems. Superior alignment is presumed to result in superior outcomes long-term; however, to date only one trial has reported some results suggesting better outcomes at 1 year.(1693) While the reduction in malposition is hopeful, the increased cost and the lack of data to support a change in failure rate result in no formal recommendation for or against those systems.

Different prosthetic designs have been reported in quality trials.(1707-1715) (1716) Components have also been coated, uncoated, cemented and uncemented.(1717-1737) Quality trials demonstrating clear superiority of one design over another are not reported. Cemented prostheses tend to migrate less in the short term, but over the intermediate term, cemented prostheses migrate equivalent amounts, and longer term results are unclear comparing the two options.

Patellar resurfacing has been used in conjunction with arthroplasty. There are numerous trials that have been performed with durations of follow-up exceeding 10 years in two studies. A high-quality study found comparable results regardless of whether the patella was resurfaced or not.(1738) Moderate-quality trials also found no differences in outcomes for patellar resurfacing compared with patellar retention/non-resurfacing.(1739-1751) Four of the trials suggested modestly better results with patellar resurfacing that included less anterior knee pain and less need for reoperation.(1752-1755) Available studies have also suggested appearance of the patella does not predict need for resurfacing. Thus, there is no recommendation for or against patellar resurfacing; however, some caution appears warranted in the surgical performance of patellar resurfacing, particularly as complications that are difficult to treat may occur though infrequently.

Autologous blood reinfusion systems have been shown to reduce transfusion needs of patients in all studies.(1756-1762) Two low-quality trials also suggest efficacy,(1763, 1764) and thus autologous blood re-infusion systems are moderately recommended.

Drains have been used indwelling, as well as intraarticular.(1765-1772) One moderate-quality trial of hip and knee arthroplasty patients reported not using drains and found no advantage to drains.(1766) Comparative data suggest no differences in outcomes. Drains that have used higher suction pressures have resulted in greater fluid removal,(1767) but no documented improvements in outcomes. Thus, there is no recommendation for or against drains. There is evidence that drains become colonized within 48 hours and thus provide a theoretical conduit for infection, and prompt removal is generally indicated.

Tourniquets have been used to keep the operative field free of blood, but concerns about failure to identify bleeders after tourniquet release and subsequent impairments of lower extremity function have been addressed in research studies.(1773-1781) Two trials have compared tourniquet use with no tourniquet use.(1776, 1782) One high-quality trial suggested comparable results although there was earlier straight-leg raising capacity in the non-tourniquet group.(1782) The second study reported moderate to heavy bleeding issues in 15% without use of a tourniquet, but otherwise good outcomes.(1776) Other trials evaluated early tourniquet release vs. late release and have variously reported early release resulted in superior function,(1773) trends towards more complications in the late release group,(1773, 1775) and modestly higher blood loss with early release.(1777) Another trial found no differences between tourniquet at 350mm Hg vs. systolic blood pressure plus 100mm Hg,(1781) suggesting lower pressures may be preferable.

Infected prostheses are catastrophic events and infectious disease precautions including at least some barrier methods (e.g., surgical ‘moon suits,’ surgical masks, ventilation) combined with antibiotics are universally utilized. Antibiotic impregnated cement combined with intravenous antibiotics is used. There is increasing use of air flow controls(1783) and supplied air in operating suites to attempt to reduce these infections.

Evidence for the Use of Knee Arthroplasty
There are 10 high- and 144 moderate-quality RCTs or crossover trials incorporated into this analysis. There are 30 low-quality RCTs in Appendix 1.

Bisphosphonates and Calcitonin

Bisphosphonates have been used to attempt to reduce periprosthetic bone resorption in the immediate peri-operative period.(1730, 1784, 1785) Calcitonin has been used to attempt to develop better healing after hip fracture fixation.(1786)

Routine Peri-operative Use of Bisphosphonates

There is no recommendation for or against the routine peri-operative use of bisphosphonates.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Routine Post-operative Use of Calcitonin

There is no recommendation for or against the routine post-operative use of calcitonin.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

Multiple studies have shown less bone loss with cemented prostheses.(1787-1790) A high-quality trial of intranasal calcitonin also found better healing after internal fixation of hip fractures compared to placebo.(1786) However, these studies are of short-term duration and there is no long-term follow-up. Thus, the utility of these medications for this purpose is unclear. Among those patients with osteoporosis however, these medications may be indicated.

Evidence for the Use of Bisphosphonates and Calcitonin

There are 1 high- and 4 moderate-quality RCTs incorporated in this analysis.

Antibiotics

Antibiotics have been utilized systemically and added to cement for many years.(1791-1814)

One-day Use of Systemic Antibiotics for Knee Surgery

One-day use of systemic antibiotics is moderately recommended for patients undergoing surgical knee procedures. Antibiotic-impregnated cement also appears effective compared with cement without antibiotics with evidence particularly in the hip and by inference assumed likely to be true of the knee as well.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Rationale for Recommendation

There are trials comparing multiple doses with a single day of antibiotics, (1815) finding no differences in outcomes. This is a similar finding to the hip as there is evidence from a non-randomized registry data of 10,905 hip prostheses that the risk of revision due to infection was reduced 75 to 78% with a systemic antibiotic combined with antibiotic-impregnated cement compared with either systemic antibiotic administration or antibiotic-impregnated cement alone.(1816) The risk, if there was only antibiotic in the cement, was 6.3-fold higher, and, if the antibiotic was only systemic risk, was 4.3-fold greater. There is a belief that some cases of aseptic loosening are undiagnosed infections(1796) as there were lower rates of aseptic loosening among those with both routes of antibiotic administration compared with either alone(1816) and those with gentamicin cement appear to have lower rates of aseptic loosening compare with systemic antibiotics.(1817, 1818) Thus, there is quality evidence that a combination of systemic and antibiotic-impregnated cement is important to prevent infections.

Evidence for the Use of Antibiotics
There are 2 high-quality and 10 moderate-quality RCTs incorporated into this analysis. There are 4 low-quality RCTs in Appendix 1(1778, 1819-1821) (see Hip and Groin Disorders guideline for additional studies).

Glucocorticosteroid Injections after Arthroscopy and Meniscectomy

Intra-articular glucocorticosteroid injections are frequently performed after arthroscopy and meniscectomy.(1485)

Glucocorticosteroid Injections after Arthroscopy
Intraarticular glucocorticosteroid injections are recommended for select patients after arthroscopy and meniscectomy.

Indications – Patients undergoing arthroscopy, particularly if osteoarthrosis is identified and patient is believed to potentially benefit from glucocorticoid injection, although there may be no long-term benefit.(1485)

Frequency/Dose/Duration – Injection performed at end of procedure.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendation
Two moderate-quality trials suggest superior short-term results from injection with glucocorticosteroid if chondromalacia is identified,(1485) or compared with placebo among patients with osteoarthrosis.(1486) There is generally no additional invasiveness of this adjunctive procedure and the complication rate (primarily due to infection) is believed to be quite low. As there is evidence of efficacy,(1325) these injections are recommended.

Evidence for the Use of Glucocorticosteroid Injections after Arthroscopy and Meniscectomy
There are 3 moderate-quality RCTs incorporated into this analysis.

Periarticular Glucocorticosteroid Injections for Arthroplasty Patients

Periarticular glucocorticoid injections have been used for arthroplasty patients.(1488)

Periarticular Glucocorticosteroid Injections for Arthroplasty Patients
There is no recommendation for or against the use of periarticular glucocorticosteroid injections for arthroplasty patients.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There is one moderate-quality trial comparing a mixture of pharmaceuticals with and without a glucocorticosteroid.(1488) While most outcomes including pain scores and narcotics consumed were negative, the length of hospital stay was inexplicably shorter in the steroid group and produced a mixed picture regarding efficacy of this intervention. Thus, there is no recommendation for or against these injections.

Evidence for the Use of Periarticular Glucocorticosteroid Injections for Arthroplasty Patients
There is 1 moderate-quality RCT incorporated into this analysis.

PRE- AND POST-OPERATIVE REHABILITATION PROGRAMS FOR KNEE ARTHROPLASTY

Numerous studies have evaluated post-operative rehabilitation and activity levels that appear important for recovery from knee procedures, especially for arthroplasty.(1839, 1840) Considerations have included pre-operative exercise programs, post-operative activity limitations, post-operative rehabilitation programs and late rehabilitation programs several months after surgery.(1841, 1842) Compliance is noted to be problematic.

Preoperative Education

Educational interventions have been utilized for rehabilitation of arthroplasty patients, particularly for pre-operative preparation.(1822-1824) These interventions may include various combinations of procedural, sensory information, cognitive coping strategies, reassurance, and relaxation and hypnosis training.(1825, 1826) Multiple modes of instruction are frequently incorporated, including oral, written, and video.

Pre-operative Educational Program Prior to Arthroplasty

A pre-operative educational program is moderately recommended prior to arthroplasty. Components should include procedural and recovery information and use at least two modes of teaching (e.g., oral and written).

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Rationale for Recommendation

Most studies of educational interventions involved hip and not knee patients and have demonstrated benefits.(565, 1827-1829) Lengths of contact have ranged widely, although most studies do not report educational contact time. Some programs encourage involvement of family members and other care givers. Better post-operative compliance with rehabilitation has been shown in patients who have participated in educational interventions.(1830) Numerous studies have combined exercises and other interventions with educational interventions. However, nearly all studies reporting length of hospital stay have shown earlier hospital discharge after hip arthroplasty with educational interventions.(1822-1824, 1831, 1832) Other studies have shown earlier performance of activities such as stair climbing(1833) and reductions in pain and anxiety.(1834)

Evidence for the Use of Pre-operative Education Prior to Arthroplasty

There are 12 moderate-quality RCTs incorporated in this analysis. There are 5 low-quality RCTs in Appendix 1.(1822, 1835-1838)

PRE-OPERATIVE EXERCISE

Pre-operative exercise programs have been prescribed to attempt to improve arthroplasty results and reduce complications.(1828, 1833, 1843-1849)

Pre-operative Exercise Program

A pre-operative exercise program particularly emphasizing cardiovascular fitness and strengthening prior to knee arthroplasty is recommended for a select, fairly small minority of patients who exhibit evidence of considerable weakness, debility or unsteady gait. Flexibility components may be reasonable in those without fixed deficits.(1833, 1846, 1848)

Indications – Highly select pre-operative arthroplasty patients who have considerable muscle weakness and/or debility, particularly sufficient weakness to have impairments such as unsteady gait or difficulty with ADLs.

Frequency/Duration – Most program elements require an initial appointment to teach exercises followed by a home exercise program prescription. Two or 3 follow-up appointments for adherence and additional exercise instruction may be needed. Patients with severe deficits may require 2 to 3 appointments a week for 4 to 6 weeks in advance of arthroplasty.(1848) Patients with minimal deficits may benefit from a single appointment to teach programmatic elements for a self-directed program.

Indications for Discontinuation – Achievement of program goals, resolution of strength or gait deficits, intolerance or other adverse effects.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There are few quality trials that evaluate pre-operative exercise programs for the treatment of knee arthroplasty, and there is no consistent evidence of benefits in either knee or hip arthroplasty patients.(1850, 1851) One trial has suggested benefits, but most have not.(588, 1852) One moderate-quality study demonstrated there were benefits from a 6-week pre-operative exercise program that consisted of several elements broadly including cardiovascular, strengthening and flexibility exercises with 30 to 60-minute sessions 3 times a week.(1848) The benefits included reduced post-operative complications, earlier discharge and higher probability to be discharged directly to the patient's home. A second moderate-quality study demonstrated benefits of a peri-operative exercise program and also demonstrated benefits lasting 6 months after surgery.(1846) Another moderate-quality study was reported as negative using the author's main outcome of changes in Harris Hip Scores. However, all 5 post-operative milestones (e.g., walking, chair transfer, stair climbing) statistically favored the exercise group.(1833) Pre-operative rehabilitation may be useful as a component of pre-operative education and exercise programs for selected high risk, deconditioned patients. However, most typical patients do not require preoperative programs.

Evidence for the Use of a Pre-operative Exercise Program
There are 4 moderate-quality RCT incorporated in this analysis. There is 1 low-quality RCT in Appendix 1.

POST-OPERATIVE REHABILITATION

Exercise, physical therapy and rehabilitation have been used pre-operatively as well as post-operatively for rehabilitation of arthroplasty patients.(580, 1850, 1851, 1853-1858) Continuous passive-motion machines have also been used in rehabilitation of arthroplasty patients.(1859, 1860)

Post-Operative Rehabilitation of Knee Arthroplasty Patients
Post-operative rehabilitation is recommended for knee arthroplasty patients.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Indications – Patients having undergone knee arthroplasty.

Duration – Treatment may need individualization based on factors including pre-operative conditioning and immediate post-operative results. Treatment is often daily while hospitalized, then 2 to 3 sessions a week. One trial suggested an educational kneeling intervention had demonstrable long-term benefits.(1854) Three trials have suggested benefits of accelerated and/or early rehabilitation.(1839, 1855, 1861)

Indications for Discontinuation – Achievement of goals, non-compliance with clinic or home-based exercises or intolerance.

Continuous Passive Motion for Knee Arthroplasty Patients

Continuous passive motion is not recommended for routine use for arthroplasty patients. It may be useful for select, substantially physically inactive patients post-operatively.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendations

Most of the available quality trials concern continuous passive-motion (CPM) devices in the immediate post-operative period.(1862-1867) This literature base has many older, lower quality trials(1307, 1860, 1868-1878) (see Appendix 1). Trials comparing CPM with splinting have suggested efficacy.(1879) However, over the past 25 years, patients have gradually been ambulated earlier and are now generally placed on immediate weight bearing status, which appears a likely reason that both of the more recent and higher quality studies have failed to show benefits from use of CPM.(1862, 1863) This device is likely preferable to no activity; however, for most patients, active exercise appears superior. Thus, CPM is not recommended for most patients, but it may retain some utility for selected, relatively inactive patients in the immediate postoperative period.

Accelerated rehabilitation programs have been assessed and appear to be superior to usual care(1839, 1855, 1861) or CPM.(1880) There is no demonstrable difference between clinic- and home-based rehabilitation programs or between home and hospital-based care after arthroplasty.(1881, 1882) One trial has suggested neuromuscular electrical stimulation was not of significant additive benefits.(1883) Exercise and rehabilitation are not invasive, have low adverse effects, and are moderately costly, depending on numbers of appointments required; thus, they are recommended for select patients who have functional deficits.

Evidence for the Use of Post-operative Rehabilitation

There is 1 high- and 12 moderate-quality RCTs incorporated into this analysis. There are 13 low-quality RCTs in Appendix 1.

Post-Operative Activities and Sports

There is a greater volume and quality of literature on post-operative hip arthroplasty patients than knee arthroplasty patients(1797) (see Hip and Groin Disorders guideline). Researchers summarizing this literature have concluded there is somewhat less return to sports in knee than hip arthroplasty patients.(1884, 1885) There are three primary methods to assess appropriate sports or activities for knee arthroplasty patients: epidemiological studies, biomechanical models, and experimental studies. While there are more hip data, the available studies for the knee also produce conflicts that are not readily resolved. Since the evidence conflicts and the epidemiological studies are the gold standard for the development of quality guidance,(1886-1888) this review emphasizes epidemiological studies.

There are many studies suggesting sizable proportions of individuals successfully returning to sports and manual labor, including high impact sports that have not been generally recommended for these patients. One study has suggested 91% of knee arthroplasty patients return to low impact sports compared with 20% to high impact activities.(1889) A small case series reported no apparent complications with high impact sports, including jogging, downhill skiing, tennis, racquetball, squash and basketball, although it may be underpowered for adverse effects.(1890) One study found 16% of

arthroplasty patients were involved in heavy manual labor or sports that were “not recommended” by the Knee Society.(1891, 1892) Yet, there are neither randomized controlled trials of returning to sports,[xv] nor are there large prospective cohort studies that have used return to sports as a primary indicator, thus the overall quality of this literature from which to draw conclusions is quite limited. Data for hip arthroplasty patients is similarly conflicted (see Hip and Groin Disorders guideline).

One concern has been increased wear rates for prosthetic joints subjected to sports or manual labor. While joint use has been thought to be an important factor, the evidence is primarily derived from biomechanical studies and not quality epidemiological studies with large sample sizes. Wear rates for knee arthroplasties are reportedly worse with activity reported in a small necropsy study.(1893) However, that study which also evaluated multiple factors found body mass index as the most important factor, which creates a conflict between physical activity and body mass index. Another large case series reported worse outcomes with increased body mass index, higher Deyo-Charlson index, female gender, age over 80 years and comorbidities.(1894) Younger patients are presumed to be more active on average than older patients, yet such a cohort of younger active patients reported a 94% 18-year arthroplasty survival rate.(1895) Thus, the importance of activity for joint survival is somewhat unclear.

Among unicondylar knee arthroplasty patients, one report noted 93 to 95% of patients returned to sports.(1896, 1897) Others have similarly found more patients with unicondylar arthroplasties return to sports compared with total knee arthroplasty patients,(1898) although these studies could be confounded by other factors.

A related issue is lack of use after arthroplasty from fear of use or fear of excessive wear, which could worsen outcomes and incur worse health outcomes associated with inactivity. For example, one descriptive study found few golfers walked the course after arthroplasty and suggested education to increase exercise is needed.(1899) Among the determinants of post-operative activity levels, pre-operative condition is thought to be an important, if not the most important factor.

Operative approaches in relation to return to sports have not been well studied, although evidence suggests minimal differences in return to usual functions (see Arthroplasty above). Minimally invasive approaches have been hypothesized to potentially be better for return to sports activity, particularly in the early phases. No differences by type of operation have been found.

The Knee Society survey of opinions on returning to sports(1900) included the following sports recommendations by category: recommended allowed sports were low impact aerobics, stationary bicycling, bowling, golfing, dancing, horseback riding, croquet, walking, swimming, shooting, shuffleboard, and horseshoes. Sports allowed with experience were road bicycling, canoeing, hiking, rowing, cross country skiing, speed walking, tennis, weight machines and ice skating. Sports not recommended were racquetball, squash, rock climbing, soccer, singles tennis, volleyball, football, gymnastics, lacrosse, hockey, basketball, jogging, and handball. Sports with no conclusion were fencing, roller blading/in-line skating, downhill skiing, and weight lifting. However, these recommendations do not necessarily conform with epidemiological evidence (see above).

Studies on prosthetic wear rates have been used to imply appropriate work limitations for the post-arthroplasty patient. However, no quality studies have been reported that address the appropriateness of work limitations. Additionally, the avocational studies reviewed above do not provide quality

[xv]Almost no RCTs have addressed return to activity other than a number of post-operative rehabilitation studies such as a study of ergometer cycling that found it ineffective in contrast with hip rehabilitation (see Hip and Groin Disorders guideline).

evidence in support of activity limitations. Thus, although reduced return-to-work status has been reported among patients with more physically demanding work, there is not a strong rationale for work restrictions in the post-surgical knee population.

Post-Operative Vocational or Avocational Activities
There is no recommendation for or against specific vocational or avocational pursuits post-operatively.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
Quality evidence does not sufficiently support evidence-based guidance and therefore there is no recommendation for or against specific vocational or avocational activities.

Evidence for the Use of Vocational or Avocational Activities
There are no quality studies evaluating the use of vocational or avocational activities.

Psychological Services

Psychological issues appear to be substantially less prevalent among patients with osteoarthrosis compared with spine disorders for unclear reasons. Thus, psychological services are rarely needed for knee pain patients (see Chronic Pain guideline for further discussion of psychological evaluation).

Psychological Evaluation

Psychological Evaluation for Chronic Knee Pain
A psychological evaluation is recommended as part of the evaluation and management of patients with chronic knee pain with any of the below indications in order to assess whether psychological factors will need to be considered and treated as part of the overall treatment plan.

Indications – 1) Knee pain or dysfunction that persists longer than typical for the condition; 2) disability or impairments thought to be disproportionate to usual or expected findings; 3) demonstration or suspicion of significant psychosocial dysfunction; 4) medication issues and/or drug problems(1901-1904); 5) current or premorbid major psychiatric symptoms or disorder thought to be impacting disorder; 6) non-compliance with the prescribed treatment regimen; or 7) experiencing delayed functional recovery.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Cognitive Behavioral Therapy

Cognitive Behavioral Therapy (CBT) for Patients with Subacute or Chronic Knee Pain
Cognitive-behavioral therapy is recommended as an adjunct to an interdisciplinary program for treatment of subacute or chronic knee pain.

Indications – Specific indications for CBT in chronic pain conditions are:

1. Management of clinically significant behavioral aberrations and/or anxiety during opiate weaning or detoxification;
2. A component therapy integrated into an interdisciplinary or other functional restoration program;
3. Clinically significant problems of noncompliance or non-adherence to prescribed medical or physical regimens;

4. Vocational counseling for resolution of psychosocial barriers in return to work (requires a current or imminent medical release to return to work);
5. Resolution of interpersonal, behavioral, or occupational self-management problems in the workplace, during/after return to work, where such problems are risk factors for loss of work or are impeding resumption of full duty or work consistent with permanent restrictions.

Frequency/Duration – Therapy provided for the above indications should be limited to 6 sessions or less. When therapy is provided as a component of an interdisciplinary or functional restoration program, the number of sessions is based on the needs of the program to provide relevant treatment objectives.

Indications for Discontinuation – Noncompliance, failure to obtain functional or behavioral improvement, or resolution of problems.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
There are no quality studies specifically addressing knee pain as nearly all studies evaluated low back pain patients (see Chronic Pain and Low Back Disorders guidelines). Psychological assessments are routinely accomplished for the purposes given above, including treatments for which various levels of evidence are provided herein, e.g., functional rehabilitation or interdisciplinary pain programs, candidacy for certain procedures, or chronic use of opioid medications. Evaluations are moderate cost and, when done appropriately, present little risk of harm.

Evidence for the Use of Psychological Evaluations/Cognitive-Behavioral Therapy
There are no quality studies evaluating the use of psychological evaluations for patients with chronic knee pain. However, there are quality studies evaluating spine patients (see Low Back Disorders and Chronic Pain guidelines).

REHABILITATION FOR DELAYED RECOVERY

Biofeedback

Biofeedback is a behavioral medicine method providing automated information and training to improve control of certain physiologic processes which are normally inaccessible to a subject's perception. Biofeedback most commonly involves surface EMG input to a monitor with audible or visual feedback of the degree to which there is muscle activity.(1905) Through this feedback, the patient may learn to control the degree of muscle contraction.

Biofeedback for Chronic Knee Pain
There is no recommendation for or against the use of biofeedback for chronic knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
Biofeedback is not invasive, has no complications, and is moderately costly. However, there are other efficacious treatment strategies.

Evidence for the Use of Biofeedback
There are no quality studies for use of biofeedback for treatment of knee pain patients.

Functional Restoration

Functional restoration is both a type of interdisciplinary pain management and rehabilitation program and a general approach to medical care. Fundamental elements of a functional restoration approach include assessment of the patient's dynamic physical and functional status including traditional tests for strength, sensation, and range of motion. Psychosocial strengths and stressors must also be assessed including the patient's support system, evidence of mood disorders, medication use, presence of litigation, work capacity, and assessment of education and skills. Following this evaluation, the emphasis is on expectation management, directed conditioning and exercise, cognitive behavioral therapy, setting functional goals and decreased medication use. An ongoing assessment of patient participation and compliance (with documentation of complicating problems and progress toward specific goals, including reduction in disability and medical utilization) is needed.

In functional restoration, the treatment team members are educators. Passive therapies and invasive interventions are de-emphasized while home exercise/self-management efforts are stressed. There should be a shift of health, function, and well-being responsibility (locus of control) from physicians and therapists to the patient. A functional restoration approach may include the limited/adjunctive use of medications and interventional measures (where specifically indicated) however, these should not be viewed as ongoing solutions. It may also involve institution of preventive measures, education for relapse prevention, proper activity and work pacing, ergonomic accommodation, and when appropriate, transitional return to employment.

Functional restoration's goals are returning to a productive life despite having a chronic pain problem and mitigation of a patient's suffering. If an individual fails to recover within the appropriate biological healing time frame, the acute care paradigms of specific diagnosis and treatment change to biopsychosocial approaches that address pain, function, work, and psychological factors impeding progress. Treatment programs focus on restoration of work-related function. These programs include work conditioning and work hardening, interdisciplinary pain rehabilitation programs and functional rehabilitation. Because functional restoration is an approach, not just a specific program, the approaches taken both overlap on a continuum.

Work Conditioning, Work Hardening, AND Early Intervention Programs

Work conditioning and work hardening programs are often recommended for patients who are not able to return to work because of persistent symptoms and functional limitations following acute care and rehabilitation. Early intervention functional restoration programs are sometimes recommended during the first 3 to 6 months if the injured worker is noted to have increased risk factors and evidence of delayed recovery. These risks and delays suggest that a more coordinated functional restoration approach with a psychosocial emphasis is needed beyond conditioning or hardening alone.

Work Conditioning and Work Hardening Programs

Differentiating work conditioning from work hardening is problematic as the terms are sometimes used interchangeably. The American Physical Therapy Association (APTA) defines work conditioning as "an intensive, work-related, goal-oriented conditioning program designed specifically to restore systemic neuromusculoskeletal functions (e.g., joint integrity and mobility, muscle performance (including strength, power, and endurance), motor function (motor control and motor learning), range of motion (including muscle length), and cardiovascular/ pulmonary functions (e.g., aerobic capacity/endurance, circulation, and ventilation and respiration/gas exchange)."(1906) APTA classifies work conditioning as a single-discipline program and work hardening program as interdisciplinary. The Commission on

Accreditation of Rehabilitation Facilities (CARF) defines occupational rehabilitation as work conditioning, and comprehensive occupational rehabilitation as work hardening. Although not universally accepted, some physicians consider work conditioning as a generalized endurance and strengthening program that includes work simulation activities, whereas work hardening is a program where a specific job has been identified and stresses involvement in sets of occupationally-related tasks and functional activities that are directly related to a patient's work. Work conditioning and work hardening programs in the U.S. are heterogeneous and are often provided by a single-therapy discipline, either physical or occupational therapy.(1907-1909)

Work conditioning and work hardening programs generally involve structured programs of gradually increased levels of exertion to bridge a significant gap between the patient's current physical or perceived capabilities and the requirements needed to return to everyday activities and work. Regardless of the terminology used, the most successful programs involve a detailed appreciation of the worker's capabilities, a detailed knowledge of the job physical requirements (if possible, obtained from on-site analysis or familiarity), and individualization of the program to address specific deficits that are barriers to return to work. These programs can be somewhat heterogeneous with varying components and there is some overlap with multidisciplinary programs.

Work conditioning and work hardening programs focus on increasing physical efforts, using fear avoidance belief training if necessary. These programs may also use a cognitive-behavioral model and overlap with early intervention programs. In the majority of return-to-work situations, work conditioning or work hardening programs are not required as the gap between worker abilities and capabilities are not sufficiently large to justify either the time or expense. These programs are generally utilized for workers involved in significant demanding jobs for the knees that may include materials handling tasks that commonly involve high-force expenditures or highly repetitious activities. Not infrequently, work conditioning or work hardening programs are the next step after conventional physical or occupational therapy is exhausted and a gap remains to return the patient back to work, particularly in the subacute pain setting. These programs are also utilized for patients who have tried to return to work but failed due to either the gap between abilities and capacities or the lack of modified duty in physically demanding occupations. These programs are not invasive and have low adverse effects, but are moderate to high cost depending on program length.

Patients who may benefit from work conditioning or hardening include those who: 1) remain completely off work or are on modified duty for 6 to 12 weeks; 2) have not responded to less costly interventions including a 4 to 6 week physical or occupational therapy program or a graded therapy program of at least 6 to 8 weeks that includes aerobic and knee strengthening exercise components; 3) have a stated strong interest and expectation to return to work; 4) involve cooperation of the employer; 5) are supervised by a qualified physical or occupational therapist; 6) have had a careful assessment of their occupational demands; 7) have a FCE that indicated appropriate performance effort and consistency at a level of work lower than that to which they need or wish to return; and 8) are in a program that includes a cognitive-behavioral approach with a focus on function rather than pain, a conditioning or aerobic exercise component and simulated graded work tasks, and is tailored to their needs and identifies gaps between current capabilities and job demands.

Early Intervention (Functional Restoration) Programs

Early identification and appropriate management of patients exhibiting signs of delayed recovery is believed to decrease the likelihood that they will go on to develop chronic pain.(1910) These patients may benefit from a limited but intense program of physical restoration with a strong emphasis on education that identifies barriers to recovery and return to work. They may require an abbreviated early

intervention interdisciplinary rehabilitation program (IPRP), preferably using functional restoration principles, rather than a longer program utilized for more complex cases. Early intervention programs are an alternative to work conditioning and work hardening programs for subacute or patients with early chronic pain who have evidence for delayed recovery with an increased need for education and psychological assessment and intervention. These programs are usually appropriate in cases of work incapacity lasting 3 to 6 months. The interdisciplinary functional restoration program used for early intervention contains the features of a functional restoration IPRP, but involves lower intensity and duration of services than a program for patients with greater chronicity of disability. The type, intensity, and duration of services is dictated by the patient's unique rehabilitation needs and may be used for those who fail work conditioning and work hardening programs, usually within 6 months of onset of disability post-injury. The time frame of 3 to 6 months post-injury is vital for intervening with the most effective treatment possible in order to avoid the negative sequelae that come with increasing duration of disability. During this time, normal musculoskeletal healing generally occurs, eliminating any remaining physical barriers to intensive rehabilitation. Such programs are appropriate for prevention, before the patient is entrenched in a chronic pain syndrome or before severe pain and illness behavior evolves.

Work Conditioning, Work Hardening, or Early Intervention Programs for Chronic Knee Pain Syndromes
Work conditioning, work hardening, and early intervention programs are recommended for treatment of chronic knee pain syndromes.

Frequency/Duration – Three (3) to 5 times a week for work conditioning and early intervention programs; daily for work hardening. Weekly evaluations demonstrating sufficient levels of physical effort and consistency, compliance with the plan of care, and functionally significant progress toward the return-to-work goal must be documented to justify continuation. Program length and intensity is dictated by each patient's unique rehabilitation needs.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality studies of knee pain patients and limited evidence that work conditioning, work hardening, or early intervention programs are effective for chronic spinal pain, nevertheless there is a longstanding belief and experience that they are highly effective. While there is potential for overlap, work conditioning, work hardening, and early intervention are distinct programs and are not intended for sequential use, although this might be appropriate in certain situations depending on program components. In acute cases, where delayed recovery is not an issue, these programs are inappropriate. In more chronic cases, particularly with pain and illness behavior and a high level of reported dysfunction, a more intense IPRP should be considered. Although less costly, work conditioning, work-hardening, and early intervention programs do not need to be attempted before moving to an IPRP as long as a quality interdisciplinary program with proven outcomes is accessible to the patient. Program choice depends on availability and matching patient needs to the services offered to provide the most cost-effective and beneficial outcome. Hence, these programs might provide the greatest potential impact when used to manage patients during the subacute phases of injury, although they might also be appropriate for use in those with chronic pain who do not, after evaluation, have significant psychosocial factors contributing to their clinical presentation.

Evidence for the Use of Work Conditioning, Work Hardening, and Early Intervention Programs
There are no quality studies evaluating the use of work conditioning, work hardening, and early intervention programs for chronic knee pain.

INTERDISCIPLINARY PAIN REHABILITATION PROGRAMS

An interdisciplinary pain rehabilitation program (IPRP) is a type of chronic pain management program that uses a biopsychosocial paradigm (preferably employing a functional restoration approach), that can enhance function, reduce pain and illness behavior, and mitigate chronic pain associated disability. These programs are intended to manage psychological, social, physical and occupational factors and are discussed in detail in the Chronic Pain guideline. All IPRP programs involve an integrated team of professionals who provide intensive, coordinated care. This team may include physical and occupational therapists, psychologists, vocational counselors, nurses, and case managers. Quality programs emphasize functional recovery and active, progressive physical activity and generally involve intensive 5-days-a-week treatment regimens that should be individualized. **All medical and therapy services must be supervised by a physician who is directly involved with the program and regularly interviews and examines the patient for relevant parameters.** For reasons that are unclear, there appear to be few lower extremity pain patients, including knee pain patients who require these programs. Nevertheless, a minority of patients may derive benefits (see Chronic Pain guideline).

IPRPs for Chronic Knee Pain

A multidisciplinary or interdisciplinary program (IPRP) with a focus on behavioral or cognitive-behavioral approaches combined with conditioning exercise is recommended for patients who due to chronic knee pain demonstrate partial/total work incapacity.

Indications – Chronic knee pain in patients who are not working, or unable to return to full duty, and have significant, pain-related limitations in activities of daily living. Patients should have failed other standard approaches (e.g., physical therapy, occupational therapy, interventions, medication) and have reasonable probability of recovery.

Frequency/Duration – Median 20 days, with trial of the first 10 days to assess patient compliance, attendance, and progress. Program duration is variable due to the patient's needs, the rehabilitation strategies used, and the demonstrated program outcomes. IPRP treatment is generally provided 5 full days per week, though slightly fewer hours and longer calendar durations are utilized in some programs. Complicating problems involving activities of daily living (such as coordinating part-time employment, transportation, or child care needs) or limitations imposed by co-morbid medical conditions which preclude the patient from participating in the program full-time (thus preventing them an assessment at 10 days) are considerations that might necessitate program modification.

Indications for Discontinuation – Failure to improve, noncompliance, resolution of symptoms and disability, exhaustion of reasonable program duration for a specific condition.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

Participation in an IPRP to treat chronic knee pain patients has not been evaluated in quality studies. These programs may be helpful if there is medical need to wean the patient from opioids or other medications and/or if the patient has shown demonstrable clinical progress with less intense rehabilitation but “pain limitation” has impeded adequate recovery. Development of entrenched psychosocial barriers to recovery and a chronic pain syndrome as sequelae of the original physical components of the injury may be associated with this group of patients. Functional restoration might be appropriate, as well as vocational re-entry in positions not requiring the same job physical characteristics when all previous treatments have failed. With the possible exception of workplace-based interventions, most successful multidisciplinary programs appear to utilize either a cognitive-behavioral approach or involve psychologists.(1911-1914) While exercise is a major focus in many of these successful programs that primarily treat spine pain,(1911-1915) the one trial that compared a

graded exercise approach with a participatory ergonomics approach found exercise inferior.(1916) This suggests that of the options available, the participatory ergonomics approach may be superior to other approaches.(1917) These heterogeneous studies also suggest that multidisciplinary programs that focus on functional improvements are superior.

IPRPs of the types described in the literature are not invasive, have few adverse effects, but are high cost. Some U.S.-based programs involve significant interventions, but there is no documentation of superior outcomes from such programs which can cost $20,000 to $50,000. IPRPs are indicated for select, more severely affected patients, including those who have failed appropriate conservative management (e.g., appropriate medications, specific exercises, etc.). Generally, these referrals are most indicated in the early chronic pain management timeframe (3 to 6 months). However, there are times when earlier referral in the mid- to late-subacute interval is indicated. (Physicians should be aware that there is a belief that earlier referral results in higher probability of successful treatment, but that supposition has not been rigorously tested and is prone to a strong spectrum bias whereby all patients tend to do worse the longer they have a acute, subacute, or chronic pain condition.) Referrals beyond 6 months might also be indicated if there has been failure to progress with numerous interventions and there is reasonable expectation for potential benefits. Referrals during the subacute phase best occur when there is a quality program with proven outcome efficacy is available, the patient has documented delayed recovery, yet there is interdisciplinary assessment that the patient is likely to benefit from the program.

PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Venous thromboembolic disease (VTED) is a high-risk complication among post-operative knee and hip arthroplasty patients resulting in morbidity and mortality. This topic is extensively reviewed in the Hip and Groin Disorders guideline. Only the recommendations are reviewed here, and the reader is referred to the Hip and Groin Disorders guideline for further details.

Reported risk factors in these post-operative patients include age, general anesthesia, and obesity. There has been some review of risk of VTED from cement; however, the evidence conflicts.(1735, 1918) Treatments have included early ambulation (discussed elsewhere), compression boots or stockings(1919) and other methods,(1920) and medications.(1921-1929) There are currently four classes of medications used to prevent VTED: warfarin/ coumadin,(1930, 1931) low molecular weight heparin,(1932-1942) Factor Xa inhibitors,(1943) and direct thrombin inhibitors. (670) Of these options, all are currently available in the U.S. with the exception of oral direct thrombin inhibitors. While initially believed to be a complication of hospitalization, post-hospital discharge surveillance data suggest high risks of thromboembolism continue well after discharge,(1944) with many studies treating patients for 30 days for longer.

Prevention of Venous Thromboembolic Disease

Prevention of venous thromboembolic disease is strongly recommended for post-operative knee patients, particularly arthroplasty patients or other post-operative patients with prolonged reductions in activity. Early ambulation is recommended.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Compressions Stockings for Prevention of Venous Thromboembolic Disease

The use of post-operative graded compression stockings is moderately recommended for the prevention of venous thromboembolic disease.(1945, 1946)

Indications – All post-operative major knee surgical patients (e.g., knee fractures, knee arthroplasties, or any other patients thought at increased risk of VTED in the post-operative period).

Duration – Duration unclear and longer use does not add expense. As risk of VTED is high, particularly for these major procedures, threshold for use of 2 weeks or longer should be generally low.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Lower Extremity Pumps for Prevention of Venous Thromboembolic Disease
The use of lower extremity pump devices is moderately recommended for the prevention of venous thromboembolic disease.(1947-1950)

Indications – All post-operative major knee surgical patients (e.g., knee fractures, knee arthroplasties, or any other patients thought at increased risk of VTED in the post-operative period).

Devices – Devices include foot pumps, foot plus calf pumps, entire lower extremity intermittent compression devices and various other combinations. As there are no quality comparative trials, there is no recommendation for a particular device.

Duration – Duration unclear. Most have utilized devices for the duration of hospitalization. As risk of VTED is high, particularly for these major procedures, threshold for use of 2 weeks or longer should be generally low, including while at home.

Indications for Discontinuation – Discontinuation is generally recommended by 14 days unless there are continuing ongoing issues, such as delayed rehabilitation and ambulation that result in a judgment of increased risk. Some patients are also unable to tolerate devices.(1951)

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Low-molecular Weight Heparin for Prevention of Venous Thromboembolic Disease
Low-molecular weight heparin is strongly recommended for prevention of venous thromboembolic disease.

Indications – Post-operative arthroplasty, knee fracture, and other major knee surgery patients, particularly those with either prolonged inactivity or prolonged reduced or sedentary activity levels.(1941, 1945, 1952-1962) There is some evidence LMWH is generally preferable to warfarin for VTED prophylaxis. Patients with prior reactions to LMWH should generally receive other treatments first.

Dose/Frequency – Subcutaneous injections of enoxaparin (Lovenox) 4,000 IU or 40mg SC QD(1945, 1952-1954, 1956, 1963-1968) for variable durations ranging from 5 to 9 post-operative days(1965-1967) to 8 to 14 days(1964) to 10 to 14 days,(1963) 21 days,(1952, 1953) 30 days,(1956) to 12 weeks.(1954) There is no consensus on duration of treatment, and individualization based on activity level appears indicated.

Duration – Duration unclear. Available quality studies utilized treatment courses ranging from 4 days(1960) to 12 weeks.(1954) A plurality of studies utilized a course of 30 to 35 days.(1955-1957, 1961) There is quality evidence that treatment is generally required beyond hospitalization; there is evidence of deep venous thromboses many months later (reviewed above). One quality trial suggested no benefits from extending 4 to 10 days treatment out to 12 weeks.(1958) In the absence of substantive quality data comparing various durations of treatment, it is suggested that approximately 30 days of treatment after surgery may be required for average patients (a single trial suggested 30 to 42 days after arthroplasty).(1944) Patients with prior histories of venous thrombi, prolonged inactivity, delayed recovery or recurrences of thromboses, or family histories of venous thrombi likely require longer

courses. Those with major risk of bleeding may warrant individualized shorter courses. Patients who regain activity rapidly may be appropriate candidates for shorter courses of treatment.

Indications for Discontinuation – Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Factor Xa Inhibitors for Prevention of Venous Thromboembolic Disease

Factor Xa inhibitors are strongly recommended for the prevention of venous thromboembolic disease.

Indications – Post-operative arthroplasty, knee fracture, or other major knee surgery patients, particularly those with prolonged inactivity or prolonged reduced or sedentary activity levels.(1918, 1969-1972) Patients with prior reactions should generally receive other treatments first. Patients with renal failure or renal insufficiency should generally receive a different medication due to renal excretion of this compound.

Dose/Frequency – Subcutaneous injections of Fondaparinux (Arixtra) 2.5mg SC QD. Currently Rivaroxaban (Xarelto) is investigational in the U.S.

Duration – Duration unclear. Literature suggests duration be individualized based on factors such as prolonged inactivity, delayed recovery or thrombotic recurrences, prior history, and risks of bleeding.

Indications for Discontinuation – Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Warfarin and Heparin for Prevention of Venous Thromboembolic Disease

Warfarin and heparin are moderately recommended for prevention of venous thromboembolic disease.

Indications – Post-operative arthroplasty, knee fracture, other major knee surgery.(1973, 1974) Patients with adverse reactions to warfarin may be maintained on heparin throughout the treatment course. Patients with reactions to heparin, but at increased risk of thrombosis may be started on the other agents and switched to warfarin.

Dose/Frequency – Subcutaneous injections of Heparin, which can be titrated to the activated partial thromboplastin time (aPTT). Warfarin dose titrated to International Normalized Ratio (INR). Magnitude of anticoagulation is recommended to be individualized, and include risks of thrombi versus risks of bleeding and it is notable that the quality studies utilized a range of INRs.

Duration – Duration unclear. Literature suggests duration be individualized based on factors such as prolonged inactivity, delayed recovery or thrombotic recurrences, prior history, and risks of bleeding.

Indications for Discontinuation – Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Prevention of Venous Thromboembolic Disease

Aspirin is moderately recommended for the prevention of deep venous thrombosis.

Indications – Post-operative arthroplasty, knee fracture, and other major knee surgery patients, particularly after cessation of other treatments such as LMWH, heparin, or other anticoagulants.(1975)

Dose/Frequency – Aspirin 160mg per day was used in PEP trial. Other studies have found 85mg/day sufficient for heart attack prevention.

Duration – Duration unclear; 1 month is suggested, however due to other risk factors, prolonged or indefinite treatment may be recommended.

Indications for Discontinuation – Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Evidence for the Prevention of Venous Thromboembolic Disease
There are 9 high- and 23 moderate-quality RCTs incorporated into this analysis. There are 3 low-quality RCTs in Appendix 1.(1976-1978)

Hamstring and Hip Flexor Strains

See Hip and Groin Disorders guideline.

Iliotibial Band Syndrome

Introduction

Iliotibial band syndrome is believed to occur in susceptible individuals with exposure to forceful, repeated movement of the iliotibial band over the lateral femoral condyle with resultant friction.(129, 141, 177, 183, 187, 189, 190) This disorder has been reported mostly in discrete, physically active populations, including runners, military recruits, weight lifters, bicyclers, and downhill skiers.(127, 175, 176, 178-184, 189, 191-196, 1979, 1980) Quality epidemiological studies are absent, but purported risk factors include increased activity, genu varus, leg length discrepancies, running surface and shoe wear.(141, 1981, 1982) The results are thought to include tendinopathy-like changes involving the iliotibial tract with accompanying inflammation of the lateral synovial recess.(131, 132, 141, 183, 189, 1983-1987)

The diagnosis is mostly clinical, although MRI has been used for evaluation of IT band syndrome.(131, 132, 1988) Treatment has largely been empiric, as quality evidence has been notably sparse.(130) Conservative treatment has been thought to be successful.(1984, 1985, 1989) Treatments have predominantly included: reducing the exposure factor(s) and rest,(177, 185, 191, 192, 1984, 1989-1991) NSAIDs, gradual return to activity, ice,(141, 192, 196, 1980, 1992) massage,(1980, 1992, 1993) physical therapy, stretching of the IT band,(192, 194, 1994) and local injections.

Treatment Recommendations

NSAIDs

Anti-inflammatory medications have been used for treatment of IT band syndrome.(141, 177, 189, 191-193, 1980, 1984, 1989, 1990, 1995, 1996)

NSAIDs for Iliotibial Band Syndrome
NSAIDs are recommended for the treatment of iliotibial band syndrome.

Indications – Iliotibial band syndrome patients with sufficient symptoms to require treatment.

Frequency/Dose/Duration – Per manufacturers' recommendations.

Indications for Discontinuation – Sufficient clinical results (NSAIDS no longer required), resolution of symptoms, intolerance, adverse effects. A trial with a different class of NSAID is reasonable for treatment failures.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
There is one moderate-quality placebo-controlled trial; however, it did not document improvements compared to placebo.(1980) That trial included patients with acute symptoms and baseline differences that may have impacted the results. It also involved very short follow-up of 1 week with continued treadmill exercise in athletes resulting in difficulty extrapolating to working populations. The use of acute patients may have resulted in underpowering due to favorable prognoses in all treatment groups. NSAIDs are thought to be helpful, are not invasive, have few adverse, effects especially in young patients, are of low cost, and are thus recommended.

Evidence for the Use of NSAIDs
There is 1 moderate-quality RCT incorporated into this analysis.

Knee Immobilization

Knee immobilization has been used for treatment of IT band syndrome.(1997)

Knee Immobilization for Iliotibial Band Syndrome
Knee immobilization is not recommended for treatment of Iliotibial band syndrome.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation
There are no placebo-controlled trials that evaluate knee immobilization for treatment of IT band syndrome. There are also no quality trials comparing knee immobilization with an intervention with known efficacy. There is one moderate-quality trial comparing knee immobilization with phonophoresis that found the phonophoresis superior.(1997) While that study is likely biased in favor of phonophoresis, it does suggest that knee immobilization is not effective, and knee immobilization is thus not recommended.

Evidence for Knee Immobilization
There is 1 moderate-quality RCT incorporated into this analysis.

Transverse Friction Massage

Transverse friction massage has been used for treatment of IT band syndrome.(1980, 1992, 1993)

Transverse Friction Massage for Iliotibial Band Syndrome
There is no recommendation for or against the use of transverse friction massage for the treatment of iliotibial band syndrome.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There is one moderate-quality trial assessing additive benefit in addition to stretching, ice and ultrasound.(197) It failed to show improvement, although it may have been underpowered. Thus, there

is no recommendation for or against the use of transverse friction massage for treatment of iliotibial band syndrome.

Evidence for the Use of Transverse Friction Massage
There is 1 moderate-quality RCT incorporated into this analysis.

PHONOPHORESIS

Phonophoresis has been used for treatment of IT band syndrome.(1997)

Phonophoresis for Iliotibial Band Syndrome
There is no recommendation for or against the use of phonophoresis for the treatment of iliotibial band syndrome.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are no placebo-controlled trials that evaluate phonophoresis for treatment of IT band syndrome. There are also no quality trials comparing phonophoresis with an intervention with known efficacy. There is one moderate-quality trial comparing phonophoresis with knee immobilization that found phonophoresis superior.(1997) However, the study was likely biased in favor of phonophoresis. Therefore, there is no recommendation for or against the use of phonophoresis.

Evidence for the Use of Phonophoresis
There is 1 moderate-quality RCT incorporated into this analysis.

Glucocorticosteroid Injections

Glucocorticoid injections have been used for treatment of IT band syndrome.(1998)

Glucocorticosteroid Injections for Iliotibial Band Syndrome
Glucocorticosteroid injections are recommended for the treatment of iliotibial band syndrome in a subset of patients with insufficient results from other treatments.

Indications – Iliotibial band syndrome patients with insufficient results from activity modification, relative rest, NSAIDs, and local applications of ice or heat.

Frequency/Dose/Duration – One quality trial used methylprednisolone acetate 40mg mixed with 1% lidocaine, injected between the IT band and lateral femoral condyle.(1998) If there is insufficient response, consideration may be given to a second injection, often with a modestly higher dose.

Indications for Discontinuation – A second glucocorticosteroid injection is not recommended if the first has resulted in significant reduction or resolution of symptoms. If there has not been any response to a first injection, there is also less indication for a second. If the interventionalist believes the medication was not well placed and/or if the underlying condition is so severe that one steroid bolus could not be expected to adequately treat the condition, a second injection may be indicated. In patients who respond with several weeks of pharmacologically appropriate, temporary, partial relief of pain, but then have worsening pain and function and are not (yet) interested in surgical intervention, a repeat steroid injection is an option. There is unlikely to be benefit with greater than about 3 injections per year.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendation
There is one moderate-quality placebo-controlled trial that suggested benefits of injection with glucocorticoid compared with placebo anesthetic for treatment of iliotibial band syndrome.(1998)

Although the trial was small, the results were statistically significant, thus meeting minimum criteria for an evidence-based recommendation. These injections are mildly invasive, have adverse effects, are moderately costly, and appear effective and are therefore recommended.

Evidence for the Use of Glucocorticosteroid Injections
There is 1 moderate-quality RCT incorporated into this analysis.

Surgery

Surgical procedures have been used for treatment of iliotibial band syndrome, which have included x-lengthening.(192, 1990)

Surgery for Iliotibial Band Syndrome
There is no recommendation for or against surgery for treatment of iliotibial band syndrome.

Indications – Iliotibial band syndrome patients with insufficient results from activity modification, relative rest, NSAIDs, local applications of ice or heat, and 2 glucocorticoid injections.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are no quality trials comparing surgery with sham surgery for treatment of iliotibial band syndrome. There are also no quality trials comparing surgery with a non-interventional control group. There also are no quality comparative trials for different operative approaches. Therefore, surgery would be a last resort for the small minority of patients with unsatisfactory results from other treatments that generally include at least 2 glucocorticoid injections. Surgery is invasive, has adverse effects, and is highly costly. Therefore, there is no recommendation for or against its use in this small group of patients as data are insufficient and inconclusive.

QUADRICEPS, GASTROCNEMIUS, AND SOLEUS STRAINS

Introduction

Quadriceps, gastrocnemius and soleus strains are thought to be true muscular strains (i.e., disrupted myotendinous junctions). These problems are usually precipitated by a high-force maneuver, including sports injuries in sprinting, football or soccer,(1999-2001) with near maximum voluntary contraction capabilities. Prior injury is likely the greatest predictor of future risk. Patients have pain exacerbated by use, stiffness and weakness.

Diagnostic Recommendations

X-RAYS and MRI

X-ray and/or MRI for Severe Quadriceps, Gastrocnemius, or Soleus Strains

In the more severe cases of quadriceps, gastrocnemius, and soleus strains, evaluation with x-ray and/or MRI are recommended for evaluation of the underlying bony structure as well as the degree of muscle tear.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Rationale for Recommendation
The examination findings for these types of strains are tenderness, usually at either the muscle origin or insertion (e.g., high vs. low hamstring strains), with swelling or large ecchymoses in more severe cases. Some cases involve complete ruptures and require surgical repair. Clinical tests are generally not necessary, although in the more severe cases, evaluation with x-ray and/or MRI are recommended for evaluation of the underlying bony structure as well as the degree of muscle tear, as severe cases may require surgery.

Treatment Recommendations

WORK LIMITATIONS

Work Limitations for Select Cases of Quadriceps, Gastrocnemius, or Soleus Strains
Work limitations are recommended for those with quadriceps, gastrocnemius, or soleus strains performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Work Limitations for Other Cases of Quadriceps, Gastrocnemius, or Soleus Strains
There is no recommendation for or against work limitations for other cases of quadriceps, gastrocnemius, or soleus strains.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
Work limitations may be necessary depending on the severity of the condition and the required job demands.

BED REST

Bed Rest for Quadriceps, Gastrocnemius, or Soleus Strains
Bed rest is not recommended for treatment quadriceps, gastrocnemius, or soleus strains, although relative rest may be required for many patients.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

NSAIDs

NSAIDs for Quadriceps, Gastrocnemius, and Soleus Strains
Nonsteroidal anti-inflammatory medications are recommended for quadriceps, gastrocnemius, and soleus strains.

Dose/Duration **–** See NSAID section for dose, frequency, discontinuation information.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

ICE/HEAT

Ice/Heat for Quadriceps, Gastrocnemius, or Soleus Strains
Ice and/or heat are recommended for treatment of quadriceps, gastrocnemius, or soleus strains.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

WRAPS

Ace Wraps for Quadriceps, Gastrocnemius, or Soleus Strains
Ace wraps are recommended for treatment of quadriceps, gastrocnemius, or soleus strains.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

REHABILITATION THERAPY

Rehabilitation Therapy for Quadriceps, Gastrocnemius, or Soleus Strains
A course of rehabilitation therapy is recommended for patients with persisting pain from quadriceps, gastrocnemius, or soleus strains.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

Progressive Agility, Trunk Stabilization, and Icing (PATS)

PATS for Quadriceps, Gastrocnemius, or Soleus Strains
PATS is recommended for quadriceps, gastrocnemius, or soleus strains.

Dose/Duration **–** See Exercise section for exercise dose, frequency, discontinuation information.

Strength of Evidence **– Recommended, Evidence (C)**

Rationale for Recommendations
There is one quality study of treatment options, however, it only addressed exercise(2002); thus nearly all treatment recommendations are empiric.(2003-2005) Bed rest is not recommended due to concern regarding deep venous thrombosis and other adverse effects of bed rest. A course of rehabilitation therapy is recommended for those with persisting pain, although long term compliance is a noted problem.(2003) Quality evidence suggests stretching and isolated progressive resistance training are not successful compared with progressive agility, trunk stabilization and icing (PATS)(2002); thus PATS is recommended.

Evidence for the Use of PATS for Hamstring Strains
There is 1 moderate-quality RCT incorporated in this analysis. There are 2 low-quality RCTs in Appendix 1.

KNEE SPRAINS (including Medial and Lateral Collateral Ligaments; Anterior and Posterior Cruciate Ligaments)

Introduction

Knee sprains are partial or complete disruptions of ligaments.(104, 2006, 2007) Thus, these injuries are usually a result of high force events, particularly including sporting injuries, slips, trips, falls, motor vehicle accidents and work injuries.(104, 2006, 2008, 2009) The 4 major ligaments of the knee are all susceptible to knee sprains.(104, 2006) These are the medial and lateral collateral ligaments, along with the anterior and posterior cruciate ligaments. Sprains are typically graded from I to III ranging from an intact ligament without laxity but with fiber disruption (I) to complete disruption (III).(104, 2006, 2007) Low grade sprains are considered to have excellent prognoses.(2006, 2010-2012) Grade III sprains are more susceptible to concomitant injuries such as the ACL and menisci.(2006) A careful history will usually result in a presumptive diagnosis that is confirmed on physical examination (see History and Physical Examination sections). Patients have pain exacerbated by use and ligament stretching. The examination findings are focal tenderness over the collateral ligament and pain augmentation with ligamentous stressing for collateral ligament sprains. Examination findings may be normal for Grade I cruciate ligament sprains or include laxity with complete disruptions. Some cases involve complete ruptures and may require surgical repair (see ACL section). Combined ruptures (e.g., MCL plus ACL) are beyond the scope of this guideline as there are few quality studies to define treatment options and both operative and non-operative care has been attempted with successes.

Diagnostic Recommendations

X-RAY AND MRI

X-rays and MRI for Evaluation of Knee Sprains

X-ray and/or MRI are recommended for the evaluation of knee sprains, particularly to rule out fracture.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ULTRASOUND

Ultrasound for Evaluation of Knee Sprains

There is no recommendation for or against the use of diagnostic ultrasound for the evaluation of knee sprains.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

Clinical tests are generally not necessary for mild sprains, although in more severe cases, evaluation with x-ray and/or MRI are recommended, particularly to rule out fracture, and MRI is helpful for defining

cruciate ligament tears. There is no recommendation for or against the use of diagnostic ultrasound to evaluate knee sprains.

Treatment Recommendations

WORK LIMITATIONS

Work Limitations for Select Knee Sprains

Work limitations are recommended for those with knee sprains performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Work Limitations for Other Cases of Knee Sprains

There is no recommendation for or against the use of work limitations for other cases of knee sprains.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

BED REST AND KNEE IMMOBILIZATION

Bed Rest and Knee Immobilization for Knee Sprains

Bed rest and knee immobilization are not recommended for treatment of knee sprains, although relative rest may be required for many patients.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

NSAIDs

NSAIDs for Knee Sprains

Nonsteroidal anti-inflammatory medications are recommended for treatment of knee sprains.

Dose/Duration – See NSAID section for dose, frequency, discontinuation information.

Strength of Evidence **– Recommended, Insufficient Evidence (I)**

ICE/HEAT

Ice/Heat for Knee Sprains

Ice and/or heat are recommended for treatment of knee sprains.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

WRAPS AND KNEE BRACES

Ace Wraps and Knee Braces for Knee Sprains

Ace wraps and knee braces are recommended for treatment of knee sprains.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

REHABILITATION THERAPY

Rehabilitation Therapy for Knee Sprains

A course of rehabilitation therapy is recommended for those with persisting pain from a knee sprain.

Dose/Duration – See exercise section for dose, frequency and discontinuation.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

OTHER PHYSICAL MODALITIES/INJECTIONS

Other Modalities/Injections for Knee Sprains

There is no recommendation for or against the use of therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, low-level laser therapy, phonophoresis, acupuncture, manipulation, mobilization or manual therapy, autologous blood injections, plasma rich platelet injections, glucocorticosteroid injections, and hyaluronic acid injections for knee sprains.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

SURGERY

Surgery for Grade III LCL Tears

Surgery is recommended in isolated Grade III LCL tears, recognizing that they are rare.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Surgery for Select Cases of Grade III MCL Tears

Surgery in isolated Grade III MCL tears is usually not necessary because of the documented excellent healing potential of this ligament with closed (i.e., non-operative) treatment. Surgery is only recommended in those rare select cases of failure of non-operative management.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations

There are no quality studies of treatment options aside from surgery and rehabilitation for complete ACL tears (see next section) and one trial comparing NSAIDs(719) and one with DHEP gel.(2013) Of necessity, guidance for treatment relies upon ankle sprains for analogy as there are considerable quality trials for ankle sprains (2014, 2015) (evidence ratings are all “Insufficient Evidence” due to the analogy with the ankle). Work limitations may be necessary depending on the severity of the condition and the required job demands.(2016) Those performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition are recommended to have work limitations.

Bed rest and knee immobilization are not recommended due to risks of venous thromboembolisms and other adverse effects of bed rest, although relative rest may be required for many patients. NSAIDs, ice and/or heat, Ace wraps, and knee braces are recommended. A low-quality trial suggested a less bulky elastic support bandage was superior to a Robert Jones bandage.(2017) Those with persisting pain are recommended to have a course of rehabilitation therapy. There is no recommendation for or against autologous blood injections, plasma rich platelet injections, glucocorticosteroid injections, hyaluronic acid injections, therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, low level laser therapy, phonophoresis, acupuncture, manipulation, and mobilization or manual therapy. RCTs and a systematic review suggested neuromuscular training for sports injury prevention was effective.(2018-2021) However, this topic is beyond the scope of these *Guidelines* but may be of interest to some readers. Warm-up stretching has been shown to increase flexibility(2022); however, its relationship to preventing injury is unclear. Surgery is recommended in isolated Grade III LCL tears, recognizing that they are rare. Surgery in isolated Grade III MCL tears is usually not necessary because of the documented excellent healing potential of this ligament with closed (i.e., non-operative) treatment. Surgery is only recommended in those rare select cases of failure of non-operative management.

Evidence for Knee Sprains
There are 5 moderate-quality RCTs incorporated into this analysis. There are 3 low-quality RCTs in Appendix 1.

Anterior and Posterior Cruciate Ligament Tears

Introduction

This section addresses complete disruptions of the cruciate ligaments. These injuries are most commonly experienced in athletics, as well as acute discrete, forceful traumatic events.(2, 4, 1061, 1064-1066, 1068, 1069, 1072-1075, 2023-2031) The history and physical examination findings have been previously discussed (see History and Physical Examination and Knee Sprain sections). There are concerns regarding subsequent development of osteoarthrosis, and a positive pivot shift after surgical repair has been reported to predict osteoarthrosis.(2032)

The anterior cruciate ligament (ACL) is considered the most important stabilizing knee ligament. Thus, this section will primarily address ACL tears. Posterior cruciate ligament tears are uncommon, and rarely require surgery in non-professional athletes. PCL ligament tears are thought to be best rehabilitated with progressive exercises which are **Recommended, Insufficient Evidence (I)** (see ACL exercise section above).

Whereas ACL tears were once universally thought to require surgical repair, there is now quality evidence of successful non-operative rehabilitation in well selected patients (see below). This has somewhat increased the complexity of patient management. For many interventions, there is not quality evidence, and either inference from treatment of other body parts, consensus, and/or expert opinion guide treatments.

Diagnostic Recommendations

X-RAYS

X-ray for Evaluation of ACL Tears
X-ray is recommended for many cases of ACL tears, particularly accompanying trauma, to rule out fractures.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

MRI

MRI for the Evaluation of ACL Tears
MRI is recommended for ACL tears, particularly if there are concerns for other soft tissue damage including meniscal tears and other sprains. However, some cases also may be managed clinically without MRI.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ULTRASOUND

Ultrasound for the Evaluation of ACL Tears

There is no recommendation for or against the use of diagnostic ultrasound for evaluation of ACL tears.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

Clinical tests may or may not be necessary depending on the mechanism of severity, physical examination findings and potential for complicating injuries. X-ray is recommended particularly in cases with accompanying trauma to rule out fractures. MRI is helpful, particularly if there are concerns for other soft tissue damage including meniscal tears and other sprains. However, some cases also may be managed clinically without MRI. There is no recommendation for or against the use of diagnostic ultrasound to evaluate ACL tears.

Treatment Recommendations

Rest, splints, ice and heat have been utilized for treatment of ACL injuries.(1066, 1068, 1072, 1074, 2023, 2033, 2034) Functional bracing has been used to prevent and treat ACL injuries; they have also been used post-operatively as part of the rehabilitation program.(1064, 1065, 1069) There are no quality studies of treatment options aside from exercise, rehabilitation, braces and surgical treatment.

BRACING

Knee bracing is commonly performed for ACL tears.(1061, 1064-1066, 1068, 1069, 1072-1077, 2023-2031, 2033, 2035, 2036) Most often, hinged braces are used, although there are different models in use.

Functional Bracing for Treatment of Non-Operative Anterior Cruciate Ligament Injuries

There is no recommendation for or against the use of functional bracing for treatment of non-operative ACL injuries.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Functional Bracing for Anterior Cruciate Ligament Injuries Post-operatively

Functional bracing is not recommended for ACL injuries post-operatively.

Strength of Evidence **– Not Recommended, Evidence (C)**

Rationale for Recommendations

There are many RCTs that evaluate the use of braces to treat and rehabilitate post-operative and non-operative patients with ACL tears. However, nearly all of the trials for non-operative treatment are of low quality. Thus, there is no recommendation for or against the use of braces for non-operative treatment of ACL tears. Use of braces in these patients must balance theoretical stabilization against disuse and delayed progression. If braces are prescribed it is suggested patients be monitored for progress and generally be engaged in an active exercise program.

There are four moderate-quality trials that evaluated post-operative patients. Three of these studies suggested no differences in outcome,(1076, 2035, 2036) and the other suggested modestly less reduction in range of motion in a post-operative group.(1077) Bracing is not invasive, has low adverse effects, and is low to moderately costly. However, available evidence does not suggest significant

benefits; therefore bracing is generally not recommended. Exceptions may include suboptimal surgical repairs and other extenuating factors.

Evidence for the Use of Bracing for ACL Tears
There are 5 moderate-quality RCTs incorporated into this analysis. There are 8 low-quality RCTs in Appendix 1.(2037-2044)

Rehabilitation after ACL Injury With or Without Reconstruction

Exercise, physical therapy, and rehabilitation have been used for treatment of ACL tears either instead of surgery or post-operatively.(224, 2008, 2009, 2045-2054) The early objectives of rehabilitation include restoration of knee range of motion, pain management, reduction of swelling, early ambulation and increasing muscle strength.(2047, 2051)

Post ACL Injury Rehabilitation with or without Surgical Repair
Rehabilitation is recommended after ACL injury with or without surgical reconstruction.

Indications – ACL injury with or without surgery.

Duration – One to 6 weeks, 2 to 3 sessions a week, decreasing over time with active treatment up to 12 weeks.(2009, 2055) There is quality evidence that a home-based program is as effective as a therapy based program for motivated post-operative patients(2047, 2056) (see Table 6).

Indications for Discontinuation – Achievement of goals, non-compliance with clinic or home-based exercises or intolerance.

Strength of Evidence – **Recommended, Evidence (C)**

Table 6. Post-operative Rehabilitation after ACL Injury

		0-4 weeks	5-8 weeks	9-12 weeks	13-16 weeks	17-24 weeks
Unloaded ROM		As tolerated	As tolerated	Normal	Normal	Normal
Muscle Function	*Quadriceps*	Unloaded, full control	Loaded, non-weight bearing in 40-120°; weight-bearing exercises in 0-80°	Closed chain exercises without limitations		
	Hamstrings	Loaded exercises	No limitations	No limitations	No limitations	No limitations
	All other lower limb muscles	Initiated	No limitations	No limitations	No limitations	No limitations
Symptoms	*Pain*	As tolerated; treat if necessary	As tolerated; treat if necessary	No pain	No pain	No pain
	Swelling	As tolerated; treat if necessary	As tolerated; treat if necessary	Occasional activity-related swelling, no treatment	Occasional activity-related swelling, no treatment	Occasional activity-related swelling, no treatment

Walking		As tolerated; may use crutches until walk backwards without limping	Full weight bearing. Daily walking without restriction	Slow and fast walking on treadmill	Running on treadmill/even surface. Non-surgical: unrestricted running	Surgical: unrestricted running
Balance/ Coordination	*One-leg standing*	Stand in functional positions	Stand in functional positions on soft ground and Babs-board	More demanding surfaces	Two legged bounces, easy sport-specific movements. Easy agility exercises	One-legged bounces. Provoked sport-specific movement. Provoked agility exercises.
Activities		Unloaded and loaded biking on stationary bike backwards and forwards	Stationary biking without restrictions. Water based running. Non-surgical: outdoor biking with restrictions.	Slide-board training	Non-surgical: introduction of sport-specific exercises. Surgical: Outdoor biking without restrictions	Surgical: introduction of sport-specific exercises.

Adapted from Frobell, et al. 2007.

Home-Based Physical Therapy for Post-ACL Operative Repair Patients

Home-based physical therapy is recommended for post-ACL operative repair patients.

Indications – ACL post-operative patients.(2047, 2056, 2057)

Duration – From 3 to 5 supervised physical therapy visits focusing on a home-based exercise program that lasts up to a total of 3 months post-operatively.(2047, 2056, 2057) The idea is to develop a continual exercise program indefinitely.

Indications for Discontinuation: Discontinuation of intermittent supervision based on achievement of goals, non-compliance or intolerance.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendations

A moderate-quality trial has shown equivalent results whether treatment is surgical or non-surgical (see Surgical section below).(2009) There are no quality studies comparing post ACL-injury with rehabilitation compared with no rehabilitation. Two moderate-quality studies evaluated home exercises after 0 to 4 supervised physical therapy sessions compared with a total of 17 or more sessions and reported no differences in several objective and subjective outcomes.(2047, 2056) A low-quality study evaluated home therapy after supervised physical therapy to supervised physical therapy and reported no significant differences in favor of a fully-supervised physical therapy program.(2057) A second low-quality study evaluated a home exercise program versus clinic-based exercises and found no significant differences.(2058) Another low-quality study evaluated a supervised home exercise program versus a knee exercise class for a minimum of 6 months after ACL reconstruction and concluded there was no difference between groups.(2059) Physical therapy appears beneficial in ACL-injured patients with no reported significant adverse events. One trial suggested supervised training to be superior to self-monitoring; however, the trial appears to have instructed the self-monitored group to avoid use, thus biasing against that treatment.(2060) Home based exercises programs appear as efficient as supervised

programs, cost less, and are recommended for most motivated post-operative patients.(2058) It is recommended that several types of exercises be included in the post injury rehabilitation program (see above).(1275, 1292, 2009, 2049, 2061-2065) Rehabilitation is not invasive, has few adverse effects and is moderately costly using the regimen noted above. Given the evidence of efficacy, rehabilitation is recommended.

Perturbation Training As Part of a Rehabilitation Program for ACL Injured Patients

Perturbation training is recommended as part of a comprehensive exercise program in patients with injured ACL with or without surgery.

Indications – ACL injured patients who choose to undergo ACL reconstruction surgery, or patients who opt for nonsurgical management. To be done as part of a comprehensive exercise therapy program that includes strength training exercises.(2066, 2067)

Duration – As part of a therapy program, both supervised and unsupervised. Available studies have examined up to 10 sessions of therapy with perturbation as a part of the therapy program.(2066, 2067)

Indications for Discontinuation – Achievement of goals, non-compliance, or lack of benefits.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

A low-quality study evaluated ACL-injured patients who opted to be treated non-operatively. The study compared physical therapy with or without perturbation training and reported slightly better improvements in the perturbation group.(2066) Perturbation training can be included in a therapy program. A low-quality study evaluated perturbation and strength training versus strength training alone prior to ACL surgery. Both groups increased strength post-operatively, but the group that included perturbation training had better gait mechanics results 6 months after surgery.(2067) It appears to have low adverse events and encourages physical activity. One trial has suggested that patients, classified as non-copers performed better with perturbation training and quadriceps strength training than quadriceps strength training.(2068)

Early Post-operative Rehabilitation After ACL Reconstruction Surgery

Early post-operative rehabilitation after ACL reconstruction surgery is recommended.

Indications – ACL reconstruction patients starting as early as the first post-operative day.(2051, 2061, 2069)

Duration – Two to 3 times a week for up to 6 weeks for guided therapy.(2062, 2070)

Indications for Discontinuation – Complications causing a need for further intervention and/or surgery.

Strength of Evidence – **Recommended, Evidence (C)**

Rationale for Recommendation

A moderate-quality study evaluated isokinetic hamstring exercises as part of a post-operative rehabilitation program. One group started the exercises 3 weeks post-operatively, the other 9 weeks post-operatively. They reported benefits of starting exercises earlier in an athletic cohort.(2071) A moderate-quality study compared patients who started quadriceps exercises on post-operative day 2 with patients who started therapy 1 to 2 weeks following surgery. They reported no increase in adverse events and faster recovery of knee range of motion and stability in the group that started therapy earlier.(2051) Earlier rehabilitation has not been reported to increase adverse events, and it has been reported to increase benefits.(2061) A low-quality study evaluated knee continuous passive range of motion starting post-operative day two to range of motion on post-operative day seven. They reported

no increase in adverse events with staring therapy earlier.(2069) Early rehabilitation is not invasive, has low adverse effects, is low cost, has documented efficacy, and is therefore recommended.

Evidence for Post ACL Injury Rehabilitation
There are 9 moderate-quality RCTs incorporated into this analysis. There are 5 low-quality RCTs in Appendix 1.

Work Limitations

Work Limitations for Select Cases of ACL Tears
Work limitations for ACL tears are usually necessary, especially in the acute phase, although required job demands must be incorporated. Severe cases may be unable to perform any work for a few days. Those performing high physical demand tasks or those who cannot avoid repeating physically demanding job tasks similar to those that resulted in the condition are especially recommended to have work limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Work Limitations for Other Cases of ACL Tears
There is no recommendation for or against work limitations in other cases of ACL tears, particularly where the worker has the ability to modulate work tasks.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

BED REST AND KNEE IMMOBILIZATION

Bed Rest and Knee Immobilization for ACL Tears
Bed rest and knee immobilization are not recommended for ACL tears, although relative rest may be required for most patients.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

NSAIDs

NSAIDs for ACL Tears
Nonsteroidal anti-inflammatory medications are recommended for ACL tears. (See NSAID section for dose, frequency, discontinuation information.)

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ICE/HEAT

Ice/Heat for ACL Tears
Ice and/or heat are recommended for ACL tears.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

OTHER MODALITIES/INJECTIONS

Other Modalities/Injections for ACL Tears
There is no recommendation for or against therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, low-level laser therapy, phonophoresis, acupuncture, manipulation and mobilization or manual therapy, autologous blood injections, plasma rich platelet injections, glucocorticosteroid injections, and hyaluronic acid injections.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
There are no quality trials specifically addressing patients with ACL and PCL tears. Work limitations are usually necessary, especially in the acute phase, although required job demands must be incorporated. Those performing high physical demand tasks or those who cannot avoid repeating physically demanding job tasks similar to those that resulted in the condition are especially recommended to have work limitations. In other cases, particularly where the worker has the ability to modulate work tasks, there is no recommendation for or against work limitations. Bed rest and knee immobilization are not recommended due to risks of venous thromboembolisms and other adverse effects of bed rest, although relative rest may be required for most patients. Nonsteroidal anti-inflammatory medications and ice/heat are recommended. There is no recommendation for or against the use of therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, low-level laser therapy, phonophoresis, acupuncture, manipulation and mobilization or manual therapy, autologous blood injections, plasma-rich platelet injections, glucocorticosteroid injections, or hyaluronic acid injections for treatment of ACL tears.

Surgery

Surgery has been utilized for reconstruction of torn ACLs.(1, 581, 1538, 1555, 1557, 1559, 1560, 1562, 1566-1570, 2008, 2009, 2045, 2048, 2072-2107) Recently, studies have documented equivalent success with non-operative management of ACL tears.(2009) The crossover rate to surgery from the non-operative arm was 37% (23 of 59), potentially signaling that significant numbers of patients may still require surgery for successful outcomes from ACL tears. There also are some concerns that meniscal injuries may occur more readily in cruciate deficient knees, and subsequent surgical repairs may be less successful.(2108-2112)

Surgery for ACL Tears
Surgical reconstruction of ACL tears is sometimes recommended for treatment of select patients with ACL tears.

> *Strength of Evidence* – **Recommended, Insufficient Evidence (I)**
> *Level of Confidence* – **Low**

Indications – Patients should generally have attempted non-operative treatment that included progressive exercise implemented after the acute phase of swelling, if any, has subsided. Duration of a non-operative treatment plan to determine success or failure is unclear and likely requires individualization. A study evaluated grafting at 2 weeks versus 8 to 12 weeks and reported no significant differences after 52 weeks of follow up.(2113) Most patients who fail non-operative treatment appear to require surgery within 3 months of the ACL tear.(2009) There is no quality evidence surgery out-performs primary rehabilitation at 5 years of follow-up (2471). Some patients, particularly those with high demand jobs or high performance athletes, may be candidates for early surgical reconstruction, as they are believed to more frequently fail non-operative rehabilitation.(1, 2113) There is moderate-quality evidence that delay in surgical reconstruction does not impair outcomes,(2009, 2113) thus there is no rush to operate that has been shown in quality studies.

Benefits – Theoretically better ability to suddenly pivot on the knee and less instability.

Harms – Increased risk of osteoarthritis in the operated knee, risk of infection, longer period of debility than with a primary rehabilitation approach.

Rationale – There is one moderate-quality trial comparing rehabilitation with surgical reconstruction of ACLs and which found no differences over time intervals up to 2 years.(2009) Four low-quality trials comparing surgical ACL reconstruction with non-operative care have also been published, with one trial suggesting mostly comparable results but more instability in the non-surgical group,(2045) one suggesting fewer subsequent meniscal tears after surgical ACL reconstruction,(2048) one suggesting comparable functional outcomes,(2008) and one suggesting superior stability with surgery.(2109)

There are numerous quality trials comparing different surgical approaches, most commonly a patellar tendon autograft or hamstring tendon autograft (see evidence table). Most RCTs have participants that are actively participating in various levels of sports, which may somewhat limit generalizability, although presumably less active patients may derive comparable benefits.

Patellar tendon autografts have been associated with fewer graft failures and less knee laxity. Hamstring tendon autografts have been associated with less anterior knee pain and less extension deficit.(2114-2116) Use of hamstring autograft compared to patellar reportedly results in less anterior knee pain up to 3 years post-operatively,(2117-2122) and other studies reported no differences up to 7 years post-operatively.(2114, 2123-2126)

Different hamstring autograft techniques have been used. There are studies evaluating the double-bundle technique versus the single-bundle technique.(378, 2127-2132) The argument for the more technically demanding anatomic double-bundle technique is that the results are more anatomical compared to the single-bundle technique.(2115, 2133, 2134) Two moderate-quality studies comparing hamstring autograft double-bundle to single-bundle techniques reported superior anterior and rotational stability, but no subjective difference.(2115, 2133) One study evaluated the double bundle hamstring autograft done with 4 strands versus 8, and reported superior outcomes in terms of laxity and subjective results in the 8-strand double-bundle group.(2134) There is no clear evidence supporting one surgical treatment over another; thus there is no recommendation regarding specific autologous tendon harvest sites or surgical techniques.

Thus, currently available quality evidence suggests autologous grafting may be superior to prosthetics or allografts,(2135-2138) although individual patient factors should be considered. This precludes a formal recommendation for or against prosthetics and allografts. Surgical reconstruction is invasive, has adverse effects, and is highly costly, but may be necessary for selected patients and is thus selectively recommended.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Ipsilateral Hamstring Autografts; Anterior cruciate ligament, posterior cruciate ligament, ACL, PCL, repair, injury; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 17 articles in PubMed, 56 in Scopus, 1 in CINAHL, 6 in Cochrane Library, 1330 in Google Scholar, and 4 from other sources. We considered for inclusion 2 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 4 from other sources. Of the 9 articles considered for inclusion, 8 randomized trials and 1 systematic review met the inclusion criteria.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: LAD technique, ligament augmentation device, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 32 articles in PubMed, 57 in Scopus, 26 in CINAHL, 10 in Cochrane Library, 5340 in Google Scholar, and 0 from other sources. We considered for inclusion 8 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 7 randomized trials and 1 systematic review met the inclusion criteria

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Anterior cruciate ligament, Posterior cruciate ligament, ACL, injuries, sprain, tear, Leeds-Keio graft, artificial ligament, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 101 in Scopus, 7 in CINAHL, 1 in Cochrane Library, 198 in Google Scholar, and 1 from other sources. We considered for inclusion 1 from PubMed, 6 from Scopus, 2 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 1 from other sources. Of the 13 articles considered for inclusion, 3 randomized trials and 3 systematic reviews met the inclusion criteria.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Patellar Tendon Graft, Bone-patellar tendon-bone grafting, Anterior Cruciate Ligament Tears and Posterior Ligament Tears, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 106 articles in PubMed, 2513 in Scopus, 16 in CINAHL, 33 in Cochrane Library, 2180 in Google Scholar, and 7 from other sources. We considered for inclusion 15 from PubMed, 0 from Scopus, 0 from CINAHL, 7 from Cochrane Library, 2 from Google Scholar, and 7 from other sources. Of the 31 articles considered for inclusion, 25 randomized trials and 6 systematic reviews met the inclusion criteria.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: quadriceps tendon graft;

Anterior Cruciate Ligament Tears, Posterior Ligament Tears, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 18 articles in PubMed, 1 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 in Google Scholar, and 2 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion, 3 randomized trial and 0 systematic reviews met the inclusion criteria.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Semitendinosus Graft, Anterior cruciate ligament, Posterior cruiate ligament, ACL, injuries, sprain, tear controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 69 articles in PubMed, 29 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 1460 in Google Scholar, and 19 from other sources. We considered for inclusion 8 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 7 from Google Scholar, and 0 from other sources. Of the 17 articles considered for inclusion, 7 randomized trials and 2 systematic reviews met the inclusion criteria.

Post-operative Rehabilitation for ACL Tears

See above.

Meniscal Tears

Diagnostic Recommendations

Magnetic resonance imaging of asymptomatic individuals has shown that among those 60 to 69 years of age, the anterior horns were normal in only 20% of the lateral menisci, and all medial menisci were abnormal.(2139) Similarly, all of the posterior horns were also showing some degenerative changes among the elderly with strong trends towards increased degeneration with age.(2139) Another study reported severity of changes and also found a strong correlation between increased degenerative changes and age.(2140) Thus, tears of the medial or lateral knee menisci are quite common. They have often been classified as trauma-related or degenerative.(2139-2141) However, due to the high prevalence of tears on MRI, designations of trauma-related tears may be a somewhat arbitrary distinction in many cases, particularly when the inciting event involves normal use or minimal exertion, rather than sporting events.

A careful history will usually result in a presumptive diagnosis that may be confirmed with physical examination (see History and Physical Examination sections above). Patients tend to have pain that lateralizes to the affected compartment and tends to not radiate and may or may not have swelling, presumably depending on factors such as the acuity and magnitude of the tear. Quality of physical examination tests has been called “poor to fair,”(138, 2142) and many examination maneuvers have relatively poor operant characteristics.(74, 75, 80, 83, 137, 2143-2146) A composite of physical

examination maneuvers has been thought to be more helpful.(108) As there is a high prevalence rate of asymptomatic tears, the examination also may be normal, but an MRI may be abnormal.(2139, 2140) Clinical tests are generally not necessary for initial presentation and evaluation of mild meniscal tears as they do not tend to affect management.

X-RAY AND MRI

X-ray and MRI for Evaluation of Meniscal Tears

X-ray and MRI are recommended in more severe cases of meniscal tears, including cases involving significant trauma, particularly to rule out fracture. MRI is also helpful for defining other injuries that may accompany tears such as cruciate and other ligament tears.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ULTRASOUND

Ultrasound for Evaluation of Meniscal Tears

There is no recommendation for or against the use of diagnostic ultrasound for the evaluation of meniscal tears.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

MRI has been commonly performed to evaluate meniscal tears.(430, 433, 2147-2177) However, MRIs have been thought to be able to be reserved for complicated and confusing cases,(2178) as they do not usually contribute to management.(2179, 2180) There also are concerns that have been raised regarding increasing unnecessary surgery by over-reliance on MRI findings(2181); although a clinical trial suggested this may not be the case.(2180) Ultrasound,(2182-2186) CT, CT arthrography, spiral CT,(2187-2190) SPECT,(2191-2193) and SPET(2194) have all been used for diagnostic purposes. There are no quality studies of treatment options aside from surgery and rehabilitation for meniscal tears (see next section). Out of necessity, guidance for treatment relies by analogy upon ankle sprains, as there are considerable quality trials for ankle sprains.

Evidence for the Use of MRI for Meniscal Tears

There are 1 moderate-quality RCT incorporated into this analysis.

Treatment Recommendations

Rest, splints, ice and heat have been utilized for treatment of meniscal tears.

Work Limitations

Work Limitations for Select Cases of Meniscal Tears

Work limitations are recommended for those with meniscal tears performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks that may have resulted in the condition.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Work Limitations for Other Cases of Meniscal Tears

There is no recommendation for or against work limitations in other cases of meniscal tears.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

BED REST AND KNEE IMMOBILIZATION

Bed Rest and Knee Immobilization for Meniscal Tears

Bed rest and knee immobilization are not recommended for meniscal tears, although relative rest may be required for some patients, particularly those more severely affected.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

NSAIDs

NSAIDs for Meniscal Tears

Nonsteroidal anti-inflammatory medications are recommended for meniscal tears. (See NSAIDs section for dose, frequency, discontinuation information).

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ICE/HEAT

Ice/Heat for Meniscal Tears

Ice and/or heat are recommended for meniscal tears.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

WRAPS/SUPPORTS/SLEEVES

Ace Wraps, Supports or Sleeves for Meniscal Tears

Ace wraps, supports, or sleeves are recommended for meniscal tears.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

REHABILITATION THERAPY

Rehabilitation Therapy for Meniscal Tears

A course of rehabilitation therapy is recommended for those with meniscal tears with persisting pain thought to not be clearly surgical.

Dose – See exercise section for dose, frequency and discontinuation.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Glucocorticosteroid Injections

Glucocorticosteroid injections have been used to treat meniscal tears (2457).

Glucocorticosteroid Injections for Meniscal Tears

Glucocorticosteroid injections are not recommended for the treatment of meniscal tears.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**
Level of Confidence – **Low**

Rationale – There is no quality evidence of efficacy of these injections for meniscal tears and thus they are not recommended. There are other indications for steroid injections. The medical expert panel differed on this recommendation with 43% supporting not recommended, 29% no recommendation and 29% recommended.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Glucocorticoids, glucocorticosteroids, steroid injections, glucocorticosteroid injections, Meniscus Injuries, Lateral Meniscus injury, Tibial Meniscus Injuries, Meniscal tears, Meniscus tears controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 19 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 175 in Google Scholar, and 2 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion, 3 randomized trials and 0 systematic reviews met the inclusion criteria.

Low-Level Laser Therapy

Low-level laser therapy has been trialed for treatment of meniscal tears (2458).

Low-Level Laser Therapy for Meniscal Tears

Low-level laser therapy is not recommended for the treatment of meniscal tears.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**
Level of Confidence – **Low**

Rationale: There are sparse trials of LLLT for treatment of meniscal tears (2458). There is no quality evidence of efficacy in large, sham-controlled trials, thus the panel (57%) felt this should be no recommended and 43% felt it should have no recommendation.

Evidence: A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Low-level laser therapy, Meniscus Injuries, Tibial Meniscus Injuries, Lateral Meniscus injury, Meniscal tears, Meniscus tears controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 article in PubMed, 168 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 149 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Manipulation and Mobilization

Manual therapy and manipulation have been used to treat meniscal tears (2459).

Manual Therapy and Manipulation for Meniscal Tears

Manual therapy and manipulation are not recommended for the treatment of meniscal tears.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**
Level of Confidence – **Low**

Rationale – One small, 2-week trial attempted a sham and suggested modest benefits of a manual technique for meniscal tear (2459). Manual therapy has low adverse effects, but in the absence of durable effects, the panel recommendation is not recommended (57%), while a minority felt this should have no recommendation.

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Manipulation, mobilization, Meniscus Injuries, Lateral Meniscus injury, Tibial Meniscus Injuries, Meniscal tears, Meniscus tears controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 106 articles in PubMed, 489 in Scopus, 2 in CINAHL, 11 in Cochrane Library, 1110 in Google Scholar, and 1 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 1 article considered for inclusion, 1 randomized controlled trial and 0 systematic reviews met the inclusion criteria.

OTHER MODALITIES/INJECTIONS

Other Modalities and Injections for Meniscal Tears
There is no recommendation for or against therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, phonophoresis, acupuncture, autologous blood injections, plasma rich platelet injections, and hyaluronic acid injections for meniscal tears.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
Work limitations may be necessary depending on the severity of the condition and the required job demands. Those performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks that may have resulted in the condition are recommended to have work limitations. In other cases, there is no recommendation for or against work limitations. Bed rest and knee immobilization are not recommended due to risks of venous thromboembolisms and other adverse effects of bed rest, although relative rest may be required for some patients, particularly those more severely affected. Nonsteroidal anti-inflammatory medications, ice, heat, Ace wraps, supports or sleeves are recommended. Those with persisting pain thought to not be clearly surgical are recommended to have a course of rehabilitation therapy. There is no recommendation for or against therapeutic ultrasound, diathermy, electrical stimulation, iontophoresis, phonophoresis, acupuncture,

manual therapy, autologous blood injections, plasma rich platelet injections, and hyaluronic acid injections. Hyaluronic acid injections have been used to treat knee osteoarthritis,(1424) and have been reported to have additive benefit for arthroscopy patients found to have arthrosis at the time of meniscal surgery.(2195)

Evidence for the Use of Hyaluronate Injections for Meniscal Tears
There are 2 moderate-quality RCTs incorporated into this analysis.

Rehabilitation of Meniscal Tears with or without Surgical Repair

Exercise, physical therapy, and rehabilitation have been used for treatment of meniscal tears.(2196-2198) Inferential current therapy has also been used.(1267)

Meniscal Tear Rehabilitation without Surgical Repair
Rehabilitation for select patients after meniscal tears without surgical repair is recommended.

Indications – Select patients with meniscal tears resolving without surgery, but particularly those with functional deficits, such as residual muscle weakness.

Duration – One to 4 weeks, 2 to 3 sessions a week.

Indications for Discontinuation – Achievement of goals, non-compliance with clinic or home based exercises or intolerance.

Strength of Evidence – **Recommended, Evidence (C)**

Meniscal Tear Rehabilitation after Surgical Repair
Meniscal tear rehabilitation for select patients after surgical repair is recommended.

Indications – Patients with meniscal tears having undergone surgical repair, particularly with functional deficits such as residual muscle weakness.

Duration – One to 6 weeks, 2 to 3 sessions a week.

Indications for Discontinuation – Achievement of goals, non-compliance with clinic or home-based exercises or intolerance.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations
There is one moderate-quality trial comparing surgery plus exercise with exercise alone suggesting equivalency.(2199) This provides some evidence for successful non-operative rehabilitation. Most trials of exercise and rehabilitation enrolled post-meniscectomy patients.(2200) Most of these trials compared supervised therapy with either a home exercise program or advice compared to a home program,(2201) physiotherapy with oral and written advice,(2202) and stationary bicycling with no treatment.(2203) One trial found functional strengthening exercises superior to a control for post-operative rehabilitation.(2204) Thus, the balance of studies implies the post-operative results are good and many patients do not appear to require formal post-operative therapy aside from advice and education. Nevertheless, exercise is thought to be helpful for select patients with weakness or other functional limitations who were not the main enrollment criteria for the available evidence-base. Some may require few appointments for teaching while others require more supervision and assistance with advancement of the program towards independence in the presence of significant deficits. One trial evaluated early rehabilitation and its suggested superiority; however, baseline differences negate the ability to utilize the trial for the development of evidence-based guidance.(1861) Exercise is not invasive,

has low adverse effects and is moderately costly, depending on numbers of appointments required, and is recommended for select patients with functional deficits.

Evidence for the Use of Rehabilitation for Meniscal Tears
There are 7 moderate-quality RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 1.

Platelet-Rich Plasma and Autologous Blood Injections

Platelet rich plasma, as well as autologous blood injections, have been used to treat several tendinopathies including lateral epicondylalgia,(2363, 2364) Achilles' tendinopathies,(2365, 2366) and patellar tendinopathy. (2367, 2368) These injections have also been used for treatment of osteoarthritis.(1346-1349, 2369-2371)

Platelet-Rich Plasma and Autologous Blood Injections for Meniscal Tears
There is no recommendation for or against the use of platelet-rich plasma or autologous blood injections.

> *Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**
> *Level of Confidence* – **Low**

Rationale – There is only one research group has reported a placebo-controlled trial suggested PRP was associated with improved healing of chronic meniscal tears and limited the need for future surgical repairs significantly (8% vs 28%), while the failure rate (non-union of the meniscal tear) was 48% in PRP group vs 70% in controls (2460). As there is only one research group reporting favorable results, there is no recommendation until reproducible and durable efficacy has been demonstrated.

Evidence – A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2108 using the following terms: Plasma rich platelet injection, platelet rich plasma; Meniscus Injuries, Tibial Meniscus Injuries, Meniscal tears, Meniscus tears controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 9 articles in PubMed, 126 in Scopus, 2 in CINAHL, 1 in Cochrane Library, 435 in Google Scholar, and 2 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 2 articles considered for inclusion, 2 were randomized controlled trials and 0 were systematic reviews.

Surgery for Meniscal Tears

Surgical partial meniscectomy has been used for treatment of meniscal tears,(2205-2213) particularly by arthroscopic means.(2214-2236) The short-term prognosis (2237, 2238) as well as the degree of subsequent arthrosis has been correlated with the amount of meniscus removed.(207, 2214, 2239-2241) Meniscal repairs have a higher operation rate than partial meniscectomies; however, reportedly more likely result in better long-term outcomes.(2242) All-inside repair has been utilized as a surgical technique.(2243-2245) There also are concerns that a lateral meniscus tear may have a worse prognosis.(2217) However, a Cochrane review concluded the lack of RCTs impaired the ability to draw conclusions regarding surgical versus non-surgical management as well as repair versus excision of torn

menisci. There also are investigational techniques, including use of stem cells to attempt to regenerate menisci.(2246-2248) Allograft transplantation,(2249-2274) collagen implants(1678, 2275) , and synthetic materials (2276) have also been utilized.

Surgery for Meniscal Tears

Arthroscopic partial menisectomy and/or meniscal repairs for symptomatic, torn menisci is recommended for highly select patients.

Strength of Evidence – Recommended, Insufficient Evidence (I)
Level of Confidence – **Low**

Indications – Relatively few patients with meniscal tears appear to be candidates for this surgery. Possible expectations include those with locking symptoms, severe tears, and/or frank traumatic onset that does not generally include onset after "exercise," "hard work," or "twisting" events.(2277) Thus, patients should be highly selected and have attempted non-operative treatment that generally included passage of at least a few weeks, NSAIDs, and activity modulation, and also may have included formal therapy.(2199) Patients with marked mechanical symptoms (e.g., mechanical locking with effusions) are candidates for early operative intervention. Patients trending towards improvement generally warrant longer periods of non-operative management, while patients failing to trend towards improvement over at least 3 to 4 weeks are candidates for earlier surgical treatment.

Benefits – Theoretical potential for faster healing, but limited to those who would not have healed or recovered without surgery.

Harms – Inherent risks of surgery, including infection and post-operative debility.

Rationale – There is one high-quality trial comparing partial meniscectomy with sham in knees without osteoarthrosis and found a lack of efficacy including at 2-year follow-up.(2277, 2461) There is one moderate-quality trial comparing meniscectomy with versus without exercise that suggested no differences in outcomes.(2199) Another trial found a lack of benefit of medial meniscectomy for horizontal tears at 2 years (2462). As noted above, meniscal degenerative tears become universal with age. These data suggest that there are many cases of meniscal tears that do not require menisectomy. Additionally, surgical indications have not been clearly defined. Those with marked mechanical symptoms have not been evaluated in randomized, quality trials and are believed to require operative treatment. Meniscal repairs have a higher re-operation rate than partial meniscectomies; however, reportedly more likely result in better long-term outcomes.(2242) One moderate-quality trial suggested a radiofrequency device was superior to a mechanical shaver to accomplish the menisectomy.(2278) Surgery is invasive, has adverse effects, is costly, and the highest quality evidence does not support efficacy; but surgery is thought to be required for treatment of selected meniscal tears, particularly those including significant mechanical symptoms. Surgery is thus highly selectively recommended.

Available evidence suggests that preservation of more meniscal tissue is superior to removal of greater quantities of the menisci for both short- to intermediate-term function,(2205, 2206, 2275, 2279-2281) as well as for reduction in subsequent risk of osteoarthrosis.(207, 2214, 2239-2241) There is no quality evidence to address utility of meniscectomy by peripheral/vascular vs. avascular zone involvement, although there are opinions about these tears.(2282-2285)

Evidence – A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Partial Meniscectomy, Meniscus Injuries, Meniscal tears, Meniscus tears, Lateral Meniscus injury, Medial Meniscus injury controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 305 articles in PubMed, 1698 in Scopus, 7 in CINAHL, 81 in Cochrane Library, 1560 in Google Scholar, and 15 from other sources. We considered for inclusion 15 from PubMed, 2 from Scopus, 1 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 19 articles considered for inclusion, 8 randomized trials and 11 systematic reviews met the inclusion criteria.

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without publication dates limits and then an updated search was conducted using multiple search engines including: PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2018 using the following terms: Total Meniscectomy, Meniscus Injuries, Tibial Meniscus Injuries, Meniscal tears, Meniscus tears, Meniscal tears, Total meniscal tear, Lateral meniscus Injury, Medial Mesicuas Injury controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 123 articles in PubMed, 1144 in Scopus, 1 in CINAHL, 30 in Cochrane Library, 2940 in Google Scholar, and 6 from other sources. We considered for inclusion 2 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 6 from other sources. Of the 11 articles considered for inclusion, 7 randomized trials and 2 systematic reviews met the inclusion criteria.

Post-operative Rehabilitation for Meniscal Tears

See above.

Knee Bursitis

Introduction

Knee bursitis is usually associated with a painless effusion of one or more of the knee bursae. (2291-2294) Acute knee bursitis may be slightly warm, but is generally non-tender or minimally tender. Septic (infected) bursitis is either a complication of aseptic knee bursitis or a direct consequence of trauma. (96, 2291, 2295, 2296) Generally, to be a complication of aseptic knee, bursitis also requires introduction of organisms through the skin, such as via abraded skin or an injection, although systemic seeding may also occur. Signs include swelling, pain, tenderness, and pain on range of motion. (2291, 2292, 2294, 2297) Bursitis due to crystal arthropathies also tends to present with findings similar to those of septic bursitis. (2292, 2298)

Diagnostic Recommendations

There are no recommended special studies for most cases of knee bursitis. If the bursa is thought to be infected, aspiration of the fluid and analyses including Gram stain and culture and sensitivity are recommended.

Fluid Aspiration and Analyses for Knee Bursitis

Aspiration of the fluid and analyses including Gram stain and culture and sensitivity are recommended to evaluate for septic bursitis in patients with suspected infection.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

X-ray for Bursitis

X-ray is recommended to rule out osteomyelitis or joint effusion in cases of significant septic knee bursitis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Treatment Recommendations

Most patients with knee bursitis are treated with soft knee padding or an ace wrap, are instructed to avoid kneeling, and require no further care other than monitoring to assure resolution.

Initial Care

Soft Knee Padding and Ace Wraps for Knee Bursitis

Soft padding of the knee and ace wraps are recommended for treatment of knee bursitis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality trials evaluating these modifications for treatment of knee bursitis. Most cases of bursitis appear to resolve with non-invasive options. Soft padding and ace wraps are not invasive, have few adverse effects, are low cost, thus they are recommended.

Evidence for the Use of Soft Padding and Ace Wraps for Knee Bursitis

There are no quality studies evaluating the use of soft padding or ace wraps for knee bursitis.

Modifying Activities to Avoid Kneeling or other Pressure Over the Knee

Modifying activities to avoid kneeling or pressure over the knee and allowing time to reabsorb the fluid are recommended for treatment of knee bursitis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality trials evaluating modification of activities for treatment of knee bursitis. Most cases appear to resolve with non-invasive options including avoiding kneeling and pressure on the knee. Activity modification is not invasive, has low or no adverse effects, is low cost and is recommended.

Evidence for the Use of Modifying Activities

There are no quality studies evaluating the use of modifying activities for knee bursitis.

Non-steroidal Antiinflammatory Drugs (NSAIDs)

Some patients with knee bursitis have been treated with NSAIDs, particularly if there is some accompanying discomfort.

NSAIDs for Knee Bursitis

There is no recommendation for or against the use of NSAIDs for the treatment of knee bursitis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There is no quality evidence that NSAIDs alter the clinical course, thus there is no recommendation for or against their use for knee bursitis. The threshold for a trial of these medications should generally be low.

Evidence for the Use of NSAIDs for Knee Bursitis

There are no quality studies evaluating the use of NSAIDs for knee bursitis.

ASPIRATION

Aspiration of the swollen bursa has been used for diagnosing septic knee bursitis, or if it is thought to be potentially infected. (2292, 2294, 2299)

Aspiration for Infected Bursa

Aspiration of a clinically infected or questionably infected bursa is recommended.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

Aspiration has been used for diagnosis, particularly when combined with Gram stain, culture and sensitivity, and complete cell count of the aspirated fluid are performed. Crystal examination (light polarizing microscopy) should also be performed at least once on the aspirated fluid. Aspiration of a bursa is invasive, has relatively low adverse effects, although it can introduce an infection, and is low to moderately costly, but is recommended for diagnosis and planning of treatment.

GLUCOCORTICOSTEROID INJECTIONS

Injection with a glucocorticosteroid (typically doses of methylprednisolone approximately 20 to 40mg or equivalent), often accompanied by aspiration, is widely used for aseptic knee bursitis.(2299)

Glucocorticosteroid Injections for Knee Bursitis

There is no recommendation for or against the use of glucocorticosteroid injections for the treatment of knee bursitis. This may be a reasonable option for patients who are failing to resolve prior to consideration of surgery.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality studies evaluating the use of glucocorticosteroid injections to treat knee bursitis. These injections sometimes appear to help speed resolution in cases not trending towards resorption. However, these injections potentially introduce bacteria, thus the one drawback is the potential to create a septic bursitis, which then often requires surgical drainage. If attempted, these injections appear to be reserved for patients thought to not be infected and/or who are not resolving with activity modifications and observation. If attempted, generally only 1 aspiration/injection is performed followed by careful observation. Some physicians aspirate and then inject, while others only inject the steroid. If

the bursitis is not satisfactorily resolved, a second aspiration/injection is often attempted, although usually not sooner than 3 to 4 weeks later. Doses of steroid are approximately, e.g., methylprednisolone 20 to 40mg or equivalent. Aspirated fluid should be sent at least once for studies including crystals (light polarizing microscopy), Gram stain, culture, and sensitivity and complete cell count. Glucocorticosteroid injection is invasive, has relatively low adverse effects, although it can introduce an infection, and is moderately costly; thus, it is recommended in those cases not trending towards resolution.

Surgical Considerations

Surgery has been used to treat knee bursitis that has not responded to activity modifications and injections or if infection is believed to be present.(2300-2304)

Surgical Drainage for Knee Bursitis

Surgical drainage is recommended for treatment of knee bursitis.

Indications – Knee bursitis that is either infected, clinically thought to be infected, or not infected but present for at least approximately 6 to 8 weeks without trending towards resolution despite being treated with soft padding and activity modifications.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Surgical Resection for Chronic Knee Bursitis

Surgical resection of the bursa is recommended for chronic knee bursitis with recurrent drainage.

Indications – Knee bursitis with recurrent drainage.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendations

There are no quality trials addressing surgery for the treatment of knee bursitis. Surgical drainage of a swollen knee bursa has been successfully used for treatment. As it is not without potential complications, it is recommended to be reserved for selected cases either involving infection or failure to respond to an adequate trial of non-operative measures. Surgical drainage is invasive, has modest adverse effects, and is moderately to highly cost, but is recommended in those cases not trending towards resolution or which are thought to be infected.

Patellar Tendinosis, Patellar Tendinopathy ("Jumper's Knee"), and Anterior Knee Pain

Introduction

Anterior knee pain is caused by several different entities that include patellar tendinosis as well as patellofemoral joint-related pain.(101, 159, 2305, 2306) The diagnosis is primarily clinical (see History and Physical Examination), and a careful history will usually result in a presumptive diagnosis that may be confirmed with physical examination. Patients have anterior knee pain, and those with patellar tendinosis have pain localized to the affected area of the patellar tendon. Those with patellofemoral joint disorders tend to have peripatellar knee pain that often is worse with use of stairs.(2305, 2307)

Diagnostic Recommendations

X-RAY

X-ray is commonly utilized, especially for evaluation of pain felt to be attributable to the patellofemoral joint.

X-ray for Evaluation of Patellofemoral Joint Pain
X-ray is recommended to evaluate patellofemoral joint pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ULTRASOUND AND MRI

Ultrasound or MRI for the Evaluation of Patellofemoral Joint Pain
There is no recommendation for or against the use of diagnostic ultrasound or MRI to evaluate patellofemoral joint pain.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Rest, splints, ice, and heat have been utilized for treatment of tendinoses, as well as for patellofemoral joint disorders. There are no quality studies of treatment options, aside from surgery and rehabilitation for patellofemoral pain or tendinosis (see next section). Out of necessity, guidance for treatment relies upon other musculoskeletal disorders for inferences on projected treatment efficacy.

Treatment Recommendations

Work Limitations

Work Limitations for Select Cases of Patellofemoral Joint Pain

Work limitations are recommended for patients with patellofemoral joint pain who perform physically demanding tasks or who have no ability to avoid repeating physically demanding job

tasks that have resulted in the condition, especially jumping for patellar tendinosis and stair use for patellofemoral joint pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Work Limitations for Other Cases of Patellofemoral Joint Pain

There is no recommendation for or against the use of work limitations for treatment of other cases of patellofemoral joint pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

BED REST AND KNEE IMMOBILIZATION

Bed Rest and Knee Immobilization for Patellofemoral Joint Pain

Bed rest and knee immobilization are not recommended for treatment of patellofemoral joint pain, although relative rest may be required for some patients, particularly those more severely affected.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

NSAIDs

NSAIDs for Patellofemoral Joint Pain

Nonsteroidal anti-inflammatory medications are recommended for treatment of patellofemoral joint pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

ICE/HEAT

Ice/Heat for Patellofemoral Joint Pain

Ice and/or heat are recommended for treatment of patellofemoral joint pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

WRAPS, SUPPORTS, AND SLEEVES

Wraps, Supports, or Sleeves for Patellofemoral Joint Pain

Ace wraps, supports, or sleeves are recommended for treatment patellofemoral joint pain.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

REHABILITATION THERAPY

Rehabilitation Therapy for Patellofemoral Joint Pain

A course of rehabilitation therapy is recommended for treatment of patellofemoral joint pain in patients with persisting pain thought to not be clearly surgical.

Dose/Duration – See exercise section for dose, frequency, and discontinuation.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

OTHER MODALITIES/INJECTIONS

Other Modalities/Injections for Patellofemoral Joint Pain

There is no recommendation for or against the use of therapeutic ultrasound, diathermy, iontophoresis, low-level laser therapy, phonophoresis, autologous blood injections, or hyaluronic acid injections for treatment of patellofemoral joint pain.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
Work limitations may be necessary depending on the severity of the condition and the required job demands. Those performing physically demanding tasks or those who have no ability to avoid repeating physically demanding job tasks that have resulted in the condition are recommended to have work limitations. In other cases, there is no recommendation for or against work limitations. Bed rest and knee immobilization are not recommended due to risks of venous thromboembolisms and other adverse effects of bed rest, although relative rest may be required for some patients, particularly those more severely affected. NSAIDs, ice, heat, Ace wraps, supports, and sleeves are recommended. Those with persisting pain thought to not be clearly surgical are recommended to have a course of rehabilitation therapy. There is no recommendation for or against therapeutic ultrasound, diathermy, iontophoresis, low-level laser therapy, phonophoresis, autologous blood injections, or hyaluronic acid injections for treatment of patellofemoral joint pain.

Exercise

Exercise, physical therapy, and rehabilitation have been used for treatment of anterior knee pain.(2308-2331) However, evidence to support physical interventions has been labeled "limited."(2332)

Exercise for Patellofemoral Joint Pain
Exercise is moderately recommended for patellofemoral joint pain.

Indications – Patients with patellofemoral joint pain, especially if insufficiently responsive to treatment with NSAIDs and activity modification.

Duration – One to 4 weeks, 2 to 3 sessions a week; additional appointments based on continuing objective improvements.

Indications for Discontinuation – Achievement of goals, non-compliance with clinic or home-based exercises, intolerance.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Rationale for Recommendation
Two moderate-quality trials compared exercise therapy with no treatment and found exercise of modest efficacy.(2333-2335) Results from another trial of specific exercise approaches, including static, dynamic, vastus medialis obliquis selective activation (VMO), is unclear,(2335) and there is no recommendation for a specific exercise approach. There also is one trial suggesting a patellar brace is of equal efficacy.(2336) One high-quality trial with two reports included multiple co-interventions and suggested benefit, but an assessment of which intervention was effective is not possible.(2310, 2337) Exercises are not invasive, have low adverse effects, are low to moderately costly depending on numbers of appointments, and thus are recommended.

Evidence for the Use of Exercise for Anterior Knee Pain
There are 2 high- and 20 moderate-quality (one with two reports) RCTs incorporated into this analysis. There are 3 low-quality RCTs in Appendix 1.(594, 2338, 2339)

TAPING

Patellar taping has been used to treat anterior knee pain.(2340-2342) There is experimental evidence supporting the idea that taping and bracing provide coronal plane and torsional control of the knee in eccentric stair step descent.(1071)

Taping for Anterior Knee Pain

Taping is not recommended for anterior knee pain.

Strength of Evidence- **Not Recommended, Evidence (C)**

Rationale for Recommendation

One moderate-quality trial attempted sham taping and found no efficacy of taping(2343); two other trials also suggested that taping is ineffective.(2344, 2345) While one trial suggested taping may be superior,(2346) the balance of studies suggest that it is not effective. There were two crossover trials, but both were of very short duration, precluding their use in guidance.(2347, 2348) Taping is not invasive, but is not tolerated by some patients and compliance is reportedly problematic. Taping is low cost for one application, but rapidly becomes costly over time. As most quality evidence suggests a lack of efficacy, taping is not recommended for treating anterior knee pain.

Evidence for the Use of Taping for Anterior Knee Pain

There are 6 moderate-quality RCTs or crossover trials incorporated into this analysis. There are 1 low-quality RCTs or crossover trials in Appendix 1.(2349)

ORTHOTICS AND KNEE SPLINTS

Orthotics has been used for treatment of patellofemoral joint pain.(594, 1118, 2336, 2350, 2351)

Orthotics or Knee Splints for Patellofemoral Knee Pain

There is no recommendation for or against the use of orthotics or knee splints for patellofemoral joint pain.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Functional Bracing for Prevention of Anterior Knee Pain

There is no recommendation for or against the use of functional bracing for prevention of anterior knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations

There are no quality studies addressing the use of knee splints, orthotics, or bracing for treatment of patellofemoral knee pain. There is one moderate-quality study comparing bracing with no bracing in prevention of anterior knee pain in military recruits and that study reported a significant decrease in the development of anterior knee pain after 6 weeks.(2352) There is one high-quality trial comparing foot orthoses, flat inserts, physiotherapy and a combination of foot orthoses plus physiotherapy and found minimal differences(2308);. Braces may be helpful for those with high-demand positions, particularly if they are not acclimated to the demands of the position. These devices are not invasive, have few adverse effects, are low cost, but absent evidence of efficacy, there is no recommendation regarding their use.

Evidence for the Use of Orthotics and Knee Splints

There are 1 high- and 3 moderate-quality RCTs or crossover trials incorporated into this analysis. There are 4 low-quality RCTs in Appendix 1.(594, 2353-2355)

Electrical Stimulation

Electrical stimulation has been used for treatment of anterior knee pain.(1269)

Electrical Stimulation for Anterior Knee Pain

Electrical stimulation is not recommended for treatment of anterior knee pain.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation

There are no quality placebo- or sham-controlled clinical trials evaluating electrical stimulation for anterior knee pain. One trial found electrical stimulation to be of no added benefit in addition to exercises.(2356) Another moderate-quality trial that used two different active treatments failed to find differences.(1269) Electrical stimulation is not invasive, has low adverse effects, and is moderately costly. It appears ineffective in treating anterior knee pain and thus, is not recommended.

Evidence for the Use of Electrical Stimulation for Anterior Knee Pain

There are 2 moderate-quality RCTs incorporated into this analysis.

Manipulation and Mobilization

Manipulation and mobilization and have been used to treat anterior knee pain, often in conjunction with axial joints.(1223, 1235, 1240, 1242, 2357)

Mobilization and Manipulation for Anterior Knee Pain

There is no recommendation for or against the use of manipulation and mobilization for treatment of anterior knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality trials comparing manipulation or mobilization with sham or no treatment controls to treat anterior knee pain. The few, small available studies comparing active treatments have methodological flaws. Thus, there is no recommendation for or against the use of mobilization or manipulation to treat anterior knee pain.

Evidence for the Use of Manipulation and Mobilization for Anterior Knee Pain

There are 2 moderate-quality RCTs incorporated into this analysis. There are 2 low-quality RCTs in Appendix 1.

Acupuncture

Acupuncture has been used for treatment of anterior knee and patellofemoral pain.(1208, 2358)

Acupuncture for Anterior Knee Pain

There is no recommendation for or against the use of acupuncture for anterior knee pain.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation
There are two moderate-quality trials with somewhat conflicting results. One trial compared electroacupuncture with minimal superficial acupuncture and failed to find evidence of efficacy,(1208) while the other suggested slight benefits compared with no treatment controls.(2358) Thus, there is no recommendation for or against the use of acupuncture to treat anterior knee pain.

Evidence for the Use of Acupuncture for Anterior Knee Pain
There are 2 moderate-quality RCTs incorporated into this analysis.

Biofeedback

Biofeedback has been used for treatment of patellofemoral pain.(2359, 2360)

Biofeedback for Patellofemoral Pain
Biofeedback is not recommended for the treatment of patellofemoral pain.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation
Biofeedback has been evaluated in two moderate-quality trials for treatment of patellofemoral pain syndrome.(2359, 2360) In both trials, there was no additive benefit for biofeedback in addition to exercise. Biofeedback is not invasive, has few adverse effects, and is low cost, but it is ineffective and thus is not recommended.

Evidence for the Use of Biofeedback
There are 2 moderate-quality RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 1.(2361)

GLUCOCORTICOSTEROID INJECTIONS

Glucocorticosteroid injections have been utilized for treatment of patellar tendinopathy.

Glucocorticosteroid Injections for Select Patients with Patellar Tendinopathy
Glucocorticosteroid injections are recommended for select patents to treat patellar tendinopathy.

Indications – Chronic patellar tendinopathy that is unresponsive to other treatments including NSAID(s), activity modification and exercises.(1326, 2362)

Strength of Evidence – **Recommended, Insufficient Evidence (C)**

Rationale for Recommendation
There is one moderate-quality placebo-controlled trial that evaluated the use of glucocorticosteroid injections for the treatment of patellar tendinopathy and found some evidence of efficacy, although somewhat less than with aprotinin.(2362) There is also one moderate-quality trial comparing glucocorticosteroid injections with two different exercise regimens that suggested that the steroid injections are inferior to heavy slow-resistance training exercises.(1326) These injections are mildly invasive, have adverse effects, are moderately costly, and have some evidence of efficacy, thus they are recommended for those select patients who fail a quality exercise program.

Evidence for the Use of Glucocorticosteroid Injections for Patellar Tendinopathy
There are 2 moderate-quality RCTs incorporated into this analysis.

PLATELET-RICH PLASMA AND AUTOLOGOUS BLOOD INJECTIONS

Platelet-rich plasma, as well as autologous blood injections, have been used to treat several tendinopathies including patellar tendinopathy. (2367, 2368) These injections have also been used for treatment of osteoarthritis.(1346-1349, 2369-2371)

Platelet-Rich Plasma and Autologous Blood Injections for Patellar Tendinopathy
Platelet-rich plasma and autologous blood injections are not recommended for the treatment of patellar tendinopathy.

Strength of Evidence – **Not Recommended, Evidence (C)**
Level of Confidence – **Low**

Rationale – One small, placebo-controlled trial for patellar tendinopathy suggested a lack of efficacy (2463). Another trial found no differences between 1 and 2 injections (2464) while another found 2 injections better than one (2465). There is one moderate-quality study suggesting efficacy of PRP over dry-needling.(2372) There are two moderate-quality trials suggesting PRP is superior to extracorporeal shockwave therapy, but ESWT appears ineffective (see ESWT).(2373, 2374) PRP injections are invasive, have adverse effects, are costly, and the sole placebo-controlled trial suggests lack of efficacy; thus, they are not recommended.

Evidence– A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2108 using the following terms: Patellar tendinopathy, Patellar tendinosis, Patellar tendinitis, Jumpers knee, Anterior knee pain, PRP, platelet rich plasma injections, autologous blood injections, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 50 articles in PubMed, 286 in Scopus, 26 in CINAHL, 10 in Cochrane Library, 120 in Google Scholar, and 2 from other sources. We considered for inclusion 9 from PubMed, 4 from Scopus, 3 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 19 articles considered for inclusion, 7 randomized trials and 12 systematic studies met the inclusion criteria.

APROTININ INJECTIONS

Aprotinin injections have been utilized for treatment of patellar tendinopathy as an anti-inflammatory treatment.(2362)

Aprotinin Injections for Patellar Tendinopathy
Aprotinin injections are recommended for select patients to treat patellar tendinopathy.

Indications – Chronic patellar tendinopathy that is unresponsive to other treatments including NSAID(s), exercise, and activity modification.

Strength of Evidence **– Recommended, Evidence (C)**

Rationale for Recommendation
There is one moderate-quality placebo-controlled trial that evaluated the use of paratendon, bursal, and tendinous insertion area aprotinin injections for the treatment of patellar tendinopathy and found suggested some efficacy.(2362) This trial did not utilize ultrasound, thus there is no recommendation for or against imaging to accomplish the injections. These injections are invasive, have adverse effects, and are moderately costly. They are recommended for use in highly select cases.

Evidence for the Use of Aprotinin Injections for Patellar Tendinopathy
There is 1 moderate-quality RCT incorporated into this analysis.

PROLOTHERAPY, INCLUDING POLIDOCANOL AND HYPERTONIC GLUCOSE INJECTIONS

Prolotherapy is performed with various sclerosing agents, including polidocanol and hypertonic saline. These have been used to treat chronic patellar tendinopathy.

Prolotherapy Injections for Chronic Patellar Tendinopathy
Prolotherapy injections are recommended for select patients to treat chronic patellar tendinopathy.

Indications – Athletes with chronic patellar tendinopathy with neovascularization corresponding to the painful area that is unresponsive to other treatments including NSAID(s) and activity modification. Whether these injections are appropriate for others, including workers, is unclear. Ultrasound guidance is recommended for accomplishing the injections.

Strength of Evidence **– Recommended, Evidence (I)**

Polidocanol Injection for Acute, Subacute, or Post-operative Patellar Tendinopathy
There is no recommendation for or against the use of polidocanol injection for acute, subacute, or post-operative patellar tendinopathy.

Strength of Evidence **– No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendations
There is one high-quality trial among athletes suggesting efficacy of a sclerosing agent (polidocanol) for chronic patellar tendinopathy although there are some weaknesses in the trial.(2377) These injections are invasive, have adverse effects, and are moderately costly. They are recommended for use in highly select cases.

Evidence for the Use of Polidocanol Injections
There is 1 high-quality RCT incorporated into this analysis.

GLYCOSAMINOGLYCAN INJECTIONS

Glycosaminoglycan injections have been used for treatment of patellar tendinosis.

Glycosaminoglycan Injections for Patellar Tendinosis
Glycosaminoglycan injections are not recommended for treatment of patellar tendinosis.

Strength of Evidence – **Not Recommended, Evidence (C)**

Rationale for Recommendation
One moderate-quality trial has suggested a lack of efficacy.(2378) Thus, these injections are not recommended.

Evidence for the Use of Glycosaminoglycan Injections for Patellar Tendinopathy
There is 1 moderate-quality RCTs incorporated into this analysis.

PERCUTANEOUS NEEDLE TENOTOMY

Percutaneous needle tenotomy has been attempted to treat chronic tendinoses.(1327-1330, 2379)

Percutaneous Needle Tenotomy for Chronic Tendinosis

There is no recommendation for or against the use of percutaneous needle tenotomy for treatment of chronic tendinosis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Rationale for Recommendation

There are no quality studies of percutaneous needle tenotomy as a treatment for chronic tendinosis. This procedure is invasive, has adverse effects, and is moderate to highly costly; thus, there is no recommendation.

Evidence for Percutaneous Needle Tenotomy

There are no quality studies evaluating the use of percutaneous needle tenotomy.

EXTRACORPOREAL SHOCKWAVE THERAPY ("Shockwave")

Extracorporeal shockwave therapy (ESWT) has been utilized for treatment of tendinoses, especially in the shoulder and ankle. It has been documented to have efficacy for treatment of calcific tendinitis in the shoulder (see Shoulder Disorders guideline).(2380-2385)

Extracorporeal Shockwave Therapy for Patellar Tendinosis

Extracorporeal shockwave therapy is not recommended for treatment of patellar tendinosis.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**
Level of Confidence – **Moderate**

Rationale – One sham-controlled trial found a lack of efficacy of ESWT for treatment of patellar tendinopathy in active athletes (2466) and another trial found a lack of effectiveness for adding ESWT to eccentric exercises (2467). One trial found no difference between focused ESWT and radial shockwave therapy (2468). There is one low-quality trial comparing extracorporeal shockwave therapy with either sham or low-energy treatment for patellar tendinosis.(2386) There are two trials suggesting ESWT is inferior to platelet-rich plasma injections (see above). For most body parts, there is evidence that ESWT is ineffective (see Elbow Disorders, Shoulder Disorders, and Ankle and Foot Disorders guidelines), with the primary exception being efficacy for the treatment of rotator cuff calcific tendinosis. ESWT is minimally invasive, is often performed with an injected anesthetic, has some adverse effects, is moderate to highly costly depending on numbers of treatments, and has two placebo-controlled trials showing lack of efficacy and thus it is not recommended.

Evidence – A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar between 1/1/2013 and 11/15/2108 using the following terms Extracorporeal Shockwave Therapy, Patellar tendinopathy, Patellar tendinosis, Patellar tendinitis, Jumpers knee, Anterior knee pain, Extracorporeal Shockwave Therapy, Shock Wave Therapy, Extracorporeal High Intensity Focused Ultrasound Therapy, High-Intensity Focused Ultrasound Therapy, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 116 articles in PubMed, 225 in Scopus, 7 in CINAHL, 0 in Cochrane Library, 1650 in Google Scholar, and 2 from other sources. We considered for inclusion 4 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 from Google

Scholar, and 2 from other sources. Of the 11 articles considered for inclusion, 7 randomized trials and 4 systematic studies met the inclusion criteria.

Surgery for Anterior Knee Pain and Patellofemoral Syndrome

Several surgical procedures have been performed for anterior knee pain and patellofemoral pain syndrome. These have included chondroplasty and patellar shaving and resurfacing. Lateral retinacular release or lengthening and arthroscopic lateral retinacular release has been performed for recurrent subluxation, and surgical realignment of the extensor mechanism has been used for some patients.(2387-2398) Lateral release has been performed without,(1245, 2399-2404) as well as in conjunction with, medial soft-tissue realignment for recurrent patellar instability.(2405-2411) Although, there are no RCTs, a comparison of these procedures concluded that medial soft-tissue realignment is superior.(2408)

Surgery for Anterior Knee Pain

Surgery is recommended in patients with anterior knee pain after a 6-month period of failed non-operative treatment provided the patient also has one or more of the below indications.

Indications – Moderate to severe anterior knee pain of at least 6 months duration with failed non-operative treatment (including 2 to 3 months of supervised exercises and home-exercise program components with which the patient has been compliant) and one or more of the following: 1) clinical and radiographical evidence of patellar malalignment; 2) clinically and/or radiographically proven subluxation; and/or 3) repeated episodes of patellar dislocation.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Rationale for Recommendation

One trial has suggested arthroscopic surgery for patellofemoral syndrome was of no additive benefit to a home exercise program, although it included techniques that are no longer recommended such as chrondroplasty.(2315) Other trials have compared operative techniques,(2412) including one suggesting no differences between open and arthroscopic lateral release.(2413) Thus, there is one trial comparing operative with non-operative management,(2414) but no trials available that include optimal techniques. Patients who have failed non-operative management are very difficult to treat, and surgery should be carefully weighed against potential failure to improve. For select patients who have significant functional impairment due to patellar malalignment, subluxation, or recurrent dislocation and have failed exercises and non-operative management with which they have been compliant, an attempt at surgical intervention is recommended.

Evidence for the Use of Surgery for Anterior Knee Pain

There are 4 moderate-quality RCTs incorporated into this analysis.

Appendix 1

Low-quality Randomized Controlled Trials and Non-randomized Studies

The following low-quality randomized controlled studies (RCTs) and other non-randomized studies were reviewed by the Evidence-based Practice Knee Panel to be all inclusive, but were not relied upon for purpose of developing this document's guidance on treatments because they were not of high quality due to one or more errors (e.g., lack of defined methodology, incomplete database searches, selective use of the studies and inadequate or incorrect interpretation of the studies' results, etc.), which may render the conclusions invalid. ACOEM's Methodology requires that only moderate- to high-quality literature be used in making recommendations.(2415)

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