Innovations in Knee Arthroplasty: State of the art in Surgery and Rehabilitation

Dr. Jason Jennings, MD, PT – Colorado Joint Replacement
Dr. Andrew Kittelson, PT, PhD – University of Colorado Anschutz Medical Campus
Dr. Jennifer Stevens-Lapsley, PT, PhD – University of Colorado Anschutz Medical Campus
Dr. Michael Bade, PT, PhD – University of Colorado Anschutz Medical Campus

Combined Sections Meeting 2019 Washington, DC, January 23-26, 2019

Learning Objectives

- Identify best practice and evidence to support the management of patients after total joint replacement.
- Understand key surgical factors that influence post-operative rehabilitation and how to effectively communicate with your patient's surgical team.
- Leverage health systems data to anticipate patient trajectories of recovery and resource utilization.
- Incorporate clinically effective treatments for some of the most common post-operative complications, including persistent muscle weakness, movement asymmetries, and lower extremity edema

Disclosure

- Dr. Jennings has the following disclosures:
  - Consultation
    - Total Joint Orthopedics
    - Xenex
  - Research support
    - Porter Adventist Hospital
    - DePuy
    - Zimmer
- Drs. Kittelson, Stevens-Lapsley, and Bade have nothing to disclose

What You Need to Know About TKA

Jason M. Jennings, MD, DPT
Colorado Joint Replacement
Porter Adventist Hospital
Denver, Colorado

Adjunct Professor
University of Denver
Biomedical Department of Engineering

DISCLOSURES

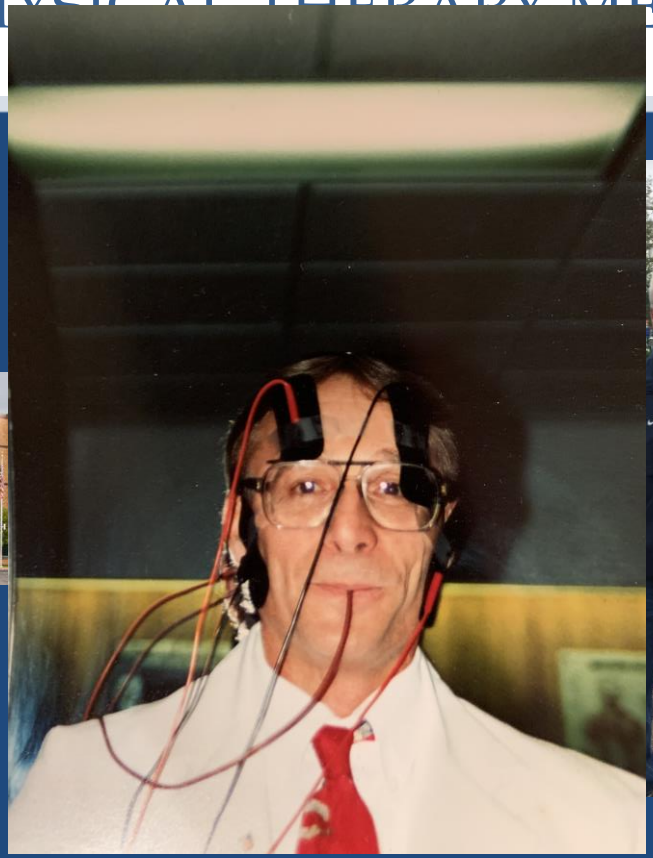
- Consultation
  - Total Joint Orthopedics
  - Xenex
- Research support
  - Porter Adventist Hospital
  - DePuy
  - Zimmer

MY BACKGROUND

- Undergraduate - University of Florida
- MPT, DPT – University of St. Augustine
- ATC – Internship route
- MD – University of South Florida
- Residency – Duke University Medical Center
- Fellowship – Colorado Joint Replacement

MY PHYSICAL THERAPY MENTORS

MY PHYSICAL THERAPY MENTORS



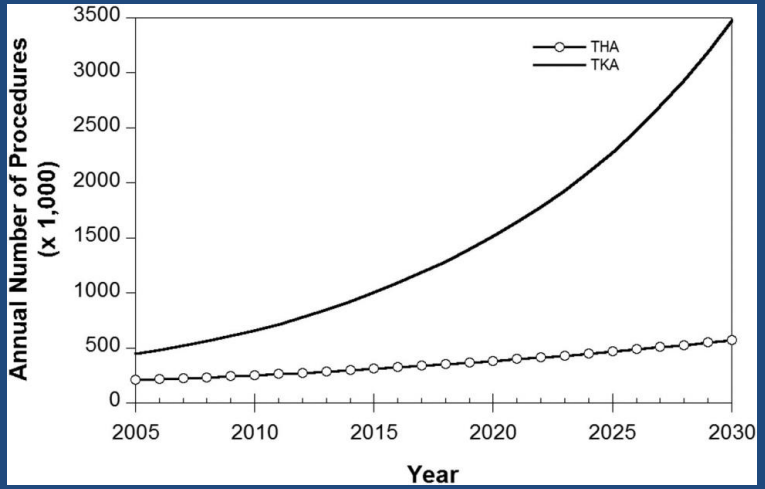
MY PRACTICE

- Colorado Joint Replacement – Denver
  - Hip and knee – primary and revision surgery
  - Academic – 10-20 publications/year
  - Fellowship – 2 per year
  - Mission work – Operation Walk (Denver Chapter)

BACKGROUND

- Arthritis is the second most common chronic condition in the US
- Healthcare cost - ~82 billion/year

EXPECTED TO INCREASE



Kurtz S,, et al. JBJS 2007.

WHAT ARE WE GOING TO TALK ABOUT?

- Preoperative
- Intraoperative
- Postoperative
- Generalizations regarding PT

DOES EVERYONE DO WELL?

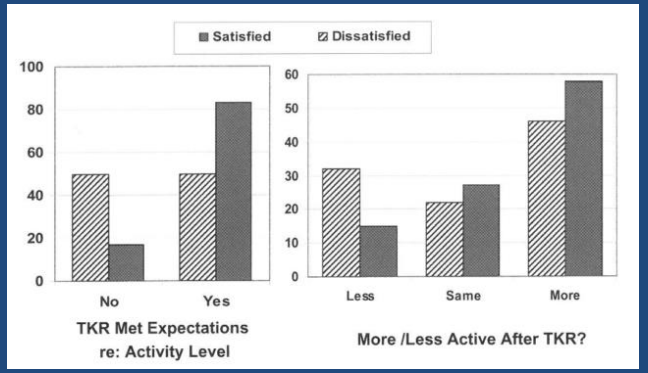
Table 3. Comparison of published satisfaction percentages after primary total knee replacement

Author	N	Followup (years)	Satisfied (%)
Anderson et al. [2]	74	1–5.5	89
Noble et al. [22]	253	1	75
Robertsson et al. [23]	27,372	2–17	82
Wylde et al. [26]	228	2	85
Hawker et al. [12]	1193	2–7	85
Heck et al. [14]	291	2	88
Current study	1703	1	81

Bourne et al. CORR 2010

PATIENT EXPECTATIONS AFFECT SATISFACTION

- Satisfaction correlated with
  - Age < 60
  - Absence of residual symptoms
  - Absence of functional impairment
  - Fulfillment of expectations
    - WE CAN CONTROL!
  - Noble et al. CORR, 2006 (John Insall Award)



PREOPERATIVE EDUCATION

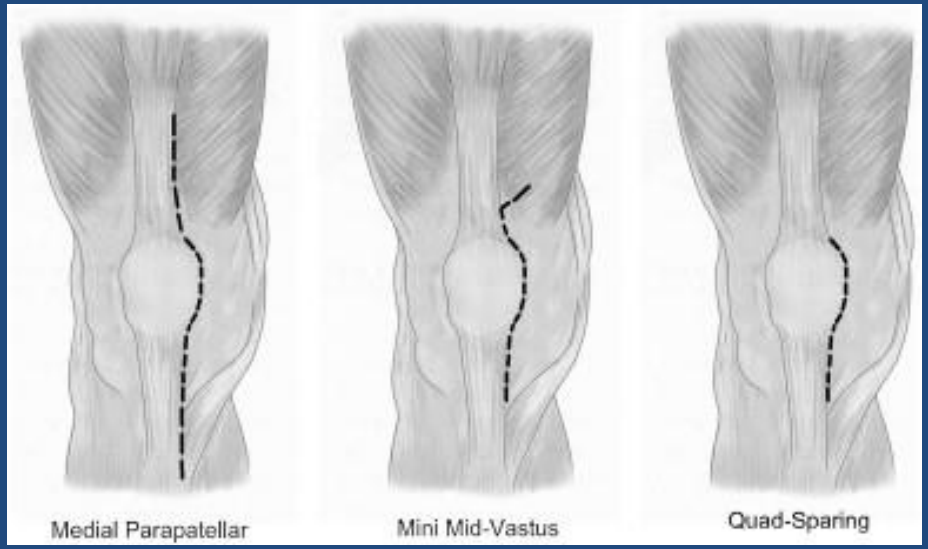
- We currently require all patients to attend a preoperative “joints” class
- We believe patients with very short hospital length of stay may benefit greatly from the education
- There is less one-on-one hospital time with these “fast-track” patients

PREOPERATIVE REHABILITATION

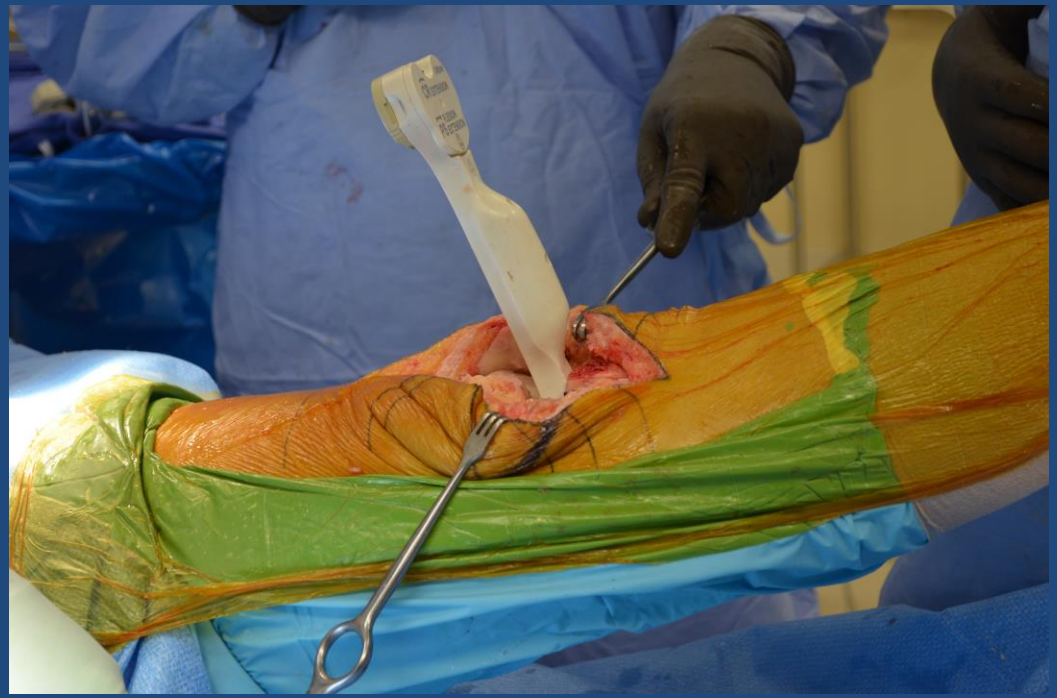
- Systematic Review and Meta-analysis of RCTs
  - Slightly reduces pain in the first 4 weeks (no differences beyond)
  - Slightly improves WOMAC function and 6-8 and 12 weeks
  - Chair, toilet and stair climbing – slightly improved early
  - NO difference in length of hospital stay, cost or quality of life
  - Conclusions: effects remain too small and short term to be considered clinically-important
  - Wang et al. BMJ Open 2016.

SURGICAL TECHNIQUE

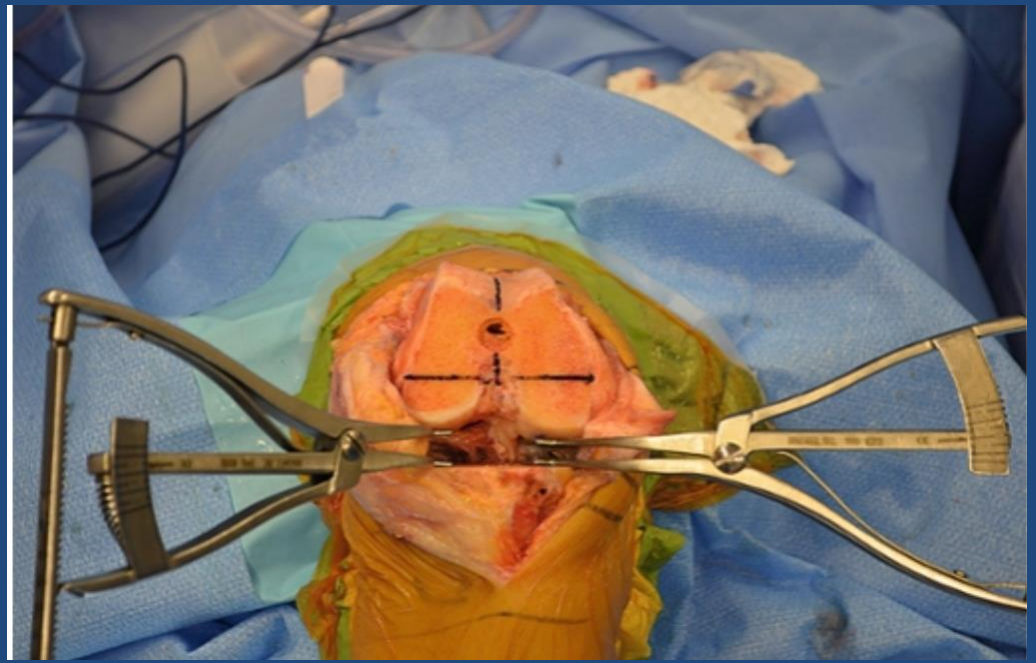
SURGICAL TECHNIQUE



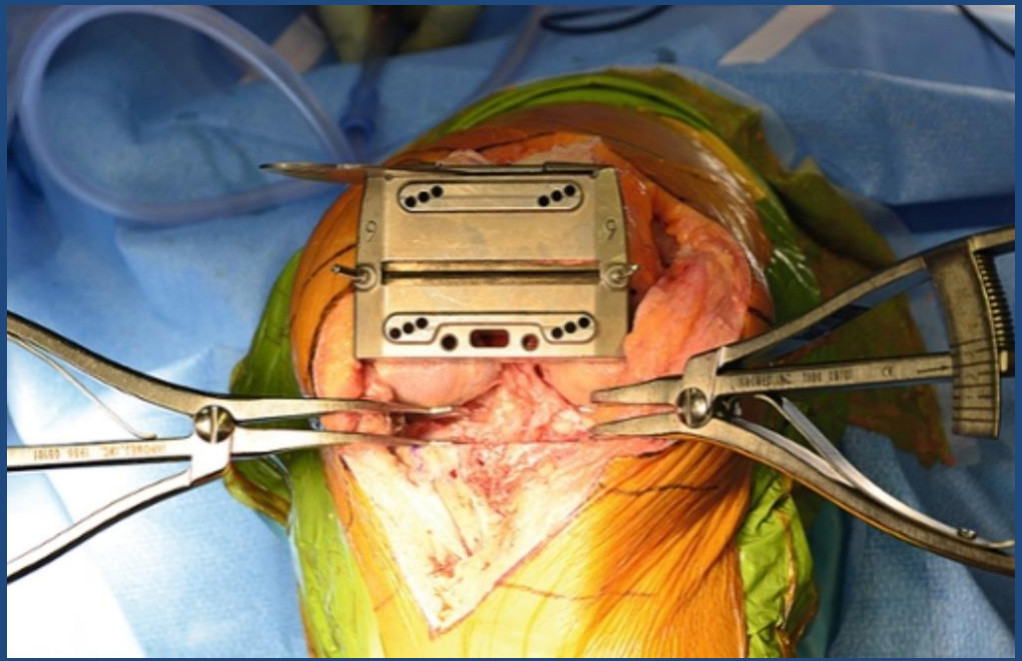
SURGICAL TECHNIQUE



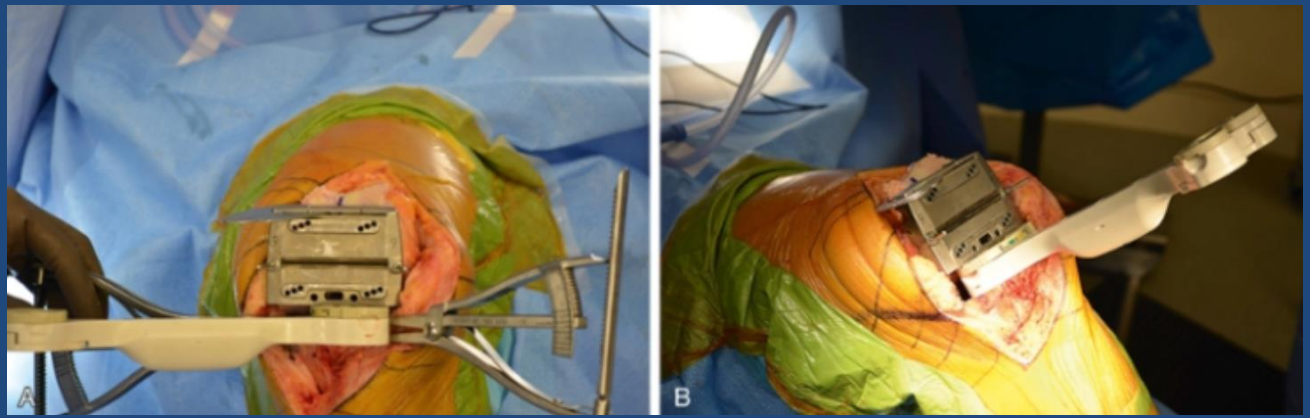
SURGICAL TECHNIQUE



SURGICAL TECHNIQUE



SURGICAL TECHNIQUE



The Journal of Arthroplasty 30 (2015) 210–215

Contents lists available at ScienceDirect

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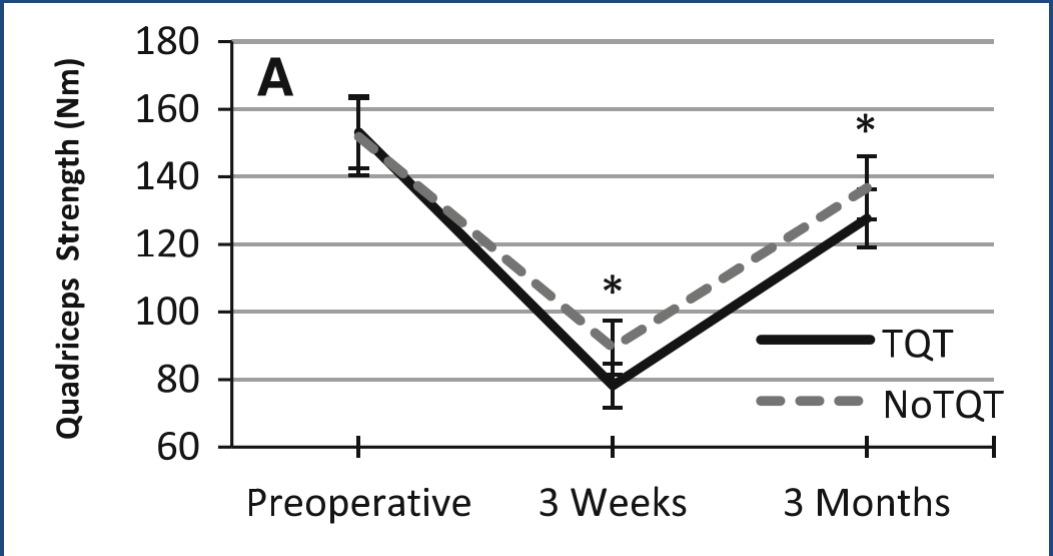
journal homepage: www.arthroplastyjournal.org

Ten-year Results Comparing Posterior Cruciate-retaining Versus Posterior Cruciate-substituting Total Knee Arthroplasty

Takashi Sando, MD, PhD, Richard W. McCalden, MD, FRCSC, Robert B. Bourne, MD, FRCSC, Steven J. MacDonald, MD, FRCSC, Lyndsay E. Somerville, PhD

Division of Orthopaedic Surgery, London Health Science Centre, University Campus, London, Ontario, Canada
University Hospital, University of Western Ontario, London, Ontario, Canada

TOURNIQUET USE



- Dennis et al. CORR, 2016.

ANESTHESIA

Table 1
Recommendations for enhanced recovery after total knee arthroplasty

Patient optimization	
Psychological	Provide additional educational resources and support to patients with depression and anxiety
Anemia	Screen for preoperative anemia and correct before elective TKA, if possible
Diabetes	Monitor HgA1c with a goal of <8; perioperative blood glucose should ideally be kept between 110 and 140 g/dL
Tobacco use	Smoking cessation 4–6 wk before surgery with behavioral support
Malnutrition	Correct malnutrition before surgery; markers indicating malnutrition are total lymphocyte count (TLL) <1500 cells/mm^3, albumin <3.5 g/dL, and transferrin <200 mg/dL
Preoperative education	
Patient expectations	Managing patient expectations with preoperative and postoperative education has potential benefits with conflicting data in the literature
Intraoperative factors	
Tourniquet use	The authors recommend limiting tourniquet use to decrease quadriceps inhibition after TKA
Blood management	Use of TXA (either intravenous, topical, or oral) reduces blood loss and transfusions after TKA
Perioperative factors	
Anesthetic methods	Neuraxial anesthesia appears to be safer and more effective than general anesthesia in TKA
Regional and local anesthesia	Motor function–sparing adjuvant methods such as ACBs and PAIs can enhance perioperative pain control
Analgesia	Multimodal pain protocols incorporating acetaminophen, nonsteroidal anti-inflammatory drugs, gapapentinoids, short-acting corticosteroids with supplemental opioids rather than opioid monotherapy are recommended
Rehabilitation	
Physical therapy (PT)	Although there is no consensus on length, duration, or intensity of PT after TKA, the authors' practice is 2–3 outpatient visits per week for 4–6 wk
Preoperative rehabilitation	The authors favor a single preoperative PT visit, especially in those with significant preoperative disability
Cryotherapy	Traditional ice or gel packs for 20–30 min per session are recommended over cryotherapy devices due to the cost and risk of thermal injury
CPM	Use of CPM is reserved for patients who have had a closed manipulation and is not used after primary TKA
Bracing	Dynamic extension bracing is reserved for severe cases of postoperative contracture
Discharge disposition	Use of clinical care coordinators and discussing disposition in advance of surgery are recommended with strong encouragement for discharge to home

- Rutherford R, Jennings JM, Dennis DA. Orthop Clin N Am. 2017

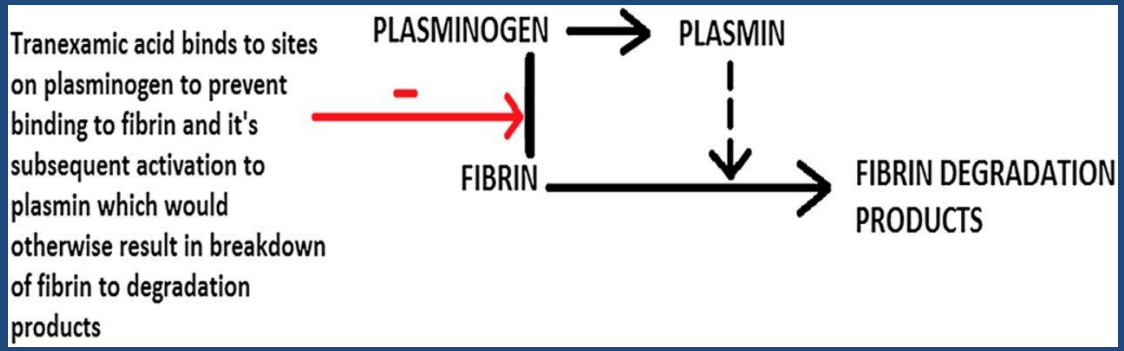
Clin Orthop Relat Res (2011) 469:2874–2880
DOI 10.1007/s11999-011-1874-2

CLINICAL RESEARCH

Tranexamic Acid Reduces Blood Loss and Blood Transfusion after TKA

A Prospective Randomized Controlled Trial

Keerati Charoencholvanich MD, Pichet Siriwattanasakul MD



DRAIN USE

- Unpublished data (submitted Bone Joint)

- No differences
  - Quadriceps strength
  - Quadriceps activation
  - Swelling
  - Effusion
  - Pain
  - Complications

POSTOPERATIVE CONSIDERATIONS

Table 1
Recommendations for enhanced recovery after total knee arthroplasty

Patient optimization	
Psychological	Provide additional educational resources and support to patients with depression and anxiety
Anemia	Screen for preoperative anemia and correct before elective TKA, if possible
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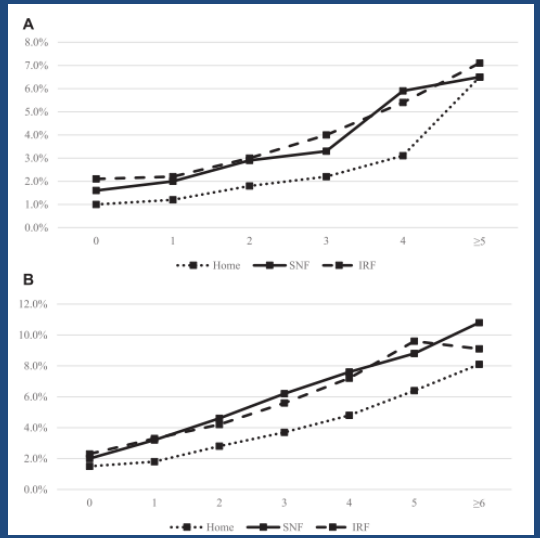
- Rutherford R, Jennings JM, Dennis DA. Orthop Clin N Am. 2017

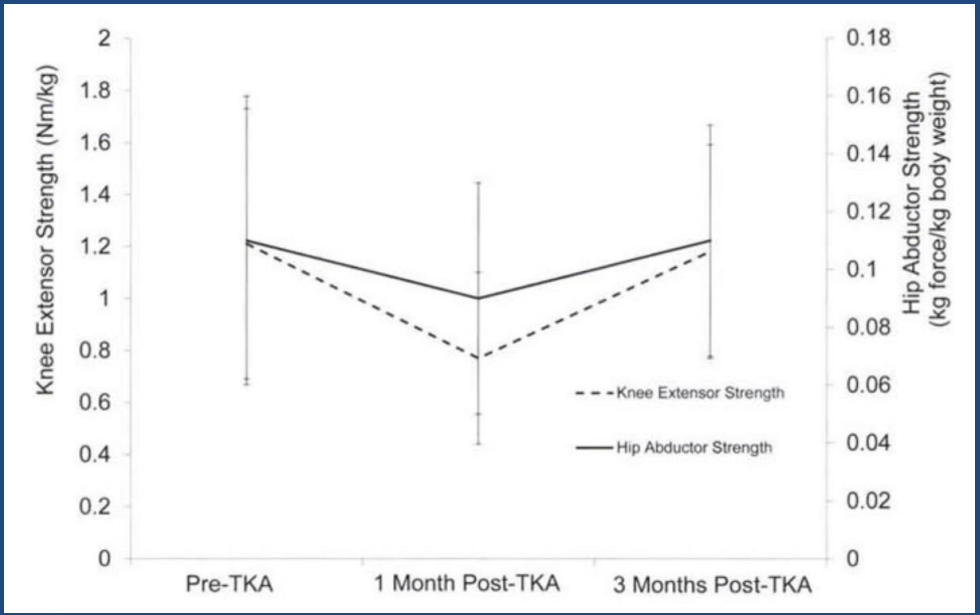
PATIENTS DO BETTER AT HOME

- Discharge destination comparisons
  - (A) – rate of 30 day adverse reactions vs. number of risk factors
  - (B) – rate of 30 day unplanned readmissions vs. number or risk factors

  - Keswani et al. JOA 2016



HIP ABDUCTION STRENGTH



Loyd BJ, Jennings JM, et al. Physical Therapy 2017.

DEFORMITY CORRECTION

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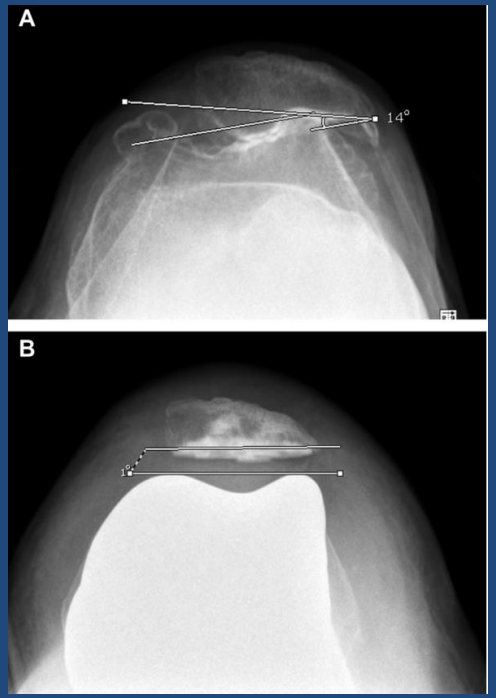


AMOUNT OF DEFORMITY CORRECTION

Table 3
Univariate Analysis of Change in Normalized Quadriceps Strength From Baseline to 1 and 6 mo Regressed on Known Covariates and Radiographic Measures.

Predictor Variables	Change in Normalized Quadriceps Strength at 1 mo (Nm/kg)		Change in Normalized Quadriceps Strength at 6 mo (Nm/kg)	
	Beta Coefficient	*P* Value	Beta Coefficient	*P* Value
Covariates				
Age	0.014	.0034[a]	<0.001	.95
Gender	−0.07	.43	−0.32	.0015[a]
BMI	−0.03	.0007[a]	−0.03	.0005[a]
Quadriceps activation	0.01	<.0001[a]	0.01	.0031[a]
Radiographic measures				
MA	0.09	.19	0.08	.41
DFA	−0.25	.0009[a]	−0.32	.0007[a]
PFA	−0.03	.67	−0.06	.53
PTA	−0.06	.41	−0.09	.34

BMI, body mass index; DFA, distal femoral angle; MA, mechanical axis; PFA, patellofemoral angle; PTA, proximal tibial angle.

[a] Meaningful contributing variables ($P < .10$) retained for multivariable analysis.

Loyd BJ, Jennings JM, et al. JOA 2017.

RANGE OF MOTION

Preoperative Range = Postoperative Range of Motion

(At least for flexion)

EFFUSION

Clin Orthop Relat Res (2019) 477:134-144
DOI 10.1097/CORR.0000000000000459

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

2018 Knee Society Proceedings

Does an Elastic Compression Bandage Provide Any Benefit After Primary TKA?

Christopher N. Matthews BS, Antonia F. Chen MD, MBA, Tanine Daryoush BA, Richard H. Rothman MD, PhD, Mitchell G. Maltenfort PhD, William J. Hozack MD

Conclusions Applying a compression bandage after TKA did not result in any clinical improvement in limb circumference, ROM, or pain. Based on this study, we believe that applying a compression bandage after TKA neither benefits nor harms the patient. Thus, we no longer use compression dressings for routine primary TKA.

Level of Evidence Level I, therapeutic study.

ARTICLE

Device or Ice: The Effect of Consistent Cooling Using a Device Compared with Intermittent Cooling Using an Ice Bag after Total Knee Arthroplasty

Michelle Bech, BScN, MN, ACNP, NP(A);[*] Joanne Moorhen, BScPT;[†] Mary Cho, BScOT;[*] M. Ruth Lavergne, MSc;[‡] Keith Stothers, MD, FRCS(C);[*] Alison M. Hoens, MSc, BScPT, PG Sports PT[*†]*

Table 3 Study Outcomes

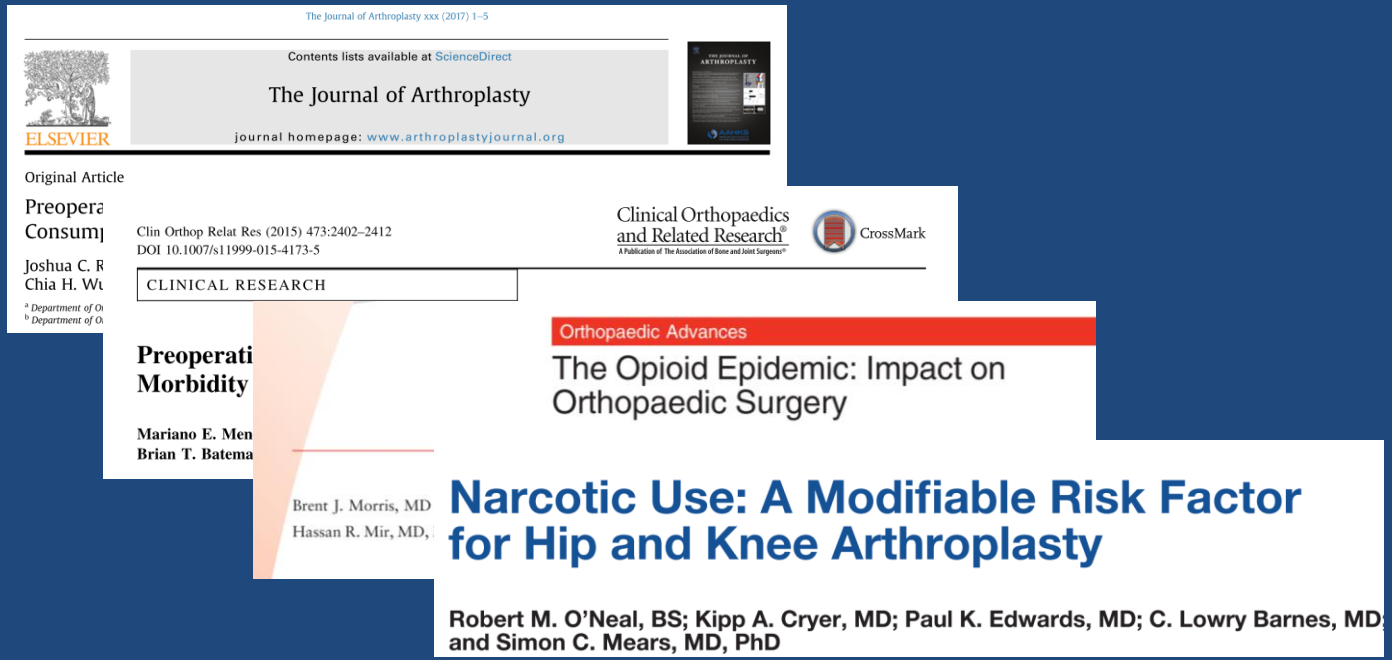
Outcome	Mean (SE)*		
	Control ($n = 34$)	Intervention ($n = 37$)	*p*-value
Primary outcome			
Pain, NPRS (24–48 h post-op)	3.6 (0.27)	3.8 (0.25)	0.67
Secondary clinical outcomes			
PROM, degrees (48 h postop)	59.8 (3.1)	54.0 (2.4)	0.14
Nausea or vomiting, % yes (24–48 h postop)	15.6	34.3	0.08
Opioid use, mg (24–48 h postop)	42.3 (4.9)	49.9 (5.8)	0.33
Change in Hgb, g/L (24–48 h postop)	−8.8 (1.7)	−7.7 (1.8)	0.68
Change in WOMAC pain	−0.7 (0.23)	−0.4 (0.23)	0.32
Change in WOMAC stiffness	−0.8 (0.23)	−0.3 (0.24)	0.14
Change in WOMAC function	−0.6 (0.21)	−0.6 (.17)	0.95
Length of stay, d	4.8 (0.39)	5.8 (0.64)	0.20
Patient satisfaction			
Patient satisfaction, cm	6.0 (0.70)	8.4 (0.36)	0.002
Patients who recommended "yes," %	63.0	96.9	0.004
Consistency of use			
Average time used during the day, % of participants			<0.001
None of the time (0%)	14.8	0	
Little bit of the time (25%)	25.9	8.6	
Half the time (50%)	29.6	5.7	
Almost always (75%)	22.2	17.1	
Always (100%)	7.4	68.6	
Average time used at night, % of participants			<0.001
None of the time (0%)	30.8	6.3	
Little bit of the time (25%)	19.2	3.1	
Half the time (50%)	19.2	3.1	
Almost always (75%)	23.1	18.8	
Always (100%)	7.7	68.8	

*Unless otherwise indicated.
NPRS = Numeric Pain Rating Scale; PROM = passive range of motion; Hgb = hemoglobin; WOMAC = Western Ontario and McMaster University Osteoarthritis Index.

CRYOTHERAPY

- Jennings JM et al, The Knee 2017.

PAIN CONTROL



The Journal of Arthroplasty xxx (2017) 1–5

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journal homepage: www.arthroplastyjournal.org

ELSEVIER

Original Article

Preopera
Consumj

Joshua C. R
Chia H. Wu

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Clin Orthop Relat Res (2015) 473:2402–2412
DOI 10.1007/s11999-015-4173-5

Clinical Orthopaedics and Related Research®
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CrossMark

CLINICAL RESEARCH

Preoperati
Morbidity

Mariano E. Men
Brian T. Batema

Orthopaedic Advances

The Opioid Epidemic: Impact on Orthopaedic Surgery

Brent J. Morris, MD
Hassan R. Mir, MD,

Narcotic Use: A Modifiable Risk Factor for Hip and Knee Arthroplasty

Robert M. O'Neal, BS; Kipp A. Cryer, MD; Paul K. Edwards, MD; C. Lowry Barnes, MD; and Simon C. Mears, MD, PhD

MINIMAL OPIOID PATHWAY

- Pre-operative
  - Tylenol
  - Meloxicam (NSAID)
  - Neurontin (Gabapentin)
  - Decadron (Steroid)
- Post-operative
  - Tylenol
  - Decadron
  - Toradol (NSAID)
  - Neurontin
  - 1st line opioid
    - Tramadol

Clin Orthop Relat Res (2019) 477:104-113
DOI 10.1007/s11999.0000000000000292

Clinical Orthopaedics and Related Research®
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2018 Knee Society Proceedings

The 2018 Chitranjan S. Ranawat, MD Award: Developing and Implementing a Novel Institutional Guideline Strategy Reduced Postoperative Opioid Prescribing After TKA and THA

Cody C. Wyles MD, Mario Hevesi MD, Eleanor R. Trousdale MD, Daniel S. Ubl MPH, Halena M. Gazelka MD, Elizabeth B. Habermann MPH, PhD, Robert T. Trousdale MD, Mark W. Pagnano MD, Tad M. Mabry MD

Table 1. Summary of new departmental guidelines for maximum opioid prescriptions in opioid-naïve patients

Level	Representative conditions	Maximum OME	Tramadol (50 mg)*	Hydrocodone (5 mg) *	Oxycodone (5 mg)*	Hydromorphone (2 mg) *	Oxycodone (5 mg) + tramadol (50 mg) *
1	Acute fracture						
	Radiculopathy	100	20	20	15	15	Oxycodone–8
	Carpal tunnel						Tramadol–8
2	Knee scope						
	ACL reconstruction						Oxycodone–15
	Thumb reconstruction	200	40	40	25	25	Tramadol–20
	MTP fusion						
3	Ankle ORIF						
	Shoulder scope						Oxycodone–20
	Wrist fracture ORIF	300	60	60	40	40	Tramadol–30
	Minor spine surgery						
4	THA						
	TKA						Oxycodone–25
	TSA	400	80	80	50	50	Tramadol–40
	Major spine surgery						

*OME conversion factors: tramadol: 0.1 = 50-mg tablet tramadol = 5 OME; hydrocodone: 1.0 = 5-mg tablet hydrocodone = 5 OME; oxycodone: 1.5 = 5-mg tablet oxycodone = 7.5 OME; hydromorphone: 4.0 = 2-mg tablet hydromorphone = 8 OME; OME = oral morphine equivalent (mg); ACL = anterior cruciate ligament; MTP = metatarsal phalangeal; ORIF = open reduction and internal fixation; TSA = total shoulder arthroplasty.

MINIMAL OPIOID PATHWAY

- Home medications
  - Tylenol
  - NSAIDs
  - Neurontin
  - Tramadol 1st line opioid
    - If needed switch to oxycodone or norco
- GOAL = Pain 5 or below at rest
- What about marijuana……..

Clin Orthop Relat Res (2018) 0:1-6
DOI 10.1097/CORR.0000000000000339

Clinical Orthopaedics and Related Research®
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2018 Knee Society Proceedings

Has Self-reported Marijuana Use Changed in Patients Undergoing Total Joint Arthroplasty After the Legalization of Marijuana?

Jason M. Jennings MD, DPT, Michael A. Williams MD, Daniel L. Levy BS, Roseann M. Johnson BA, Catherine L. Eschen BS, Douglas A. Dennis MD

- Pre-legalization
  - 0.8% (4/500)
- Post-legalization
  - 11% (55/500)
- Risk factors for use (self-reporting)
  - Younger age
  - Male gender
  - Current smokers or those who did not report a smoking status
  - History of current substance abuse
  - Medicaid insurance
  - Preoperative narcotic use

OUTCOMES – MJ & TJA

- Primary unilateral TJA
- Retrospective
- Minimum 1 year follow-up
- Exclusion: alcohol, opioid or illicit drug use, tobacco use
- Match
  - Age
  - Gender
  - BMI
  - Insurance type

OUTCOMES TKA

- 71 patients in each cohort (user:nonuser)
- ROM – no difference
- KSS – no difference
  - Follow-up or overall change
- VR-12 – no difference
  - Physical
  - Mental
- No differences in readmissions/reoperations

- Marijuana use does not appear to influence (adverse or beneficial) outcomes in patients undergoing a primary TKA

- Jennings et al, AAOS Poster 2019

DOES IT WORK?

2 Week Follow UP (Knee Patient)			
	User (Average ± SD) N = 25*	Non-User (Average ± SD) N = 25*	Statistical Analysis
Pain - Week 1 Average	4.6 ± 1.8	4.0 ± 1.9	p = 0.255
Pain - Week 2 Average	4.2 ± 1.9	3.7 ± 1.4	p = 0.314
Pain @ 2 Week Follow Up	3.1 ± 1.9	2.5 ± 1.5	p = 0.258
Narcotic Usage (Morphine Equivilence) – Week 1 Average	55.9 ± 31.8	55.2 ± 42.4	p = 0.946
Narcotic Usage (Morphine Equivilence) – Week 2 Average	40.7± 26.3	32.9 ± 28.4	p = 0.313

DOES IT WORK?

6 Week Follow Up (Knee Patient)			
	User (Average ± SD) N = 25*	Non-User (Average ± SD) N = 25*	Statistical Analysis
Pain (Self-Reported at Visit)	1.7 ± 1.6	1.56 ± 1.9	p = 0.747
Pain on Knee Score	37.6 ± 12.3	37 ± 11.1	p = 0.857
Function	73 ± 19.3	79.0 ± 17.3	p = 0.253
ROM (Ext/Flex)	122.4 ± 10.2	121.9 ± 9.2	p = 0.862
KSS	157.3 ± 28.0	164.6 ± 21.1	p = 0.305
VR-12 (MCS)	52.1 ± 9.6	56.5 ± 9.4	p = 0.110
VR-12 (PCS)	37.2 ± 8.3	34.4 ± 9.7	p = 0.273

ONLY PROSPECTIVE STUDY

- No differences that we have found in our prospective analysis. Only attempt to study to date in TJA patients

- What is next?
  - Prospective randomized blinded
  - Marinol

WHAT SHOULD YOU DO WITH ABNORMAL FINDINGS?

- Do not ever hesitate to call the surgeon or their team
- Always do the right thing for the patient

WOUND ISSUES

ERYTHEMA

ECCHYMOSIS

ECCHYMOSIS

ADHESIVE REACTION

WHAT IS HAPPENING WITH PT

- Reimbursement most likely to decrease
- You need more evidence based outcomes

PHYSICAL THERAPY: FREQUENCY & DURATION

- No evidence based guidelines
- Functional testing and ideal target for rehabilitation needs to be established
- We typically suggest 3x/week for 4-6 weeks
- Educate patients to "not depend on your therapist"
  - Patient must work on therapy program t.i.d. on their own

BUNDLED CARE – IT IS HERE

Bundled Payment Initiatives for Medicare and Non-Medicare Total Joint Arthroplasty Patients at a Community Hospital: Bundles in the Real World

James P. Doran, BS [a], Stephen J. Zabinski, MD [b]

[a] NYU Langone Medical Center, NYU Hospital for Joint Diseases Department of Orthopaedic Surgery, New York, New York
[b] Division of Orthopaedic Surgery, Shore Orthopaedic University Associates, Somers Point, New Jersey

Strategies and Tactics for Successful Implementation of Bundled Payments: Bundled Payment for Care Improvement at a Large, Urban, Academic Medical Center

Richard Iorio, MD

Orthopedic Surgery, Department of Orthopedic Surgery, NYU Langone Medical Center, Hospital for Joint Diseases, New York, NY

LOOK HOW FAR YOU HAVE COME

TABLE 3
Guidelines for Postoperative Physical Therapy Management

	Geomedic	Walldius
Length of immobilization	1 week	4-6 weeks
Begin knee range of motion	Week 1 (average 5-7 days)	Week 4-6
Training in activities of daily living	Week 1 (in cast) Week 2 (cast removed)	Week 1 (in cast) Week 4-6 (cast removed)
Strengthening exercises to knee	Week 2-4	Week 5-7
Begin ambulation, weight bearing to tolerance	Week 2-3	Week 2 (in cylinder cast) Week 6-8 (cast removed)

Waters. Physical Therapy 1974

SHIFT IN REHABILITATION PROTOCOL "ACCELERATED REHABILITATION"

TABLE I Protocols for Standard and Accelerated Interventions for Eighty-seven Patients Treated with Total Hip or Knee Arthroplasty in Denmark from 2005 to 2006

Standard-Protocol Group	Accelerated-Protocol Group
Information given separately to each individual patient on the day of admission	Patients receive information in groups at an outpatient clinic visit prior to hospitalization
Hospitalization on the day before surgery	Hospitalization on the day of surgery
Patients treated with arthroplasty placed randomly among other patients	All patients treated with arthroplasty placed together in one separate part of the ward
Various nurses in charge of care, and various occupational therapists and physiotherapists responsible for mobilization	One nurse in charge of a multidisciplinary team of nurses, occupational therapists, and physiotherapists
Nutrition screening	Nutrition screening and special focus on daily consumption of 1.5 L of fluid, including two protein beverages
Mobilization and exercise started on the first postoperative day	Mobilization and exercise started on the day of surgery
Individual and gradual mobilization according to the patient's tolerance	Intensive mobilization of patients in teams after preset daily goals
Four hours of mobilization daily	Eight hours of mobilization daily
No difference in operating theater	
No difference in pain relief, nausea control, or bowel regulation	

Clin Orthop Relat Res (2019) 477:60-69
DOI 10.1097/CORR.0000000000000561

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

2018 Knee Society Proceedings

2018 John N. Insall Award: Recovery of Knee Flexion With Unsupervised Home Exercise Is Not Inferior to Outpatient Physical Therapy After TKA: A Randomized Trial

Andrew N. Fleischman MD, Meredith P. Crizer BS, Majd Tarabichi MD, Shelby Smith BS, Richard H. Rothman MD, PhD, Jess H. Lonner MD, Antonia F. Chen MD, MBA

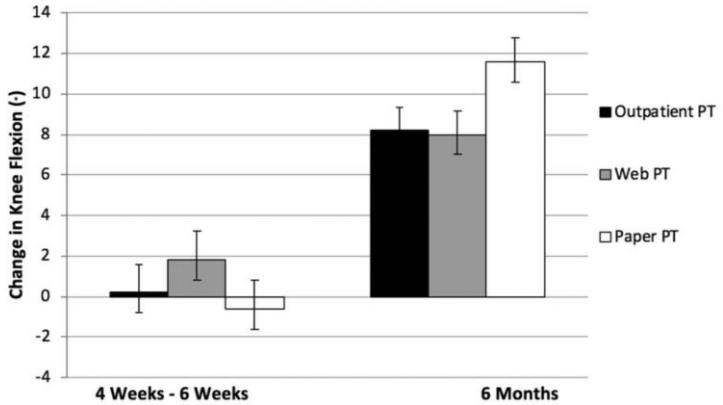


Fig. 2 This histogram demonstrates the change in knee flexion from preoperative baseline at 4 to 6 weeks to 6 months.

A commentary by Mark J. Spangehl, MD, FRCS(C), is linked to the online version of this article at jbjs.org.

In-Home Telerehabilitation Compared with Face-to-Face Rehabilitation After Total Knee Arthroplasty

A Noninferiority Randomized Controlled Trial

Hélène Moffet, PT, PhD, Michel Tousignant, PT, PhD, Sylvie Nadeau, PT, PhD, Chantal Mérette, PhD, Patrick Boissy, PhD, Hélène Corriveau, PT, PhD, François Marquis, MD, François Cabana, MD, Pierre Ranger, MD, Étienne L. Belzile, MD, and Ronald Dimentberg, MD

Investigation performed at the Center for Interdisciplinary Research in Rehabilitation and Social Integration, Québec; the Research Centre on Aging, Sherbrooke; and the Center for Interdisciplinary Research in Rehabilitation of Greater Montréal, Montréal, Québec, Canada

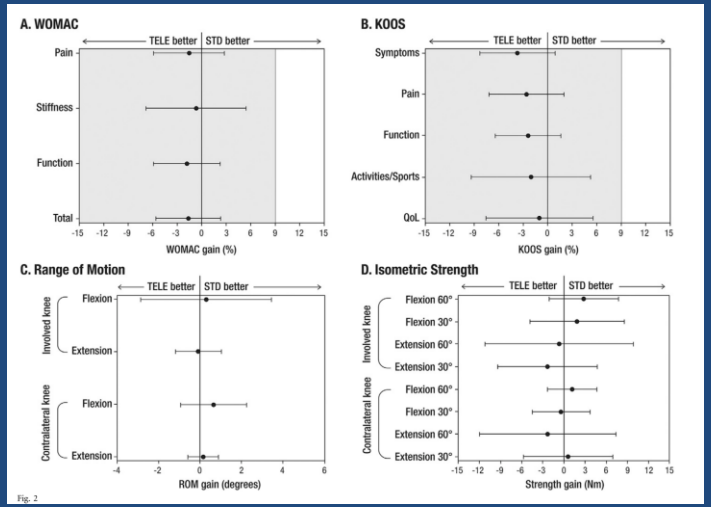


Fig. 2

Home-Health-Care Physical Therapy Improves Early Functional Recovery of Medicare Beneficiaries After Total Knee Arthroplasty

Jason R. Falvey, DPT, Michael J. Bade, PhD, Jeri E. Forster, PhD, Robert E. Burke, MD, MS, Jason M. Jennings, MD, Eugene Nuccio, PhD, and Jennifer E. Stevens-Lapsley, PhD

Investigation performed at the University of Colorado, Anschutz Medical Campus, Aurora, Colorado

TABLE II Improvement in ADL Function by PT Utilization

PT Utilization	Mean Improvement in ADL Score (95% CI) *(points)*	
	Unadjusted	Adjusted*
≤5 visits	1.67 (1.62-1.73)	1.91 (1.86-1.96)
6-9 visits	2.09 (2.06-2.13)†	2.13 (2.09-2.17)†
10-13 visits	2.34 (2.29-2.39)†	2.22 (2.17-2.27)†
≥14 visits	2.50 (2.43-2.58)†	2.22 (2.15-2.28)†

*Adjusted for age, sex, baseline ADL function, non-elective admission, duration of home health care, living alone, CCI, baseline dyspnea, and presence of severe pain. †$P < 0.0001$ compared with low PT utilization.

JOINTS WITH ALTITUDE

OPERATION WALK

OPERATION WALK

THANK YOU

Leveraging Health Systems Data to Anticipate Patient Recovery Trajectories and Shape Resource Utilization

Andrew Kittelson, PT, PhD

Assistant Professor

University of Colorado Denver

Physical Therapy Program

Rehabilitation Science PhD Program

Provider Challenges

Provider Challenges

How to help patients understand TKA and recovery

Provider Challenges

How to help patients understand TKA and recovery

Demonstrating resource-responsible care

Provider Challenges

How to help patients understand TKA and recovery

Standardizing person-centered care

Demonstrating resource-responsible care

Patient Challenges

Patient Challenges

Burden to understand surgery and recovery

Patient Challenges

Information based on the “average patient”

Burden to understand surgery and recovery

Patient Challenges

Information based on the “average patient”

No framework for person-centered discussions

Burden to understand surgery and recovery

Patient Challenges

Information based on the “average patient”

No framework for person-centered discussions

Burden to understand surgery and recovery

Benchmarking recovery:

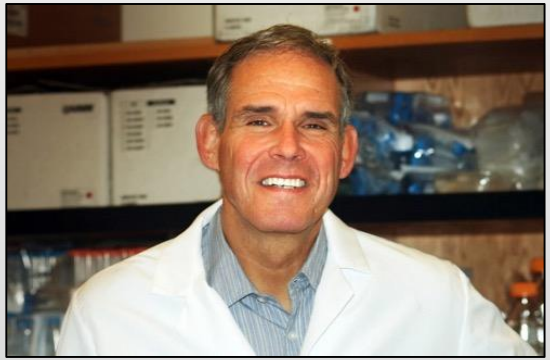
“Am I recovering as I should be?”

The Washington Post

Dr. Eric Topol Dec. 16, 2016

Health & Science

A doctor with a bad knee runs into one-size-fits-all medicine



"Most people do well with intensive physical therapy, but for me it backfired and set up a vicious cycle of inflammation. I needed a different protocol than the standard one that works for the majority. I needed a protocol for patients with histories and conditions like mine."

The Washington Post

Dr. Eric Topol Dec. 16, 2016

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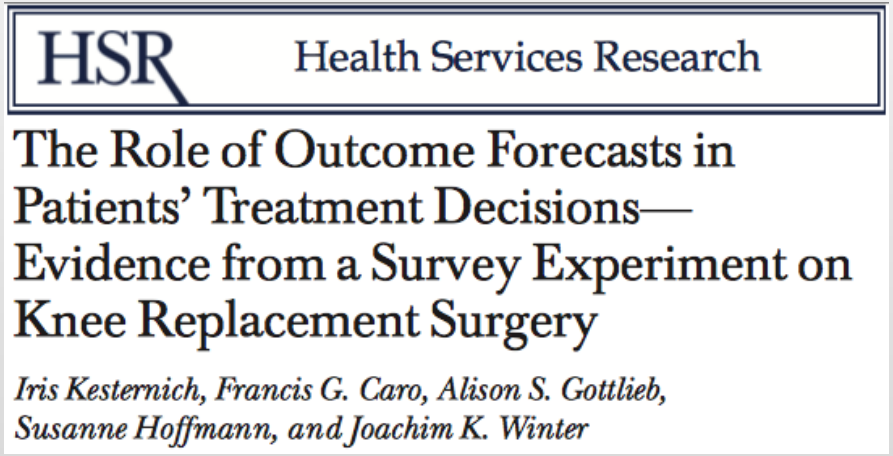
“Personalized Outcome Forecasts”



HSR Health Services Research

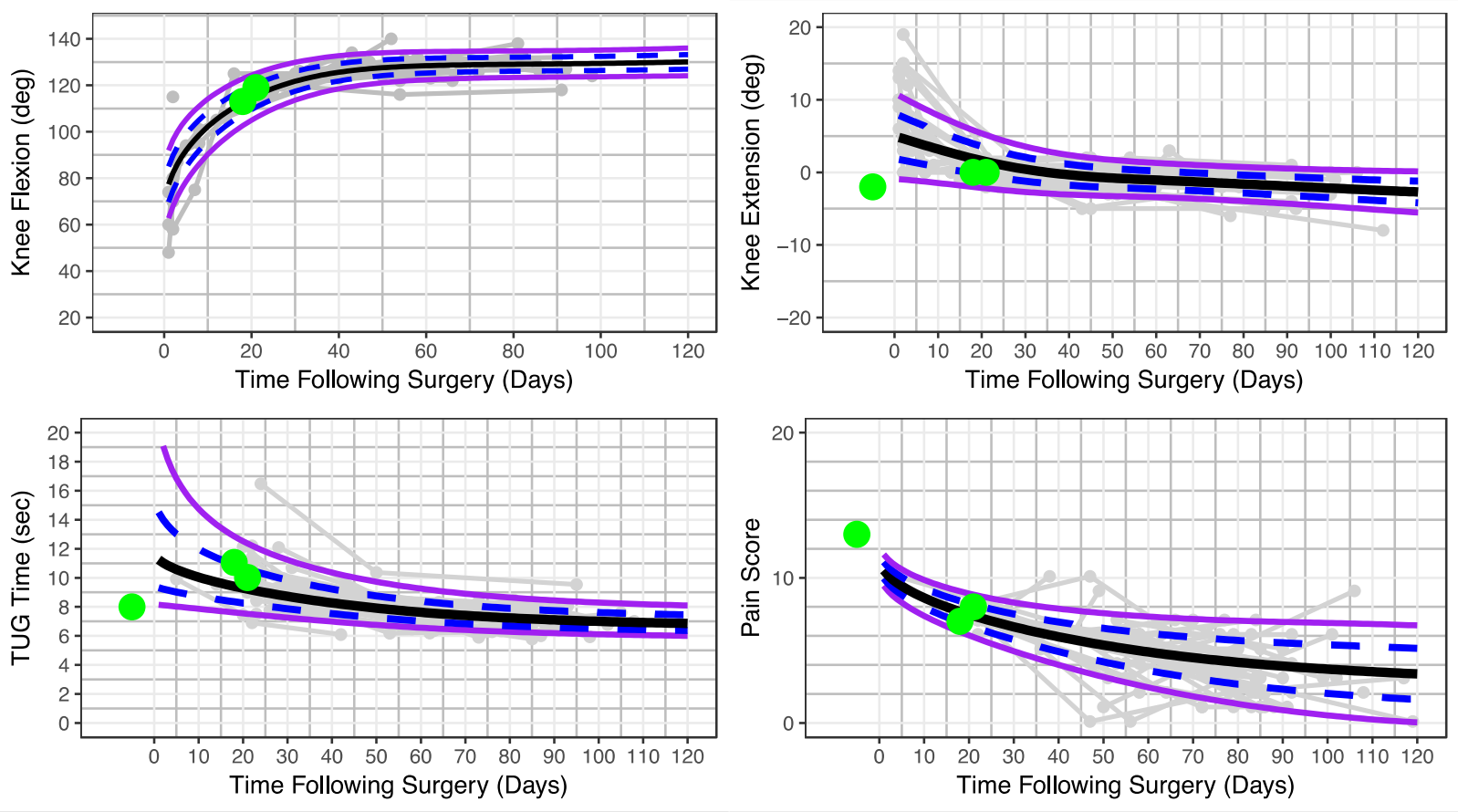
The Role of Outcome Forecasts in Patients’ Treatment Decisions—Evidence from a Survey Experiment on Knee Replacement Surgery

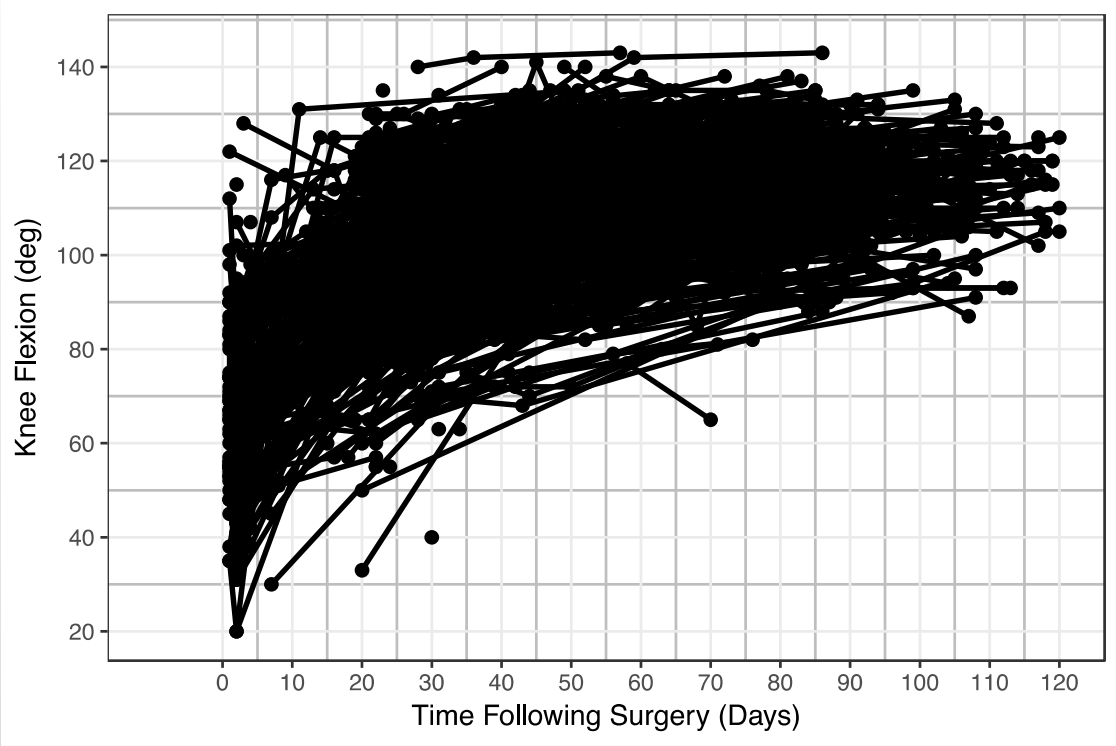
Iris Kesternich, Francis G. Caro, Alison S. Gottlieb, Susanne Hoffmann, and Joachim K. Winter

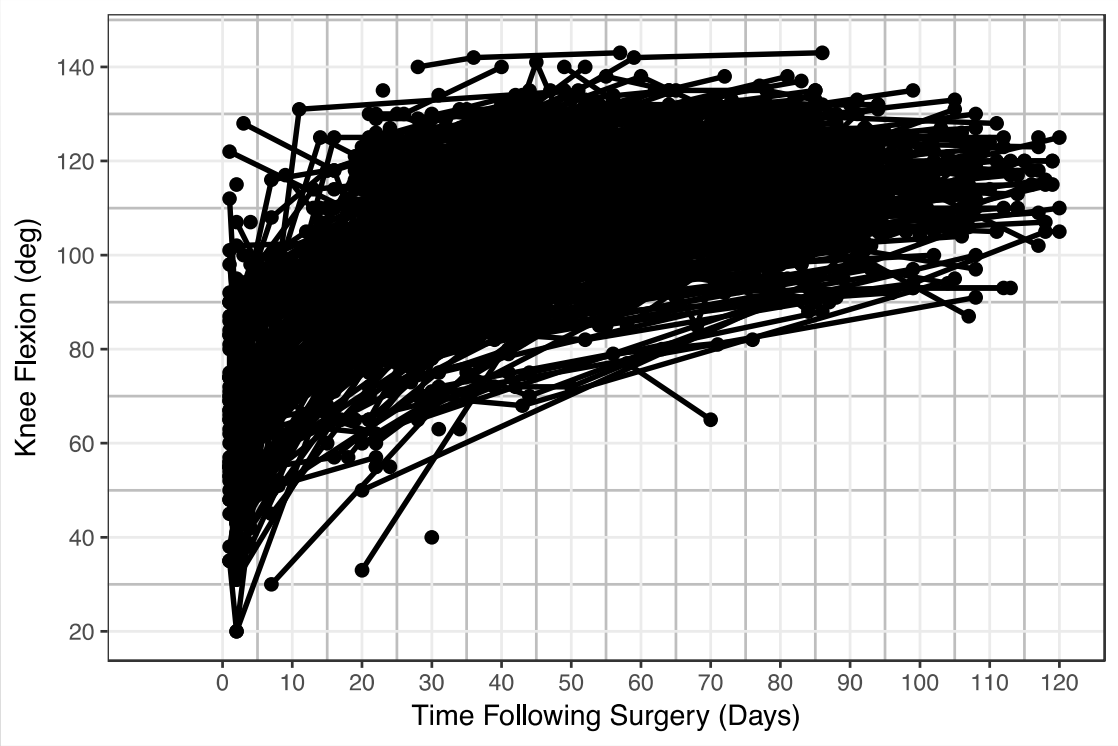
Contributions of Second Opinions, Outcome Forecasts, and Testimonials to Patient Decisions about Knee Replacement Surgery

Susanne Hoffmann Dr. oec. publ., Francis G. Caro, PhD, Alison S. Gottlieb, PhD, Iris Kesternich, Dr. oec. publ., Joachim K. Winter, Dr. rer. pol.

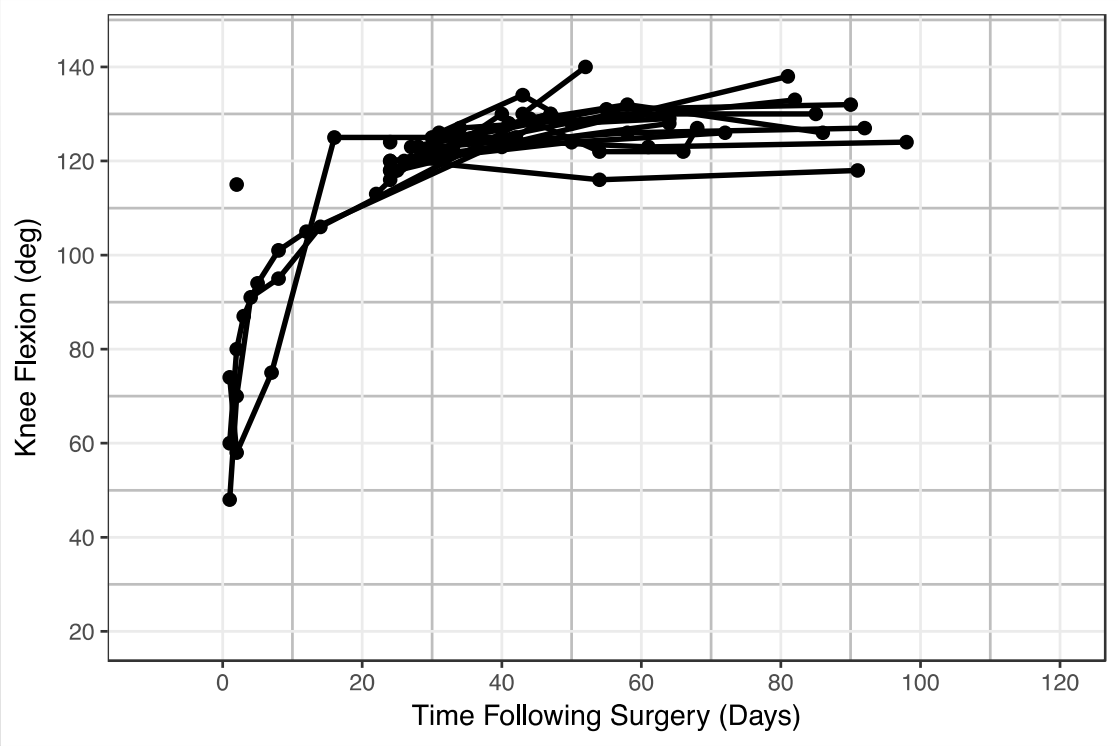
MEDICAL DECISION MAKING/JULY 2014


Knee Flexion (deg)
Time Following Surgery (Days)
Knee Extension (deg)
Time Following Surgery (Days)
TUG Time (sec)
Time Following Surgery (Days)
Pain Score
Time Following Surgery (Days)

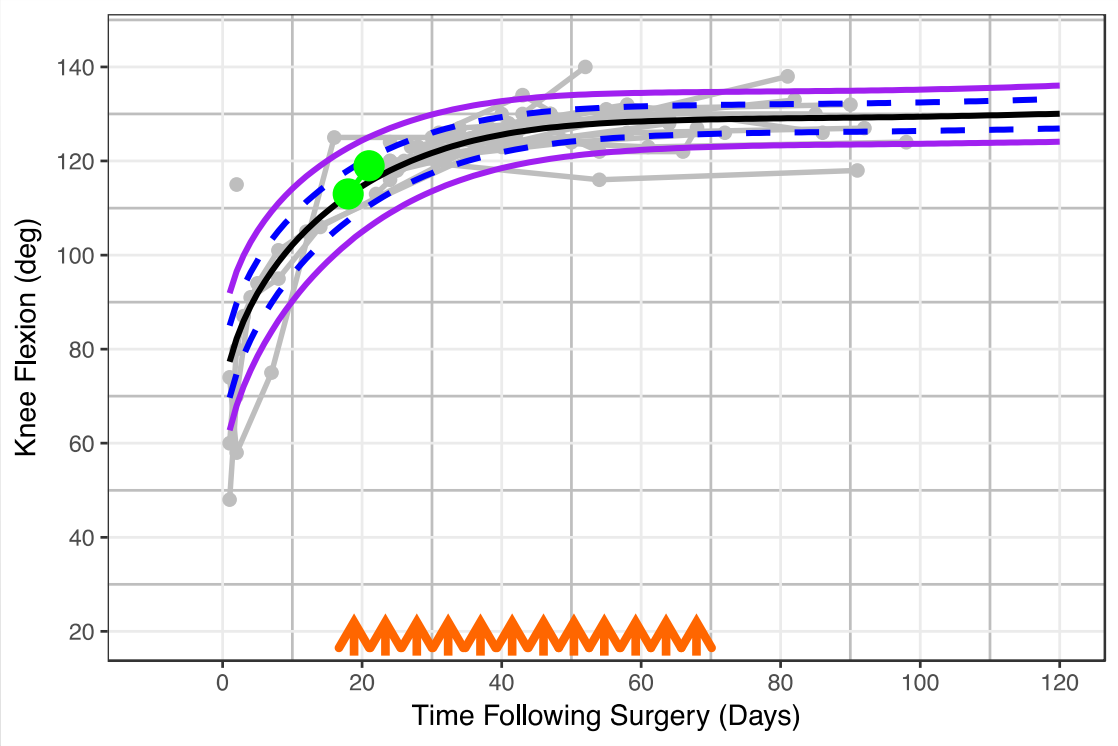

Knee Flexion (deg)
140
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
110
120
Time Following Surgery (Days)



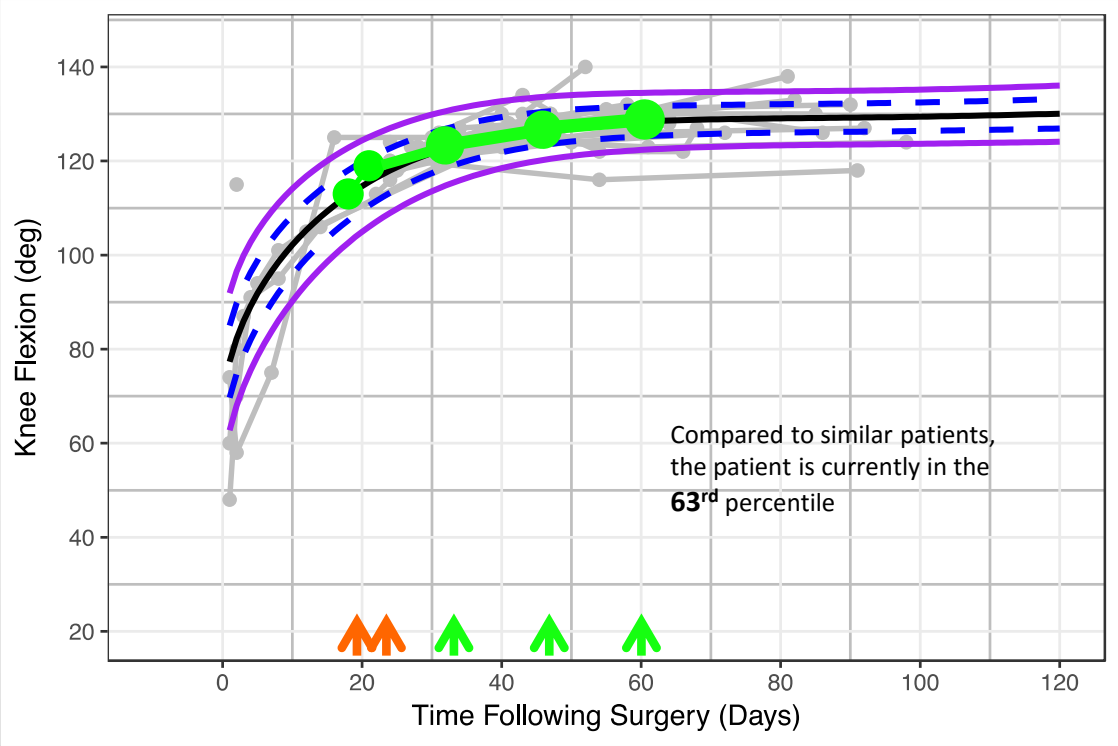
- Age
- Gender
- BMI



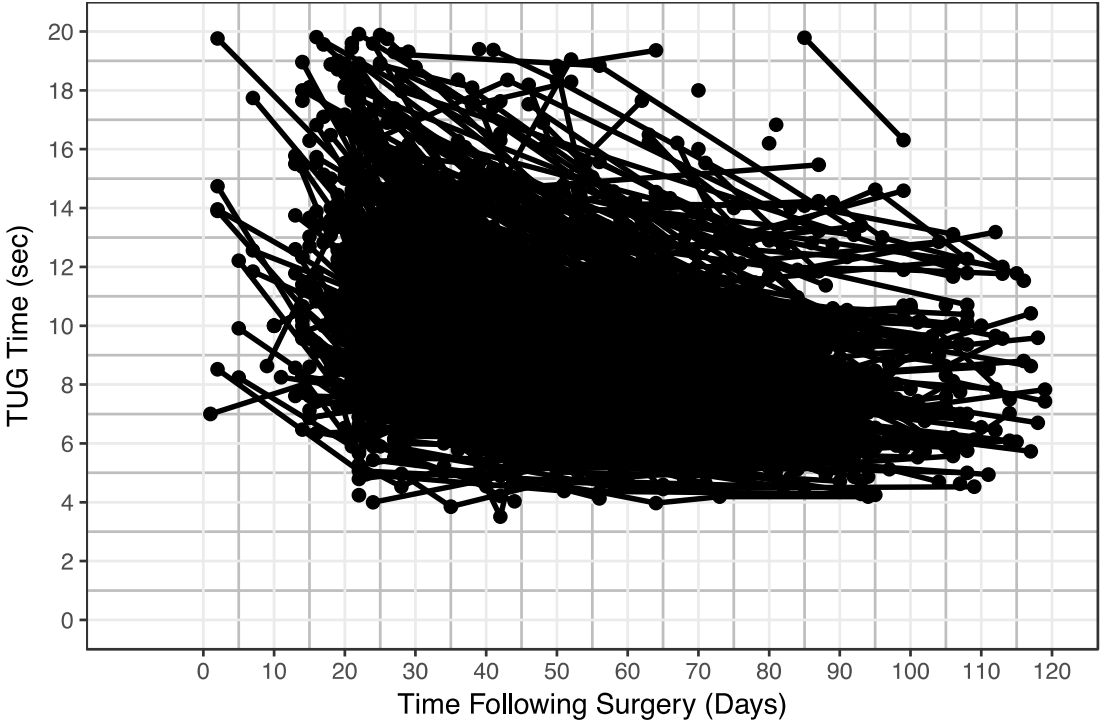
- Age
- Gender
- BMI



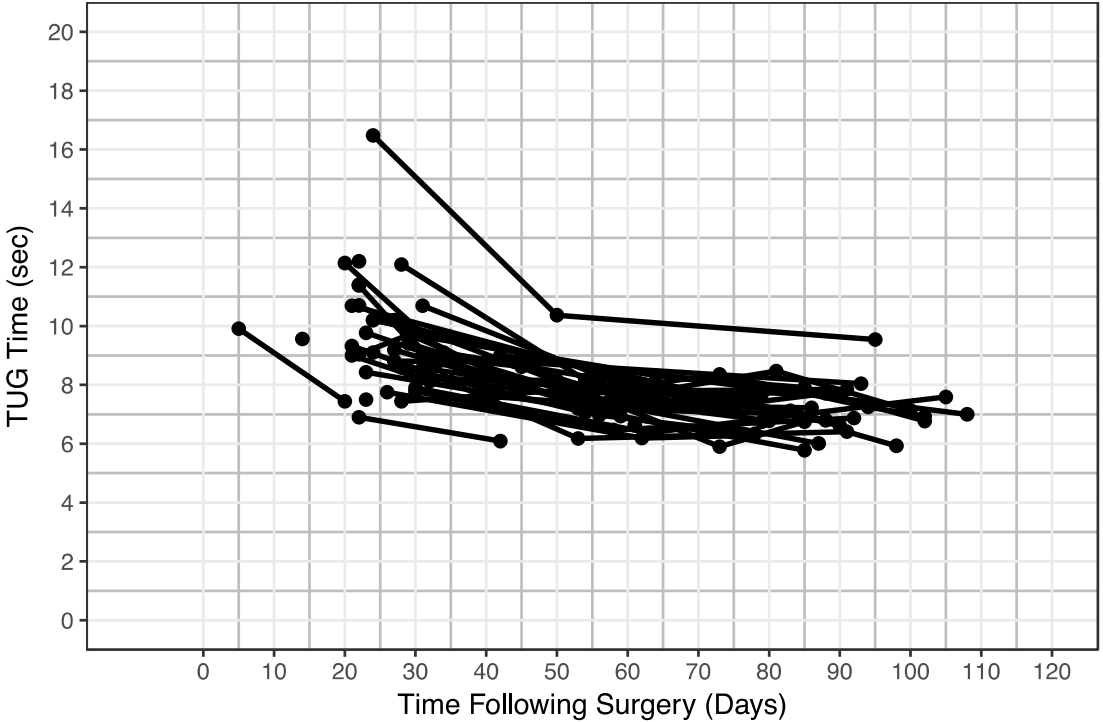
- Age
- Gender
- BMI



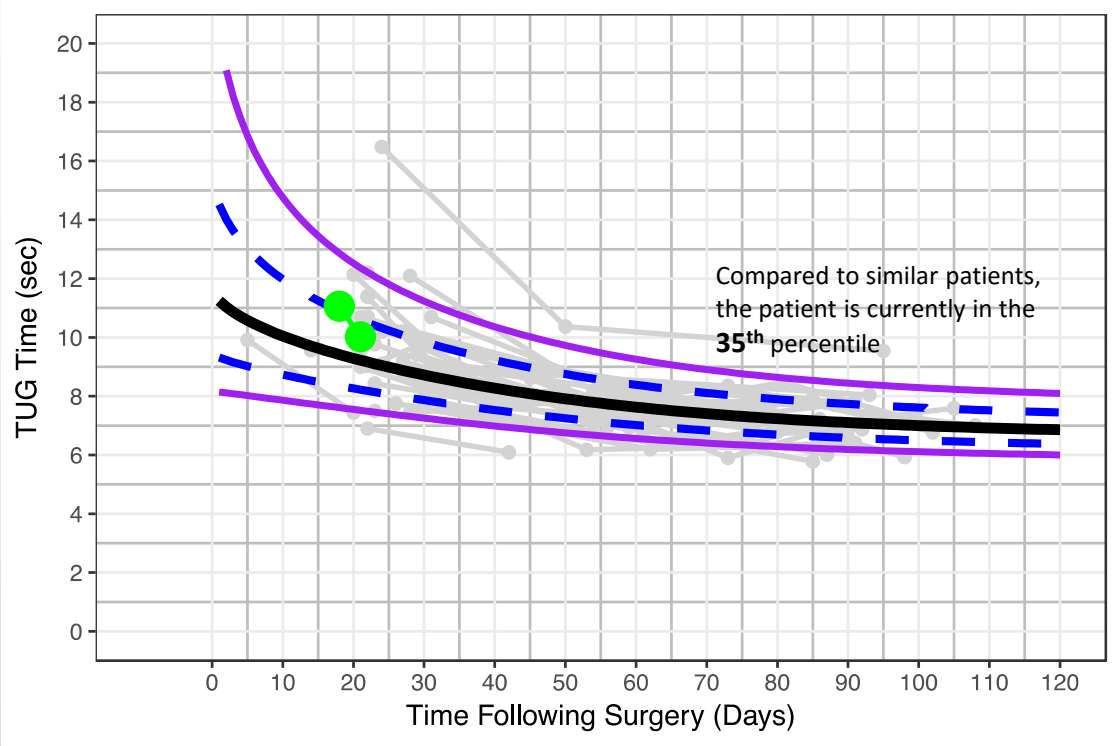
- Age
- Gender
- BMI



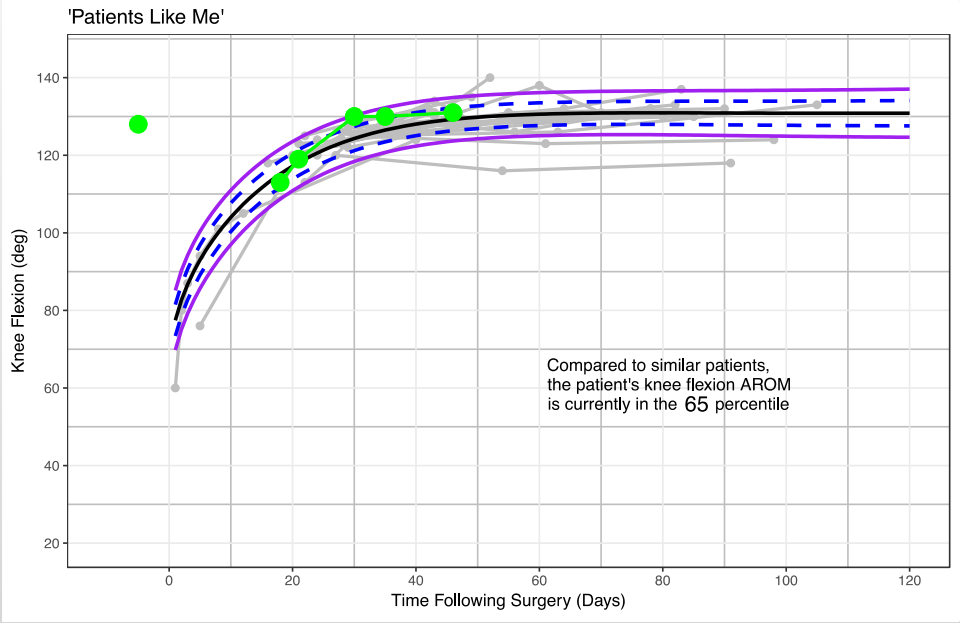
- Age
- Gender
- BMI

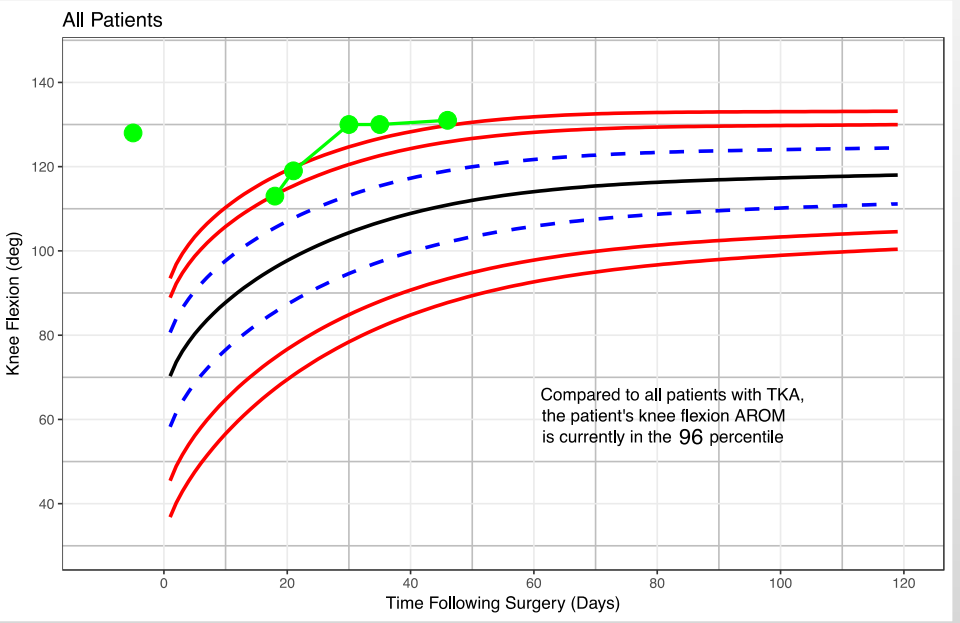


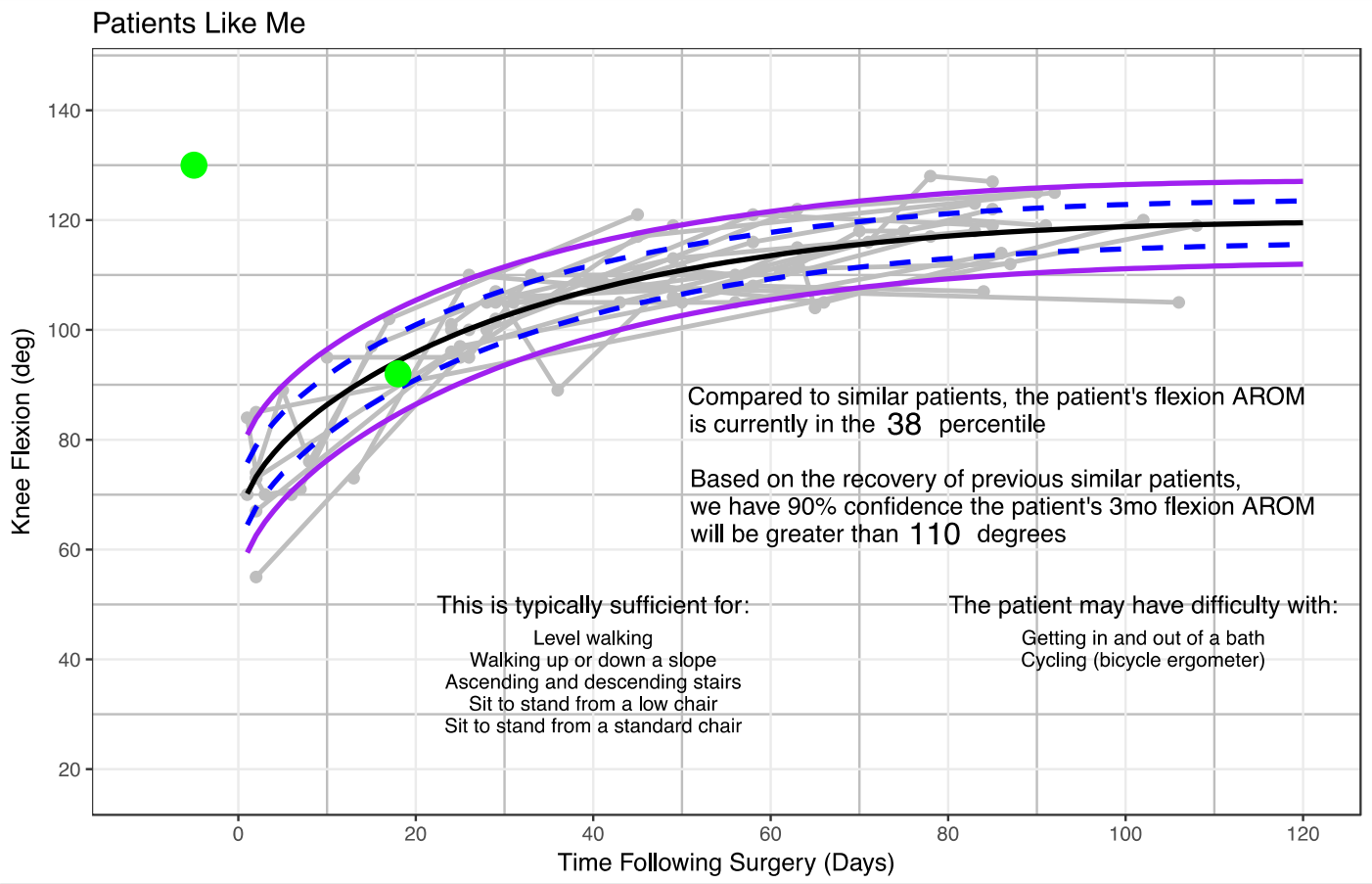
- Age
- Gender
- BMI



- Age
- Gender
- BMI


'Patients Like Me'
Knee Flexion (deg)
Time Following Surgery (Days)
Compared to similar patients,
the patient's knee flexion AROM
is currently in the 65 percentile


All Patients
Knee Flexion (deg)
Time Following Surgery (Days)
Compared to all patients with TKA,
the patient's knee flexion AROM
is currently in the 96 percentile


Patients Like Me
Knee Flexion (deg)
140
120
100
80
60
40
20
0
20
40
60
80
100
120
Time Following Surgery (Days)
Compared to similar patients, the patient's flexion AROM is currently in the 38 percentile
Based on the recovery of previous similar patients, we have 90% confidence the patient's 3mo flexion AROM will be greater than 110 degrees
This is typically sufficient for:
Level walking
Walking up or down a slope
Ascending and descending stairs
Sit to stand from a low chair
Sit to stand from a standard chair
The patient may have difficulty with:
Getting in and out of a bath
Cycling (bicycle ergometer)

It starts with a conversation…

"When you don't know what is going on or what is causing the pain or what to expect…you don't know if your experience is typical or something is wrong…either I'm not on track or something is wrong"

"Average patient like me has no idea what is coming"

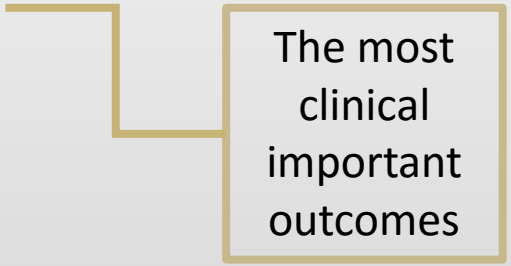
"The patient wants to know, well where do I fall in? I would have loved that"

It starts with a conversation…

- Data should support clinical interactions (feedback and feedforward)

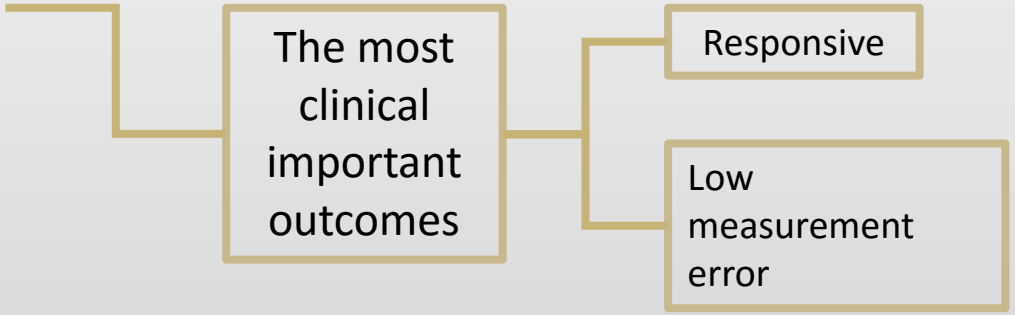
It starts with a conversation…

- Data should support clinical interactions (feedback and feedforward)



It starts with a conversation…

- Data should support clinical interactions (feedback and feedforward)

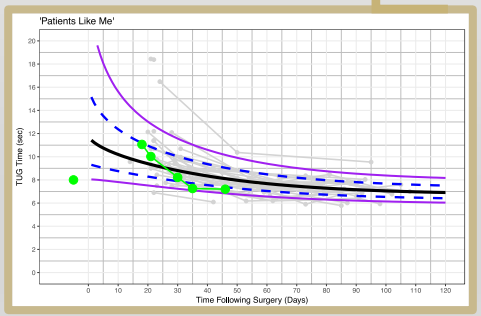


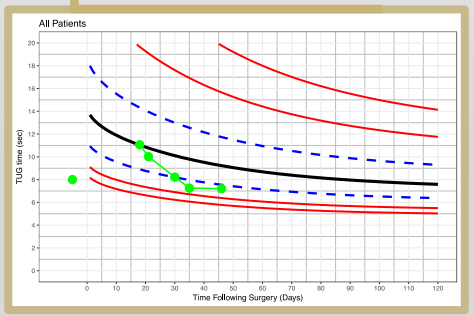
It starts with a conversation…

- Data should support clinical interactions (feedback and feedforward)
- Address the key “pain points” of patients and providers

It starts with a conversation…

- Data should support clinical interactions (feedback and feedforward)
- Address the key “pain points” of patients and providers
- The importance of user-centered design





RESTORE

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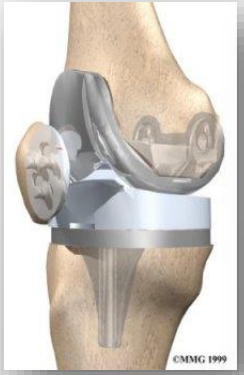
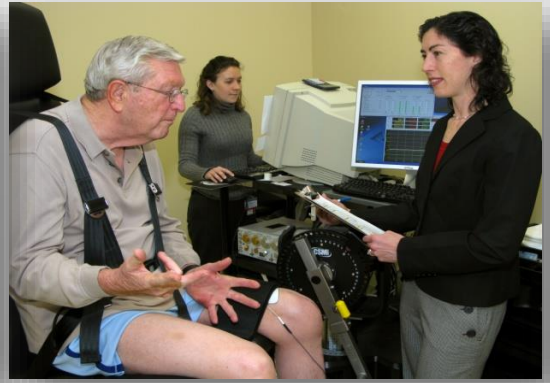
Lower Extremity Weakness after TKA



Jennifer Stevens-Lapsley, PT, PhD
Professor
Director, Rehabilitation Science PhD Program
University of Colorado
Eastern Colorado Geriatrics Research Education and Clinical Center

TKA Outcomes: Pain

- 90% of patients have a substantial reduction in their knee pain
- Pain reduction = #1 Benefit of TKA

(Gill 2001, Konig 2002, Huang 2001, Petterson 2009, Ethgen 2004….)

TKA Outcomes

- Range of motion (ROM) at 1 year
  - Flexion: 110-124°
  - Extension:-1-0°

Walsh *Phys Ther* 1999; Yoshida et al *Clin Biomech* 2007

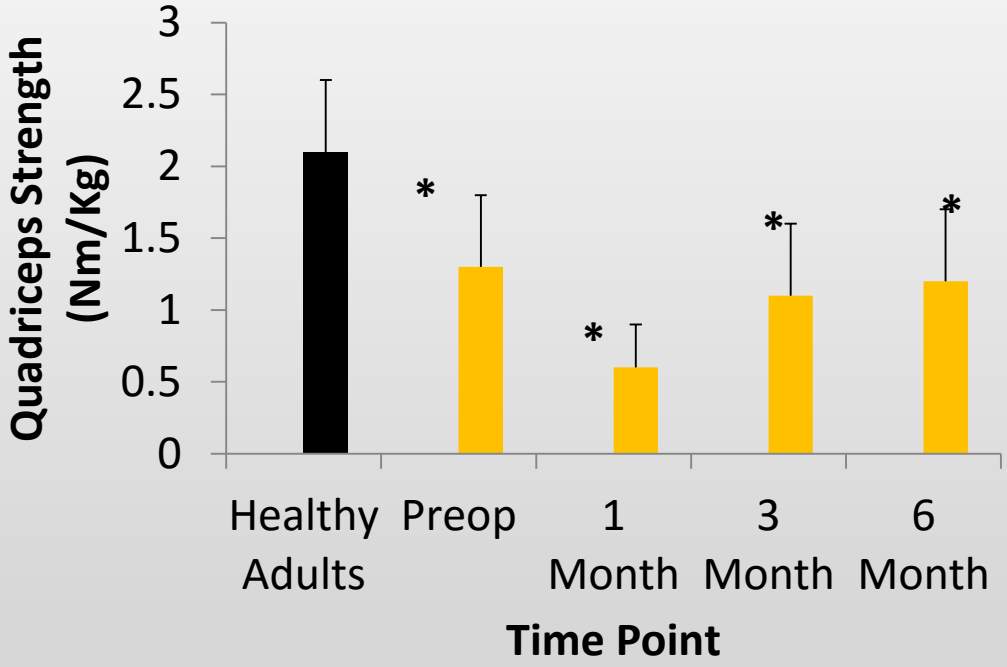
- Knee ROM limits function only when ROM limited acutely

Outcomes with TKA

Long-term deficits in strength and function compared to healthy adults:

- 40% deficits in quadriceps strength
- 30% deficits in walking distance
- 105% deficit in stair climbing speed

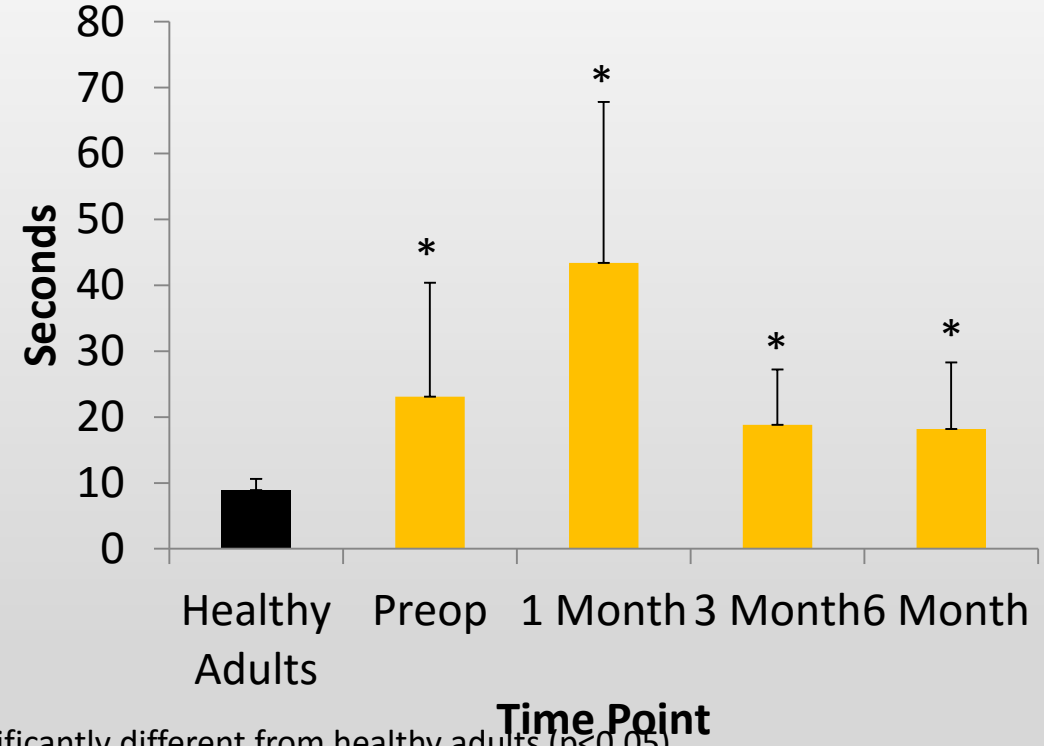
Quadriceps Strength Loss After TKA



* Significantly different from healthy adults (p<0.05)

Bade *et al* JOSPT , 2010

Stair Climbing Performance After TKA



* Significantly different from healthy adults ($p<0.05$)

Bade, 2010

What should be the focus to improve outcomes?

- Quadriceps strength is directly related to functional performance.
  - Brown et al 1995
  - Connelly et al 1997
- Therefore, quadriceps strength is the focus of much ongoing research.

Clinical Implications

- Activation deficits account for a greater proportion of the post-operative weakness than muscle atrophy. (Mizner 2005)

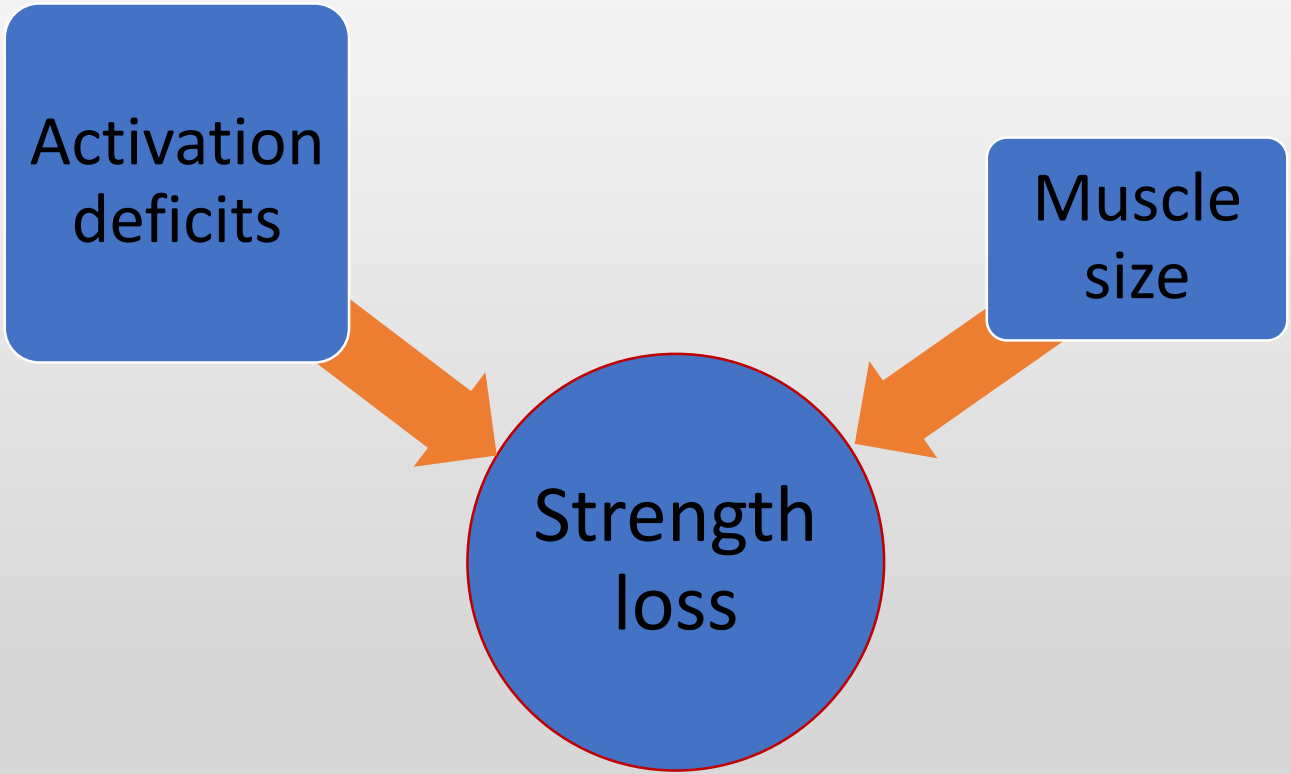
- Patients with large muscle activation deficits have negligible improvements in force even after intensive rehabilitation. (Hurley 1993)

Clinical Implications

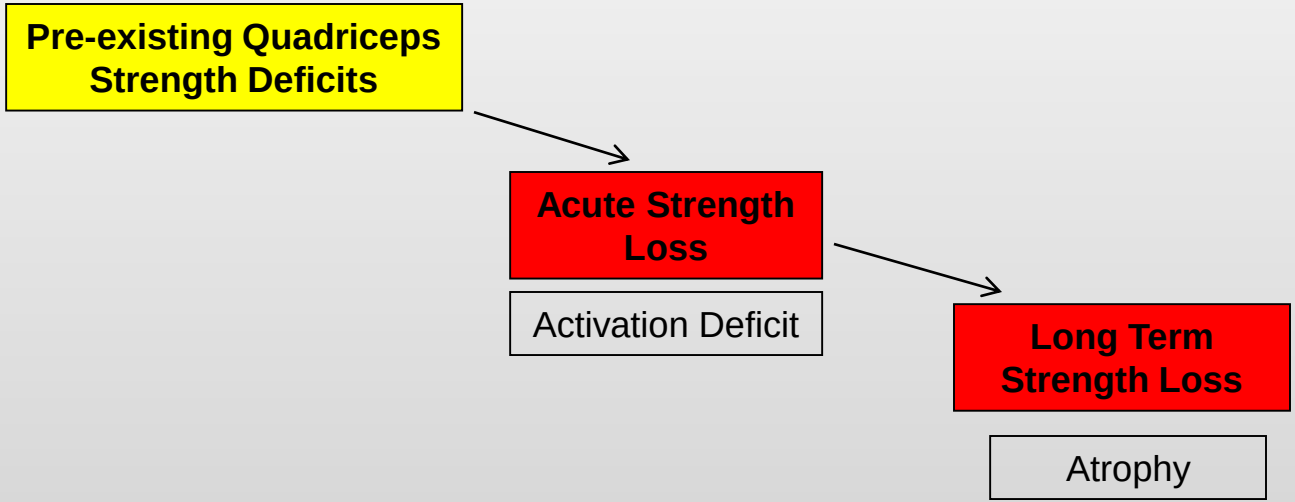
- Muscle activation deficits moderate the relationship between quadriceps strength and physical function with OA.

- Physical function loss
  - Weakness with activation failure
  - Weakness without activation failure

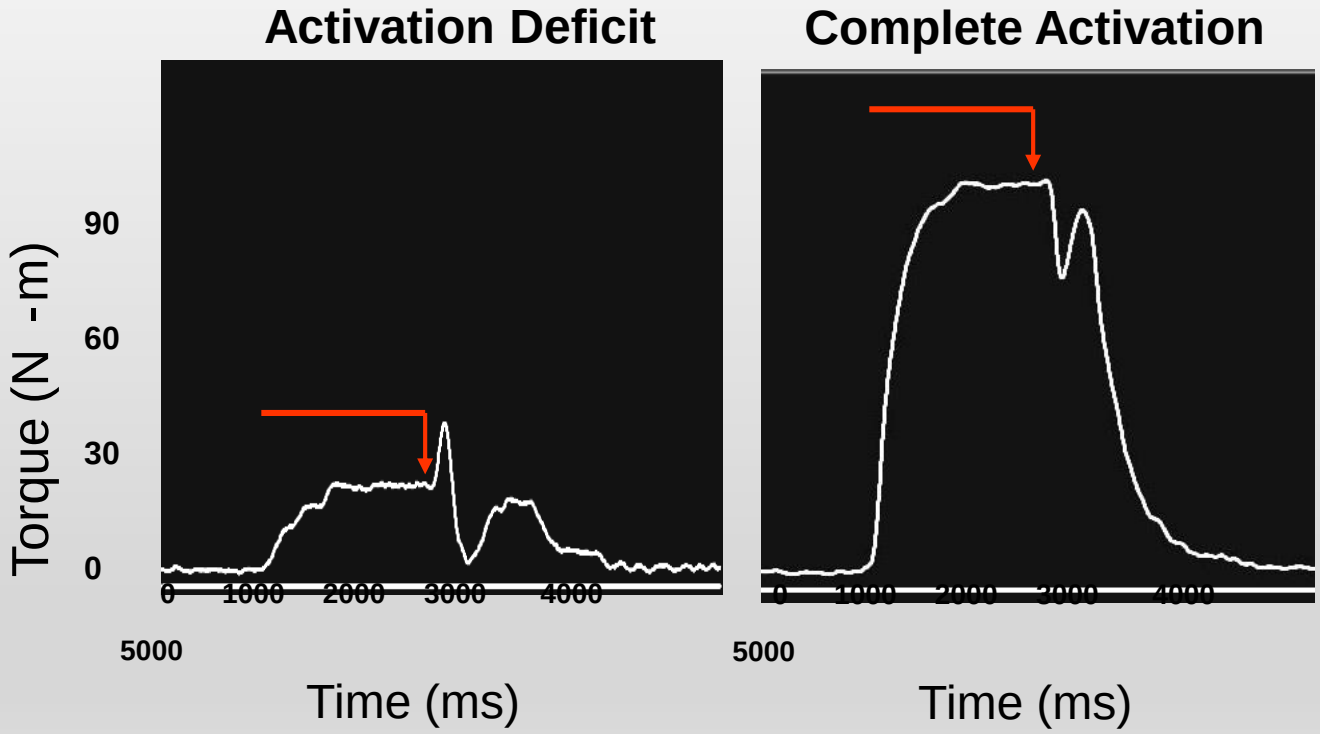
Fitzgerald et al. Arthritis Rheum 2004


Activation deficits
Muscle size
Strength loss

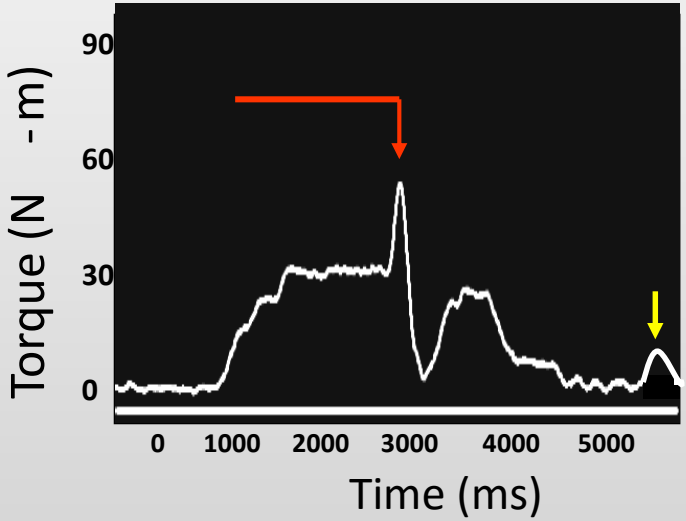
Mechanisms for Quadriceps Strength Loss



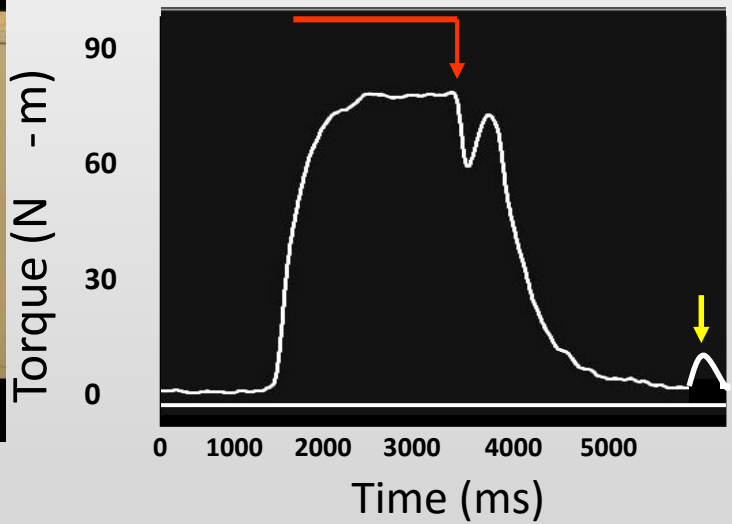
Muscle Force and Activation



Activation Deficit



Complete Activation



Clinical Activation Battery

3 Tasks (Total Possible Score = 6 points):

QUAD SET

0: Unable to initiate contraction

1: Poor contraction no superior patellar movement

2: Strong contraction, visible superior movement of patella

STRAIGHT LEG RAISE

0: Unable to perform

1: Performed with Flexed Knee

2:Good form (lift leg >2 feet)

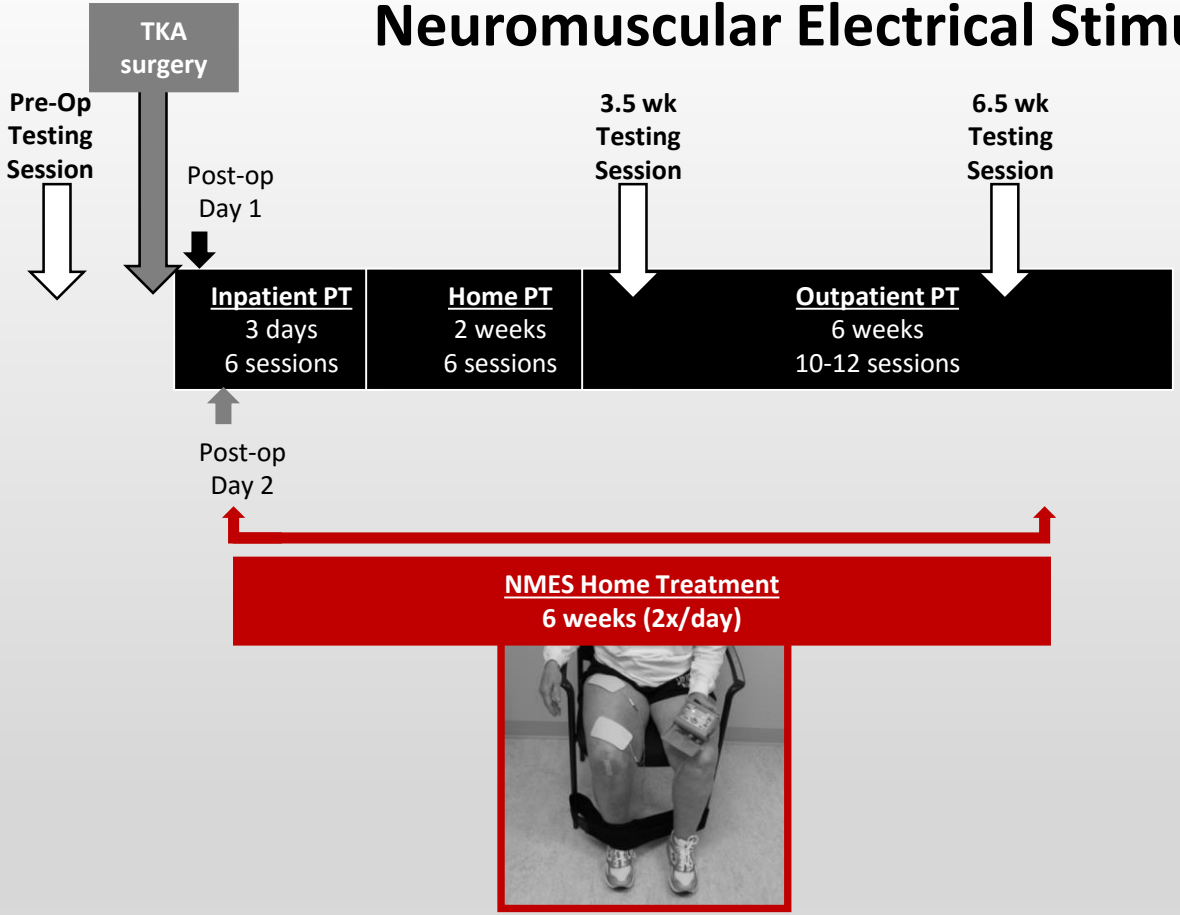
EXTENSION LAG TEST

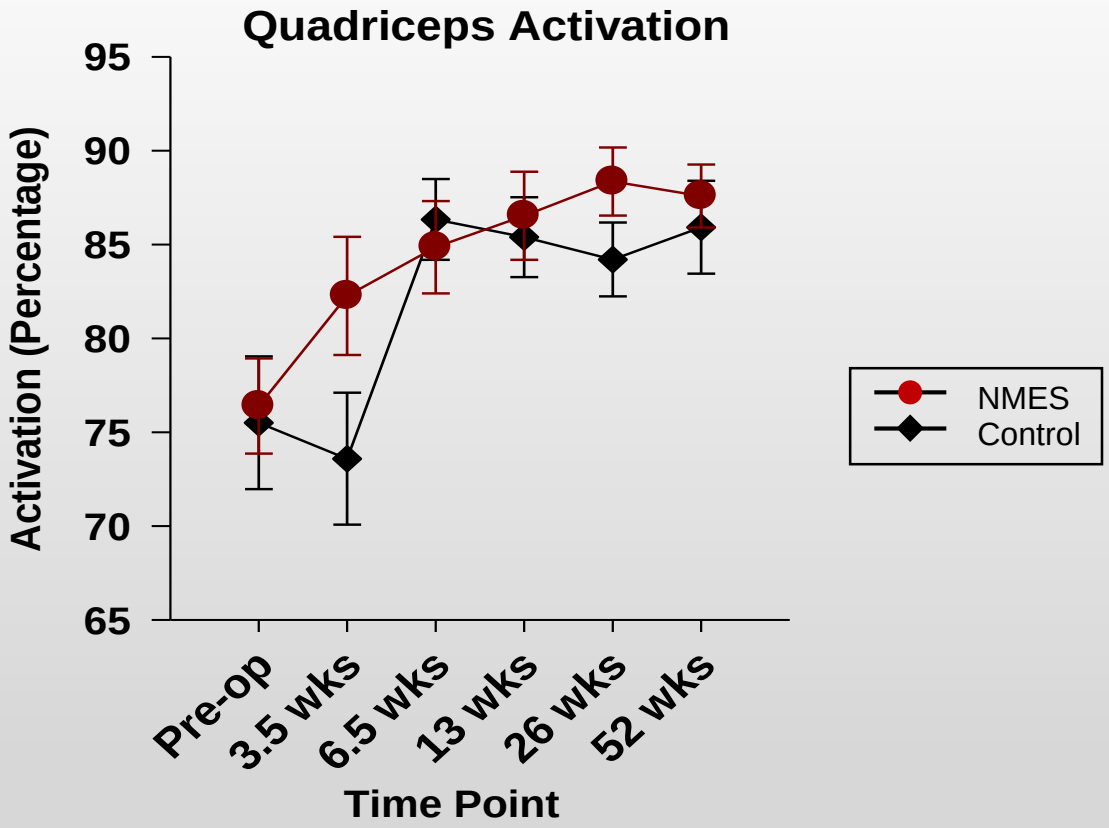
0: Unable to hold against gravity

1: Able to maintain <1 s, slows leg

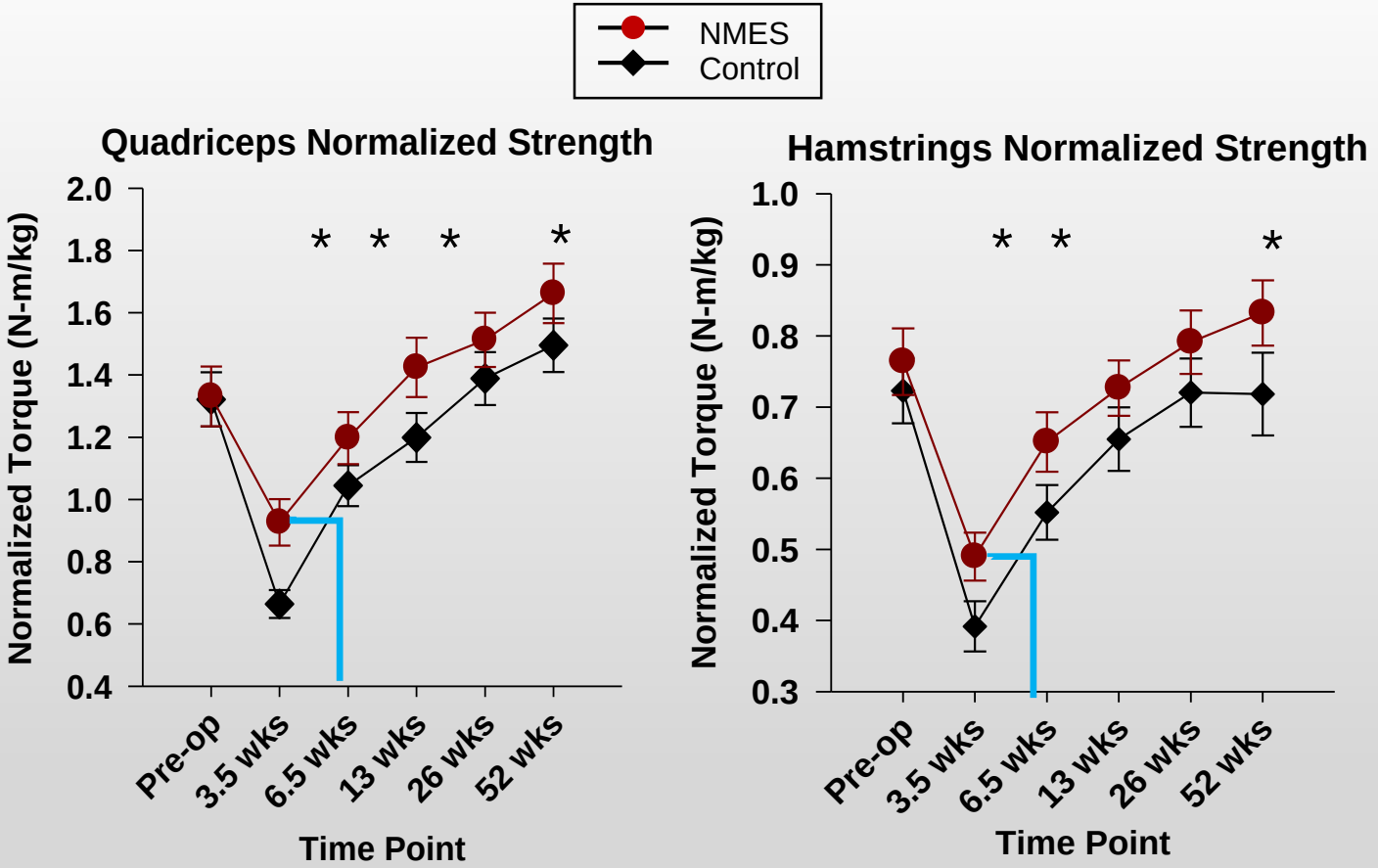
2: Able to maintain >1 s.

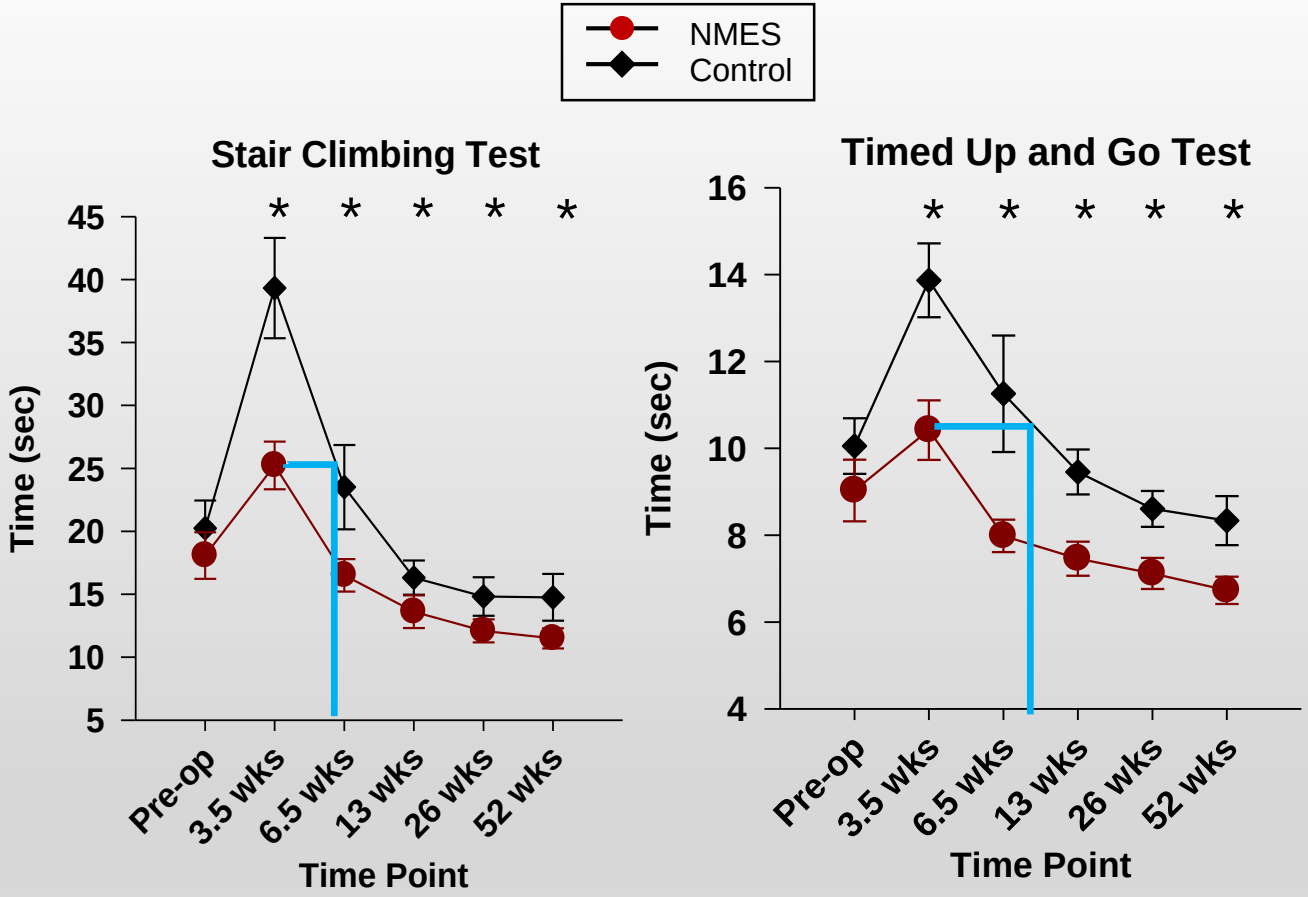
Neuromuscular Electrical Stimulation





Stevens-Lapsley et. al. *PTJ* 2012


NMES
Control
Quadriceps Normalized Strength
Normalized Torque (N-m/kg)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
* * * *
Pre-op
3.5 wks
6.5 wks
13 wks
26 wks
52 wks
Time Point
Hamstrings Normalized Strength
Normalized Torque (N-m/kg)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
* * *
Pre-op
3.5 wks
6.5 wks
13 wks
26 wks
52 wks
Time Point

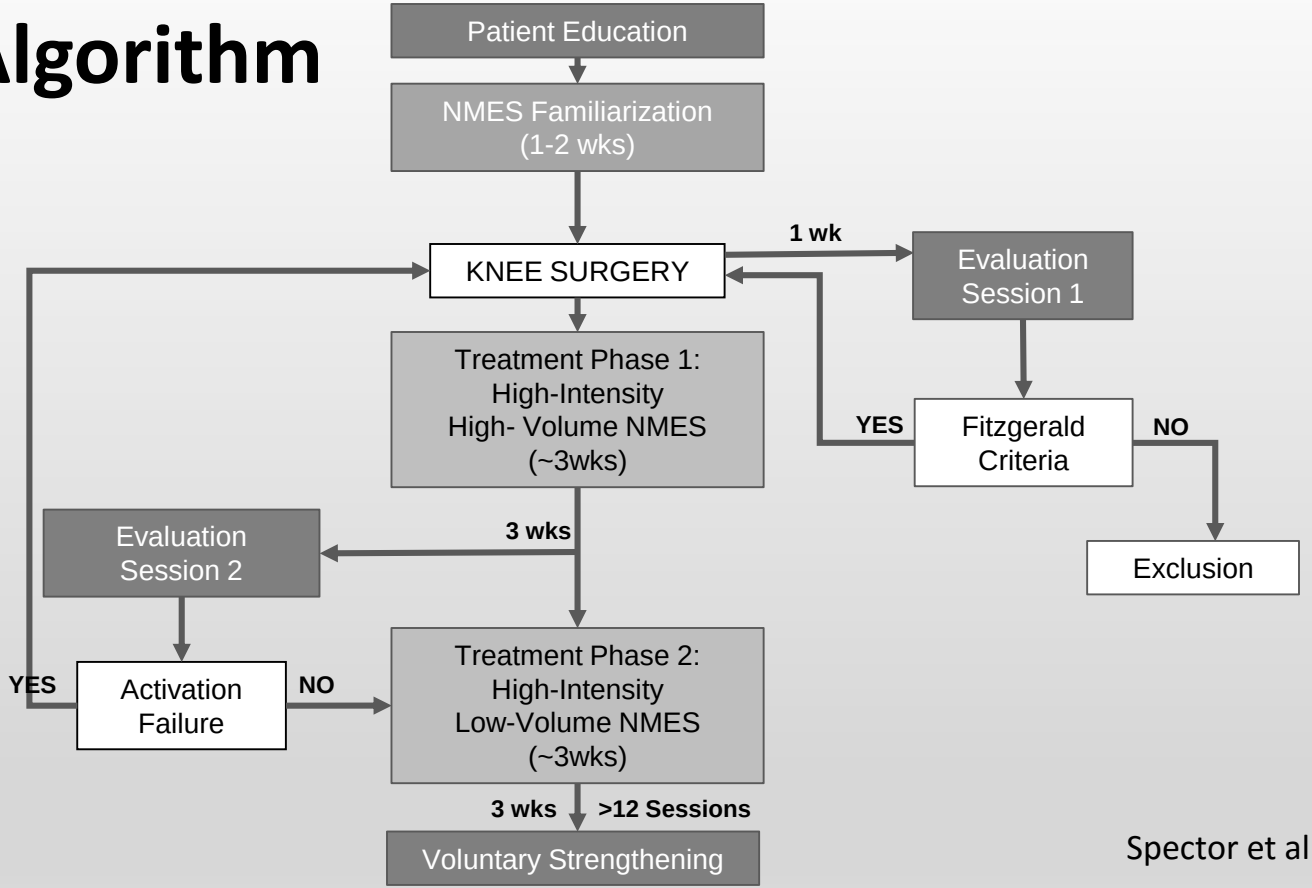

NMES
Control
Stair Climbing Test
Time (sec)
45
40
35
30
25
20
15
10
5
*
Pre-op
3.5 wks
6.5 wks
13 wks
26 wks
52 wks
Time Point
Timed Up and Go Test
Time (sec)
16
14
12
10
8
6
4
*
Pre-op
3.5 wks
6.5 wks
13 wks
26 wks
52 wks
Time Point

Clinical Application

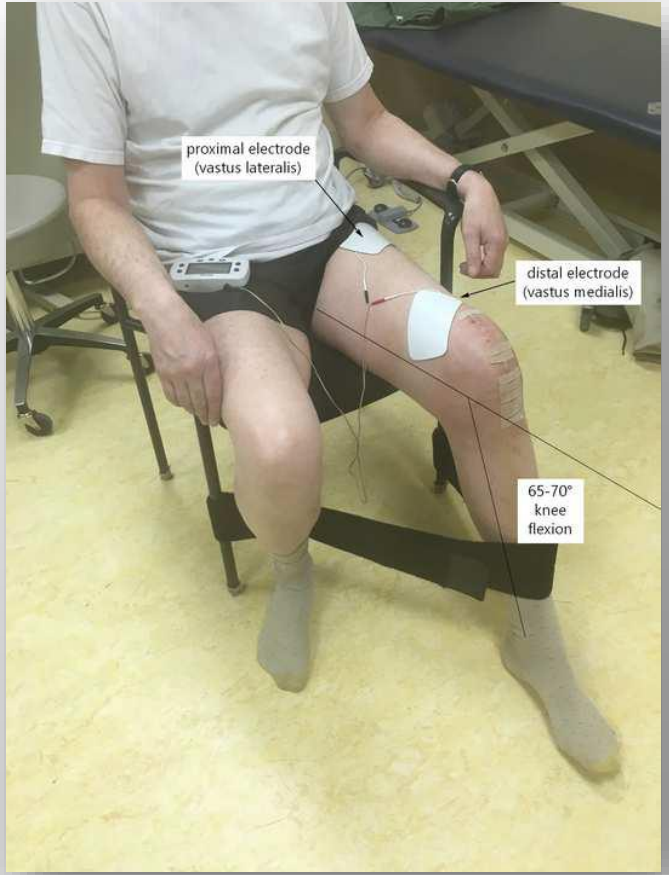
- Two-phase algorithm for patient selection and treatment intended to improve clinical decisions regarding
  - 1) the appropriateness of NMES therapy
  - 2) monitoring of patient progress
  - 3) the timing and rationale for NMES therapy modifications or cessation

Spector et al. *JBJS* 2016

Algorithm



Spector et al. *JBJS* 2016

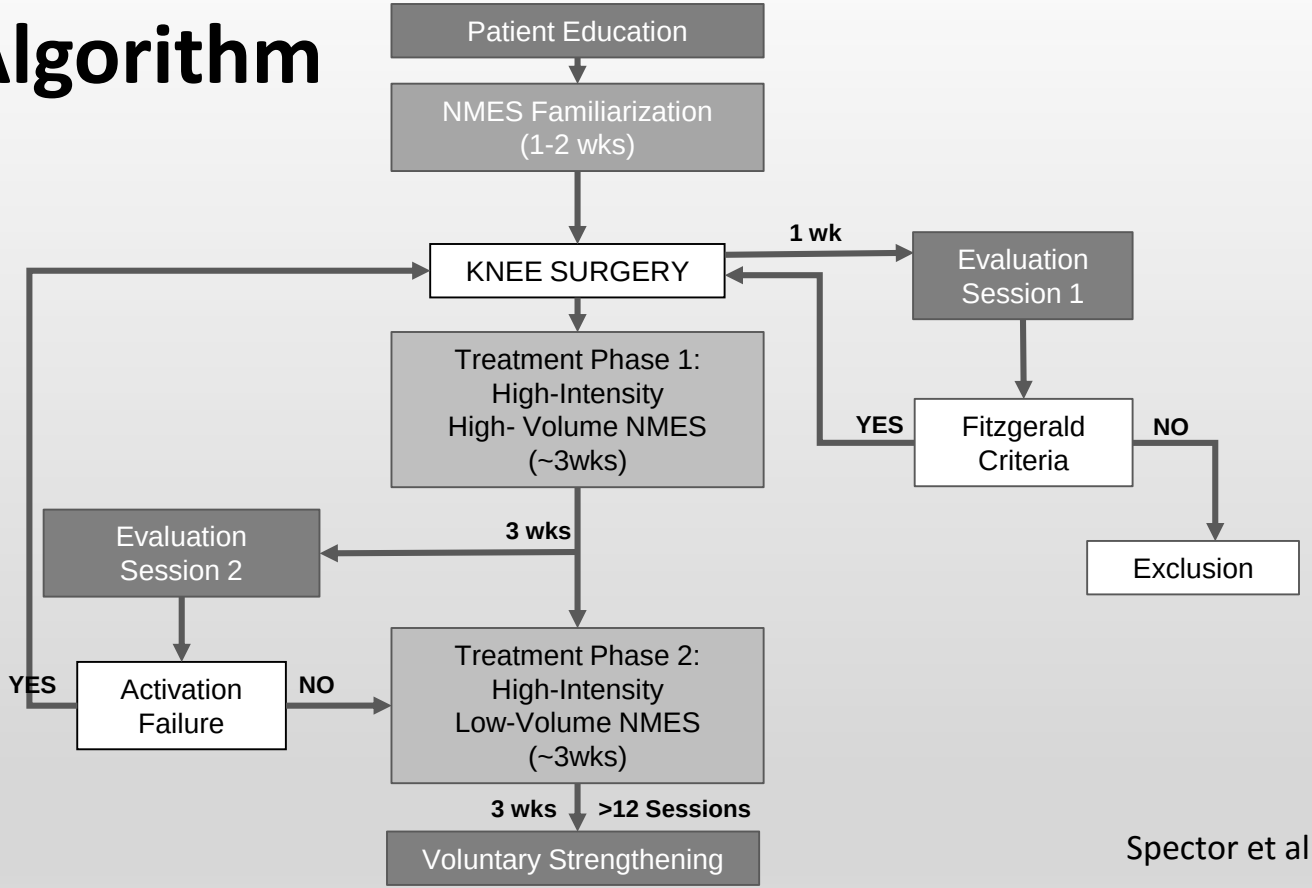

proximal electrode
(vastus lateralis)
distal electrode
(vastus medialis)
65-70°
knee
flexion

Recommendations for Quadriceps NMES Therapy

	Treatment Phase 1	Treatment Phase 2
	Current Characteristics	
Pulse waveform	Symmetrical biphasic rectangular or sinusoidal	
Pulse Duration*	200-300 µs	
Frequency	~ 50 Hz	
Intensity	Highest tolerable	
On:off time	~10:30 s¥	
	Treatment session characteristics	
Duration	~10 min/session	~15 min/session
Number of contractions	~15/session	~22/session
Frequency	2-3 session/day	4-6 sessions/week
General Settings (see also Fig 2)		
Electrode number and size	Two rectangular electrodes (e.g. 3x5 inches)	
Electrode position	Over vastus medalis (distal electrode) and vastus lateralis (proximal electrode)	
Knee angle	60-75° of flexion	

Spector et al. *JBJS* 2016

Algorithm

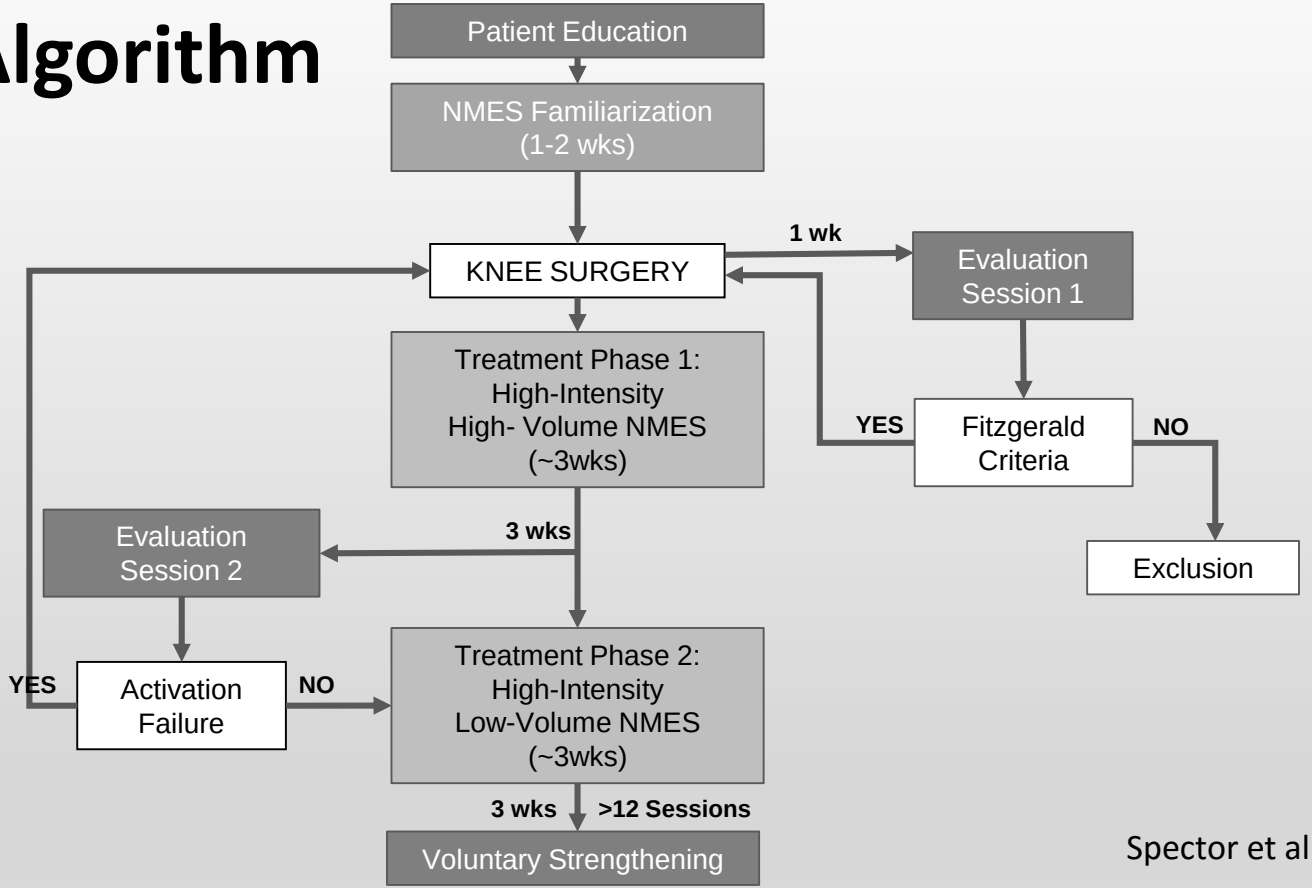


Spector et al. *JBJS* 2016

Fitzgerald Criteria

NMES should evoke a full, sustained, tetanic contraction of the quadriceps with visual or palpable evidence of superior patellar glide.

Algorithm



Spector et al. *JBJS* 2016

Clinical Activation Battery

3 Tasks (Total Possible Score = 6 points):

QUAD SET

0: Unable to initiate contraction

1: Poor contraction no superior patellar movement

2: Strong contraction, visible superior movement of patella

STRAIGHT LEG RAISE

0: Unable to perform

1: Performed with Flexed Knee

2:Good form (lift leg >2 feet)

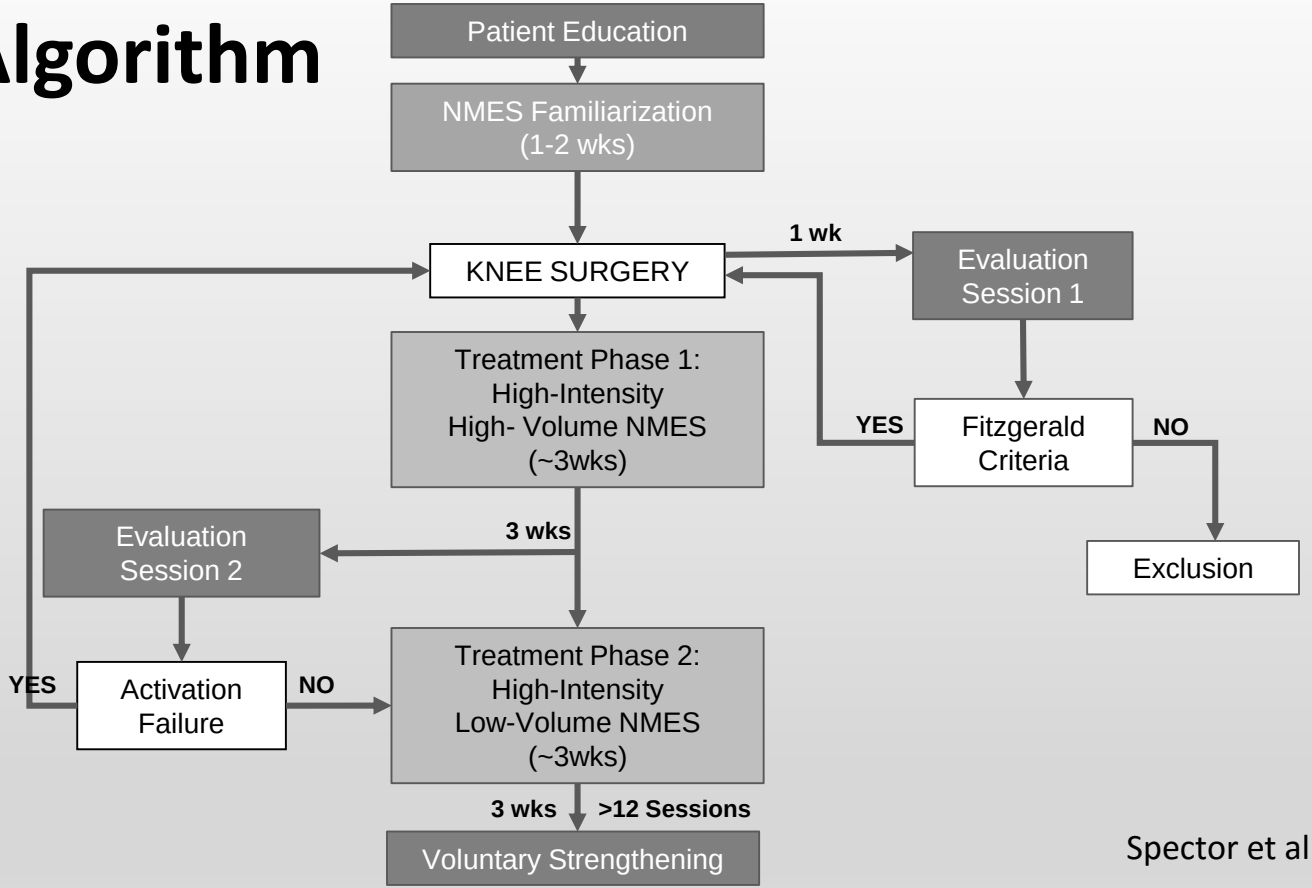
EXTENSION LAG TEST

0: Unable to hold against gravity

1: Able to maintain <1 s, slows leg

2: Able to maintain >1 s.

Algorithm



Spector et al. *JBJS* 2016

Portable NMES Units

EMSI

Flex-MT Plus™

Designed to help with muscle re-education, reduction of atrophy, muscle spasm, and pain, the Flex-MT Plus is now a more powerful, yet still portable device to help patients recover.

InTENSity Select Combo II

J Arthroplasty. 2018 Jul;33(7):2330-2337. doi: 10.1016/j.arth.2018.01.070. Epub 2018 Feb 6.

Systematic Review of Three Electrical Stimulation Techniques for Rehabilitation After Total Knee Arthroplasty.

Yue C[1], Zhang X[1], Zhu Y[1], Jia Y[1], Wang H[1], Liu Y[1].

Orthopedics. 2011 Mar 11;34(3):175. doi: 10.3928/01477447-20110124-06.

Does electric stimulation of the vastus medialis muscle influence rehabilitation after total knee replacement?

Avramidis K[1], Karachalios T, Popotonasios K, Sacorafas D, Papathanasiades AA, Malizos KN.

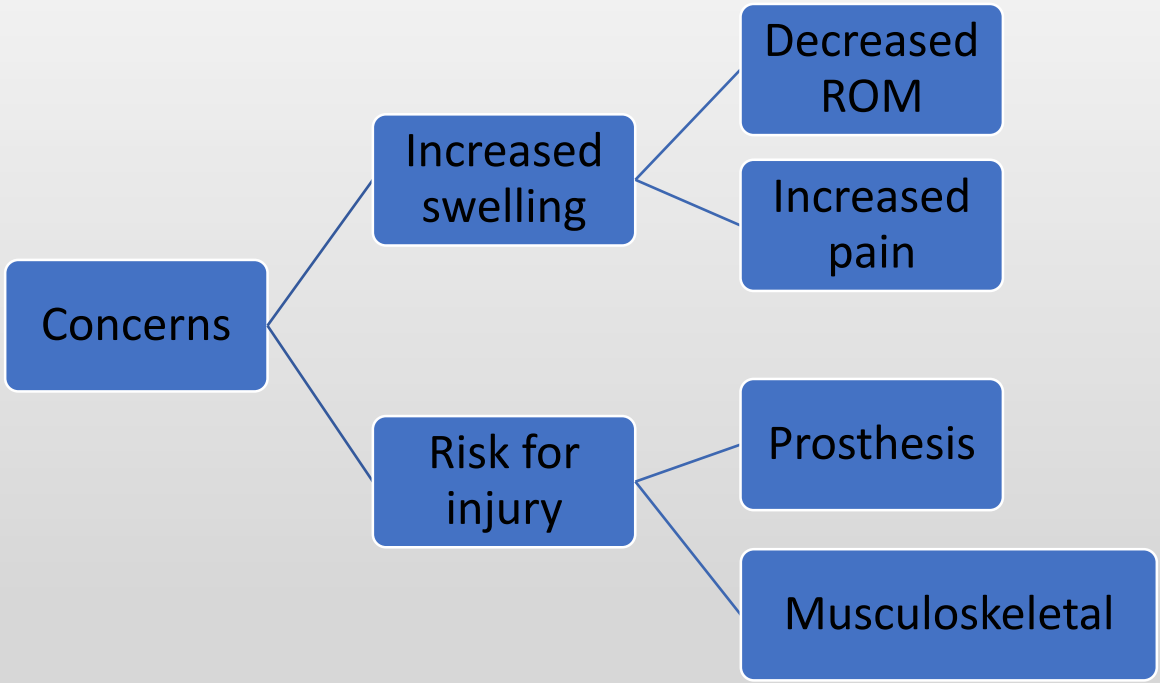
Arch Phys Med Rehabil. 2017 Dec;98(12):2364-2370. doi: 10.1016/j.apmr.2017.05.005. Epub 2017 Jun 10.

Comparison of the Effect of Sensory-Level and Conventional Motor-Level Neuromuscular Electrical Stimulations on Quadriceps Strength After Total Knee Arthroplasty: A Prospective Randomized Single-Blind Trial.

Yoshida Y[1], Ikuno K[2], Shomoto K[3].

Repetitive Facilitated Long Arc Quad

Alternative to NMES: Intensive Rehabilitation



Original Article

Early High-Intensity Versus Low-Intensity Rehabilitation after Total Knee Arthroplasty: A Randomized Controlled Trial

Michael Bade PT, PhD , Tamara Struessel PT, DPT, Michael Dayton MD, Jared Foran MD, Raymond Kim MD, Todd Miner MD, Pamela Wolfe MS, Wendy Kohrt PhD, Douglas Dennis MD, Jennifer Stevens-Lapsley PT, PhD

Arthritis Care & Research
Vol. 69, No. 9, September 2017, pp 1360–1368

Accepted Articles

Browse Accepted Articles
Accepted, unedited articles published online and citable. The final edited and typeset version of record will appear in future.

- RCT of 162 subjects after TKA
  - high-intensity progressive rehabilitation protocol (HI)
  - lower-intensity rehabilitation protocol (LI)

Methods

Higher level of exercise progression

Lower level of exercise progression

High-Intensity Group

Early initiation of an intensive rehabilitation program targeting:

- Lower extremity strength
- Balance
- Agility
- Faster progression to weight-bearing strengthening

Progression: pain, ROM, swelling, & function

Participants

N = 162 (89 females)

63 ± 7 years of age

Outcome Measures

pre-op,1, 2, 3, 6, 12 mos post-op

1. Stair climbing test
2. Timed-up-and-go
3. Five-times sit-to-stand
4. 6-minute walk
5. Quadriceps/Hamstrings strength & activation
6. Surgical limb ROM
7. WOMAC Index of OA

Low-Intensity Group

Standard rehabilitation targeting:

- ROM
- Stretching
- Moderate resistance bands
- Moderate-demand functional exercises

Progression: time-based

2-3x/wk for 12 weeks
25 total visits

Key Differences Between Interventions

Element	High-Intensity Intervention	Low-Intensity Intervention
Exercise Difficulty & Complexity	Quick Progression to WB Exercise Utilization of Weights (8RM) Higher Level WB Exercises	Initial focus on NWB exercises Slower progression through WB exercises
Progression	Ability-Based (Progression Criteria)	Time-Based (Tissue Healing)
Education	Focused on detrimental effects of surgery and that knee replacements are strong and safe to use	Focused on the need to protect the new joint in the early postoperative period to facilitate healing
Activities	Early prescription of a home walking program with progression to higher level activities	Instructed to minimize activity in the 1st month to ADLs only with gradual progression in walking program by 3 months

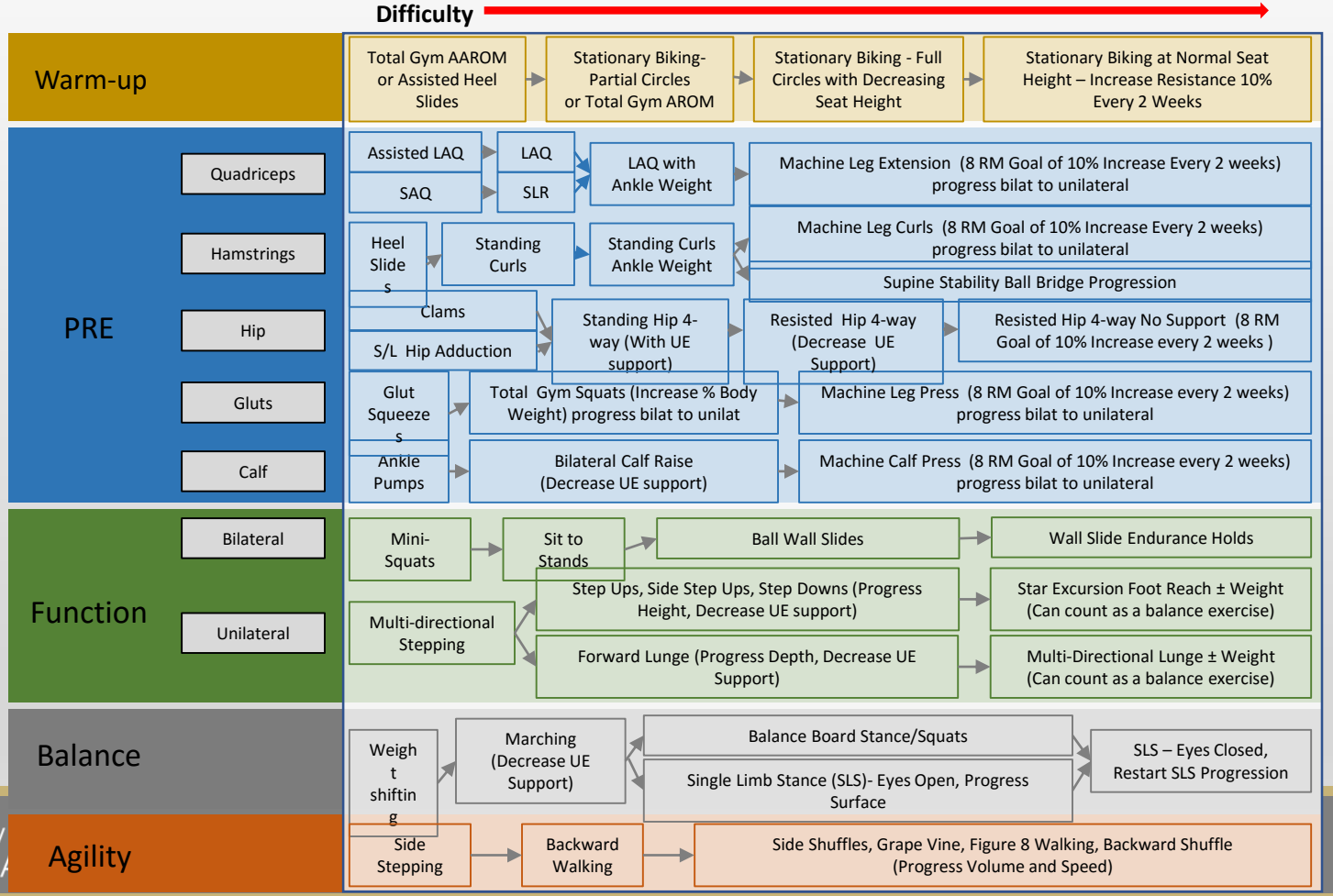
Progression Criteria:

- Decrease in ability to rise from a chair or walking endurance?
- Any soreness >2 hours following last tx?
- Decrease in AROM by 5°?
- Increase in swelling > 2cm?
- Increase in resting VPRS by 2 points?

- *If one criteria is positive maintain current level of provocative exercise/s and advance all others as tolerated…*

- *If two or more criteria are "yes" decrease tx intensity*

High Intensity Exercise Progression (performance-based)



Low-Intensity Exercise Progression (time-based)

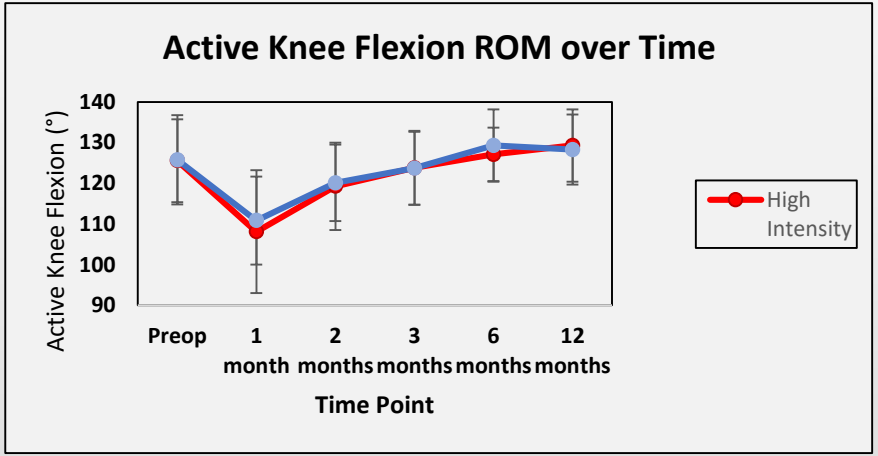
Time

CLINICAL TREATMENT	Phase 1 Surgery – Week 2	Phase 2 Week 3 – Week 4	Phase 3 Week 5– Week 6	Phase 4 Week 7– Week 9	Phase 5 Week 10 – End
Manual techniques	• Patellar mobilization • Distraction • Proximal tib/fib as needed • PROM (knee/hip) • Soft tissue mobilization	• Patellar mobilization • Distraction • Proximal tib/fib as needed • PROM (knee/hip) • Soft tissue mobilization • Incision massage (if healed)	• Patellar mobilization • Distraction • Proximal tib/fib as needed • PROM (knee/hip) • Soft tissue mobilization • Incision massage (if healed) • Manual stretching techniques	• Patellar mobilization • Distraction • Proximal tib/fib as needed • PROM (knee/hip) • Soft tissue mobilization • Incision massage (if healed) • Manual stretching techniques	• Patellar mobilization • Distraction • Proximal tib/fib as needed • PROM (knee/hip) • Soft tissue mobilization • Incision massage (if healed) • Manual stretching techniques
Ther Ex	• Functional training (bed, transfers, stairs) • Gait training • AD progression • Heel slides • Glut sets • Quad sets • Ankle Pumps • Mini-squats	• Warm up on bike with no resistance (5 min) • Functional training (stairs) • Gait training • AD progression • Short arc quads • Straight leg raises • Ankle Pumps • Standing hamstring curls • Standing weight shifts • Mini-squats	• Warm up on bike with no resistance (5 min) • Gait training • AD progression • Seated theraband hamstring curls (min resistance) • Marching • Closed chain TKE (min resistance) • Sit to stands • Bilateral calf raises	• Warm up on bike with no resistance (5 min) • Gait training • AD progression • Seated theraband hamstring curls (min/mod resistance) • Stool scoots fwd/bkwd • Single leg stance • Balance board stance • Closed chain TKE (mod resistance) • Bilateral calf raises	• Warm up on bike with no resistance (5 min) • Gait training • AD progression • Seated theraband hamstring curls (mod/heavy resistance) • Stool scoots fwd/bkwd • Single leg stance - foam • Balance board mini-squats • Closed chain TKE (mod/heavy resistance) • Bilateral calf raises
Education	• Pain management • Swelling control • Wound healing • Educate on overdoing it in the early phase of rehab and need to decrease swelling first	• Pain management • Swelling control • Wound healing • Activity counseling	• Activity counseling	• Activity counseling	• Activity counseling
Modalities	• None	• Ice after therapy (10-15 min)	• Ice after therapy (10-15 min)	• Heat before therapy or Ice after therapy (10-15 min)	• Heat before therapy or Ice after therapy (10-15 min)

Low-Intensity Exercise Progression (time-based)

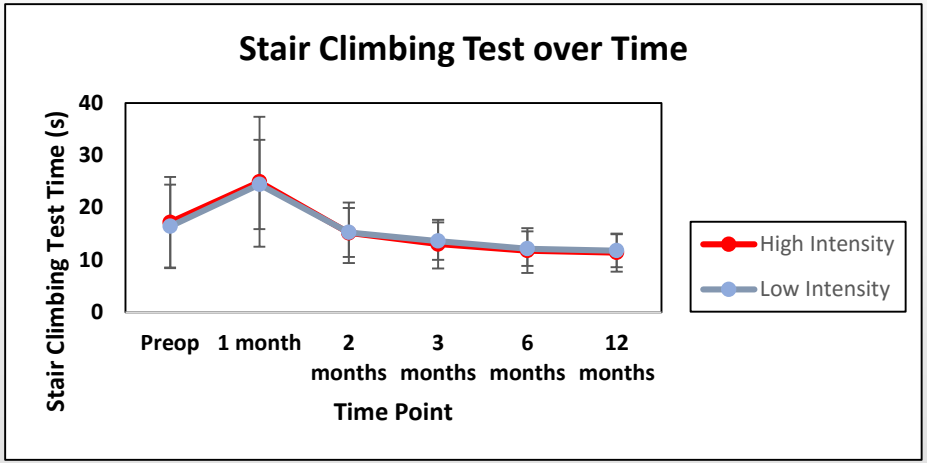
HOME EXERCISE PLAN	Phase 1 Surgery – Week 2	Phase 2 Week 3 – Week 4	Phase 3 Week 5– Week 6	Phase 4 Week 7– Week 9	Phase 5 Week 10 – End
Strength	• 2 x 10 reps 2x daily on non-therapy days: • Heel slides • Glut squeezes • Ankle pumps • Quad sets	• 2 x 10 reps 2x daily on non-therapy days: • Short arc quads • Straight leg raises • Ankle pumps • Clams • Standing hamstring curls • Standing weight shifts	• 2 x 10 reps 1x daily on non-therapy days: • Long arc quads • Straight leg raises • Standing hamstring curls • Marching • Bilateral calf raises	• 2 x 10 reps 3x/week on non-therapy days: • Seated hamstring curls (min/mod resistance TB) • Closed chain TKE (mod resistance TB) • Bilateral calf raises • Single leg stance	• 2 x 10 reps 3x/week on non-therapy days: • Seated hamstring curls (mod/heavy resistance TB) • Single leg stance - foam • TKE (mod/heavy resistance TB) • Bilateral calf raises
Stretching	• AROM/AAROM warm-up • 30-60 min/day flexion/extension static stretching • Self patellar mobilization	• AROM/AAROM warm-up • 30-60 min/day flexion/extension static stretching • Self patellar mobilization • Daily quad, hamstrings, calf, hip stretching as appropriate	*If needed; discontinued if ROM 0-120 degrees* • AROM/AAROM warm-up • 30-60 min/day flexion/extension static stretching • Self patellar mobilization • Daily quad, hamstrings, calf, hip stretching as appropriate	*If needed; discontinued if ROM 0-120 degrees* • AROM/AAROM warm-up • 30-60 min/day flexion/extension static stretching • Self patellar mobilization • Daily quad, hamstrings, calf, hip stretching as appropriate	*If needed; discontinued if ROM 0-120 degrees* • AROM/AAROM warm-up • 30-60 min/day flexion/extension static stretching • Self patellar mobilization • Daily quad, hamstrings, calf, hip stretching as appropriate
Activity	• ADLs only, including: • Errands • Social outings • Limited community ambulation	• ADLs only, including: • Errands • Social outings • Limited community ambulation	• Up to 10 min of stationary biking (min resistance) or walking if patient does not spend a large amount of time standing during the day	• Up to 20 min of stationary biking (min resistance) or walking if patient does not spend a large amount of time standing during the day	• Up to 30 min of stationary biking (min resistance) or walking if patient does not spend a large amount of time standing during the day
Modalities	• Ice 3-5x/day with emphasis on elevation	• Ice after HEP	• Ice after HEP and as needed	• Heat/ice as needed	• Heat/ice as needed

Results - Safety



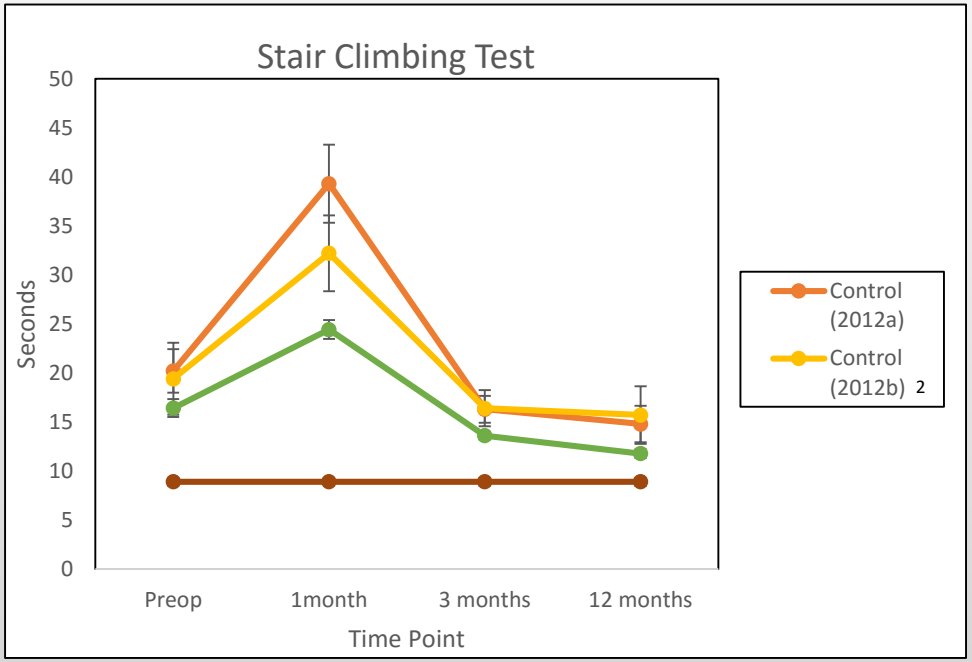
- No significant differences in ROM between groups ($p>0.05$)
- No significant differences in adverse events between groups ($p>0.05$)

Results - Efficacy



- No significant difference between groups at any time point in functional performance, strength, activation, or WOMAC score ($p>0.05$).
- Notable variability in both interventions

Comparison with Prior Study Results



Poorer Performance

Better Performance

Stevens-Lapsley 2012, Stevens-Lapsley 2012

Secondary Analyses

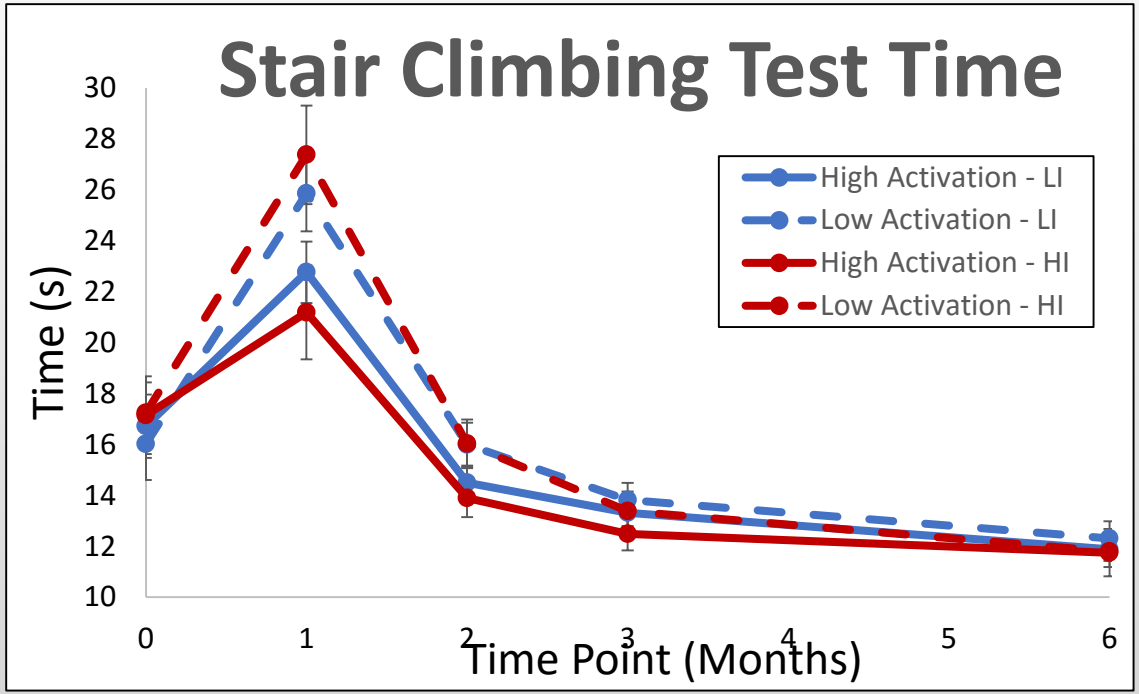
Home exercise compliance differed by group

- HI: 76% compliance
- LI: 83% compliance

Activity compliance

- PASE score did not differ by group over time
- PASE scores should have been different at all time points during the intervention

Early Activation and Recovery



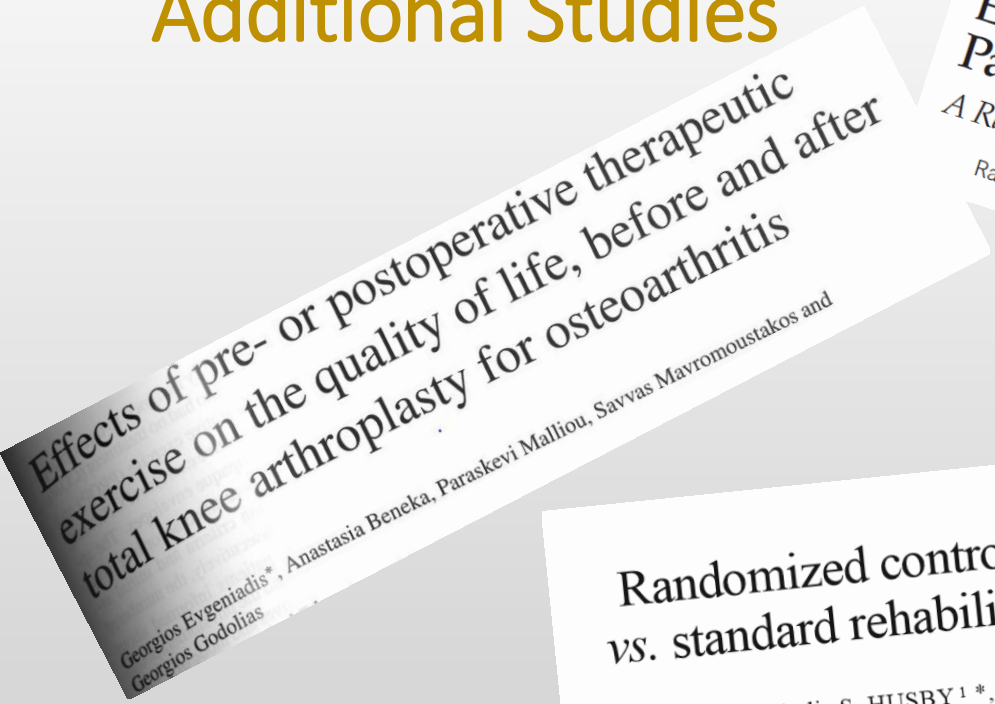
Poorer Performance

Better Performance

Conclusions

- High-intensity rehabilitation after TKA:
  - Is safe to utilize and does not compromise ROM or safety
  - Decision to utilize this approach should be based on several factors (e.g. patient preference, activation deficits)
  - Both high-intensity and lower-intensity programs were effective in improving functional performance after TKA
- Neither program was more effective in helping individuals with activation deficits recovery as quickly as those without activation deficits

Additional Studies

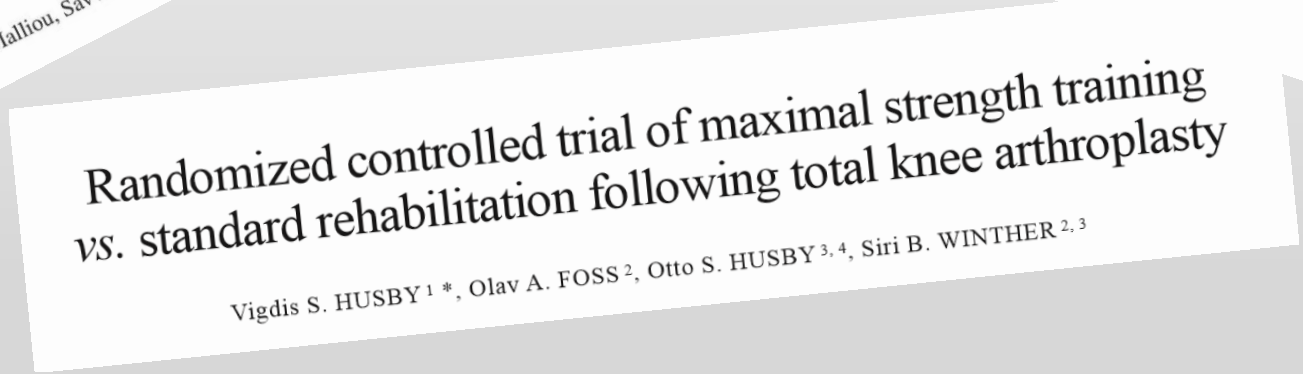

Effects of pre- or postoperative therapeutic exercise on the quality of life, before and after total knee arthroplasty for osteoarthritis

Georgios Evgeniadis*, Anastasia Beneka, Paraskevi Malliou, Savvas Mavromoustakos and Georgios Godolias


The Effect of Early Progressive Resistive Exercise Therapy on Balance Control of Patients With Total Knee Arthroplasty

A Randomized Controlled Trial

Razieh Yousefian Molla; Heydar Sadeghi, PhD; Amir Hossein Kahlaee, PhD


Randomized controlled trial of maximal strength training *vs.* standard rehabilitation following total knee arthroplasty

Vigdis S. HUSBY [1] *, Olav A. FOSS [2], Otto S. HUSBY [3, 4], Siri B. WINTHER [2, 3]

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Movement Pattern Training after Total Knee Arthroplasty

Michael Bade, PT, PhD, OCS, FAAOMPT

Movement Pattern Asymmetry After TKA

Movement Pattern Asymmetry

Transitions from Sitting to Standing

Use of Hands and Poor Eccentric Control
Quadriceps Avoidance

Increased Hip Flexion
Hip Extensor Substitution

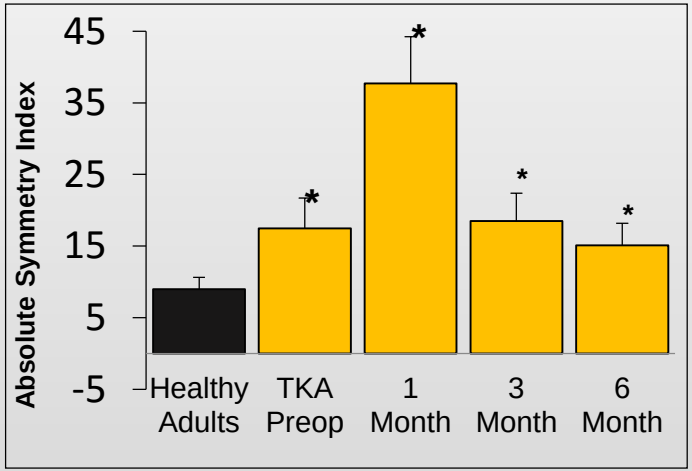
Affected Limb

Asymmetrical Foot Placement
Quadriceps Avoidance

Weight Shift Towards Non-Surgical Limb
Unloading Substitution

Asymmetry Increases with:
- Constrained Foot Position
- Depth
- Speed

Why is Asymmetry Important?



TIME POINT	PAIN	STRENGTH RATIO	6MWT	SCT
PRE TKA	**-0.34***	**0.37***	**0.29***	**-0.39***
TKA 1M	-0.18	0.20	-0.05	**-0.39***
TKA 3M	-0.19	**0.46***	**0.35***	**-0.37***
TKA 6M	0.07	**0.40***	**0.38***	**-0.39***

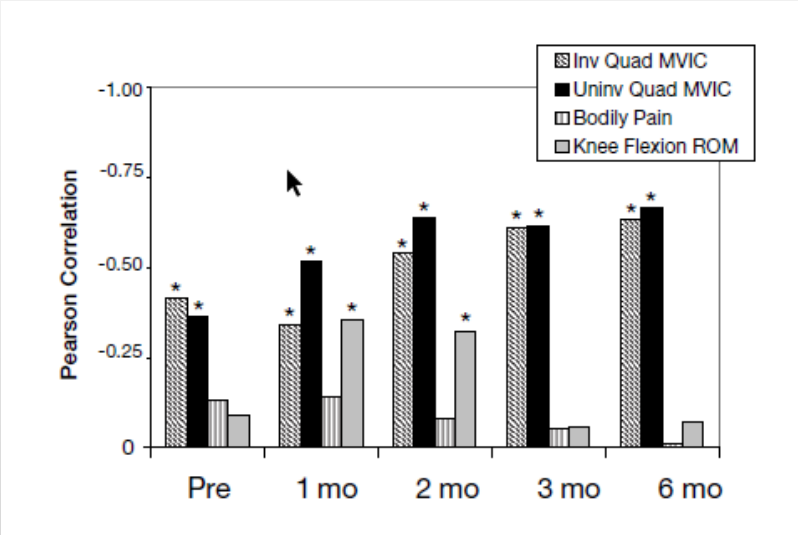
Pearson Correlations with Weight Bearing Ratio
* p<0.05

- Movement asymmetry persists in the long-term
- Asymmetry is related to recovery of strength and function

Christiansen 2011

Potential Long-Term Implications

- The “good leg” becomes the “bad leg”
  - Contralateral strength decreases and pain increases
  - Contralateral strength and pain are the main contributors to function at 3 years
- 46% of patients will require a contralateral TKA in 3 years after their initial procedure
- Rates of Contralateral TKA by OA Severity at initial procedure
  - None – 5%
  - Mild – 20%
  - Moderate – 54%
  - Severe -93%



Shao 2013, Mont 1995, Farquhar 2010, Mizner 2005

Predicting Weight Bearing Asymmetry 1 month After TKA

Potential Predictors:

- Strength
- Strength Ratios
- ROM
- Pain
- Age
- Sex
- BMI
- Preoperative Weight Bearing

$$WBA_1 = WBA_0 + \text{Quadriceps Ratio} + \text{Hamstring Ratio}$$

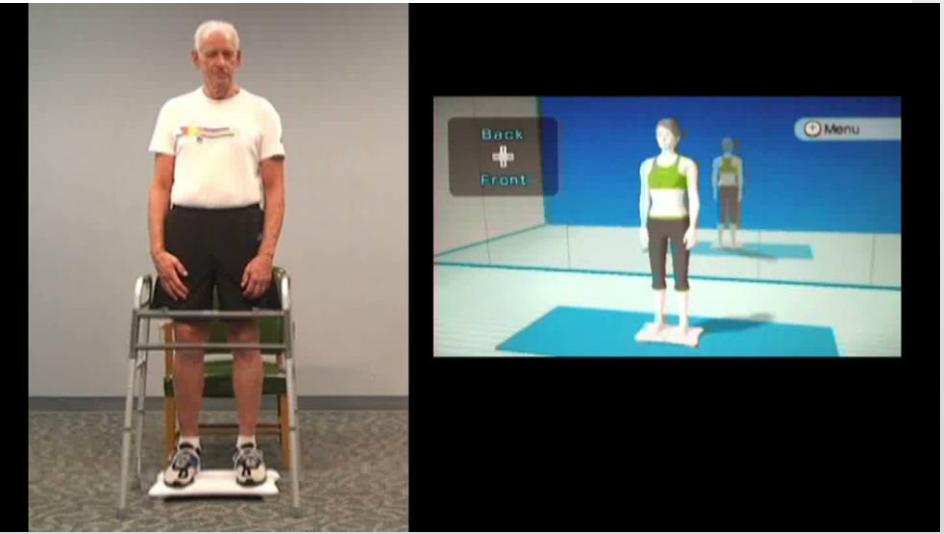
- **Preoperative** weight bearing asymmetry is a strong predictor of **postoperative** weight bearing asymmetry!
- Postoperative strength loss may also be related to learned disuse

Christiansen 2013

[RESEARCH REPORT]

CORY L. CHRISTIANSEN, PT, PhD[1] • MICHAEL J. BADE, PT, PhD[2] • BRADLEY S. DAVIDSON, PhD[3]
MICHAEL R. DAYTON, MD[4] • JENNIFER E. STEVENS-LAPSLEY, PT, PhD[1]

Effects of Weight-Bearing Biofeedback Training on Functional Movement Patterns Following Total Knee Arthroplasty: A Randomized Controlled Trial



Standard of Care Intervention (both groups)

Inpatient Stay 3 days	**Home PT** 2 weeks (6 sessions)	**Outpatient PT** 4 weeks (6 sessions)

Weight-bearing Biofeedback (RELOAD group only)
6 weeks (12 sessions)

TABLE 1 ACTIVITIES FOR THE RELOAD GROUP USING WEIGHT-BEARING BIOFEEDBACK

Activity*	Weight-Bearing Biofeedback Progression Tasks (Games)
Bilateral stance	Static bilateral stance (ultimate balance challenge) Mediolateral weight shift, basic (penguin slide) Mediolateral lateral weight shift, medium (skiing) Multidirectional weight shift, basic (table tilt) Above progression with foam placed on balance board
Unilateral stance	Unilateral stance (yoga: standing knee bend or tree pose) Unilateral stance on foam (yoga: standing knee bend or tree pose)
Sit-to-stand	Self-paced squat (ultimate balance challenge) Static squat (yoga: chair pose) Dynamic squat (strengthening: rowing squat) Above progression with a chair target and gradually increased depth
Lunging	Static lunge (yoga: warrior pose) Dynamic lunge (strengthening: lunge)

**Patients were progressed within each activity as able.*

JOSPT 2015

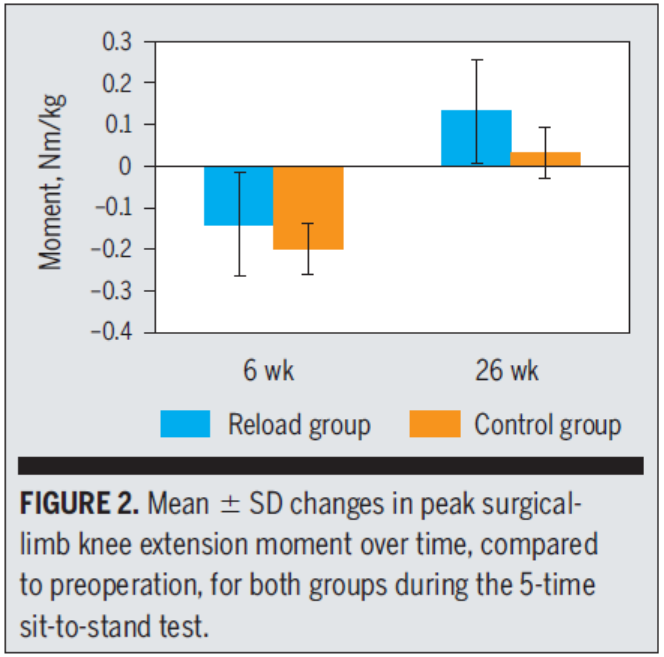


FIGURE 2. Mean ± SD changes in peak surgical-limb knee extension moment over time, compared to preoperation, for both groups during the 5-time sit-to-stand test.

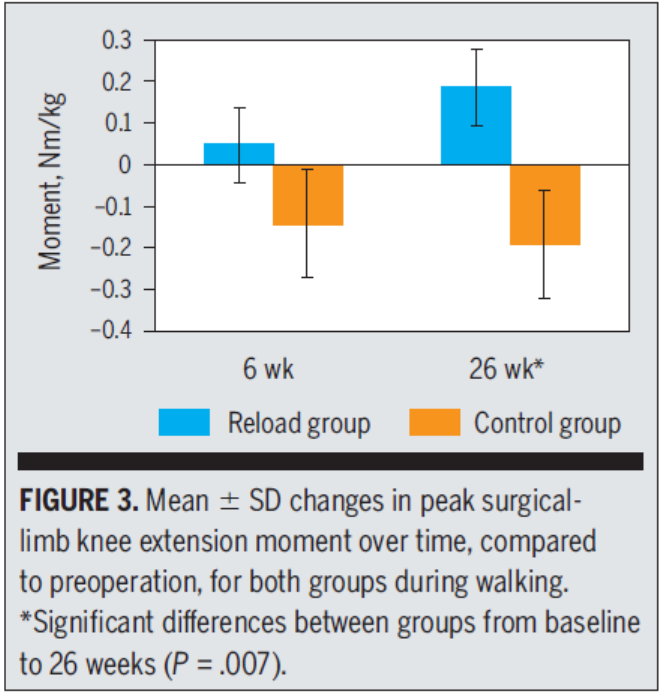


FIGURE 3. Mean ± SD changes in peak surgical-limb knee extension moment over time, compared to preoperation, for both groups during walking. *Significant differences between groups from baseline to 26 weeks (P = .007).

Performance on the FTSST and quadriceps strength improved to a greater extent in RELOAD and patients found the RELOAD intervention more motivating than traditional exercise

JOSEPH ZENI, JR., PT, PhD[1] • SUMAYAH ABUJABER, PT, MS[1,2] • PORTIA FLOWERS, MS[1]
FEDERICO POZZI, PT, MA[1] • LYNN SNYDER-MACKLER, PT, ScD, FAPTA[1]

Biofeedback to Promote Movement Symmetry After Total Knee Arthroplasty: A Feasibility Study

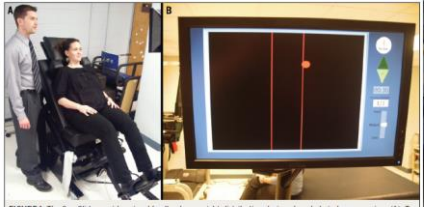


FIGURE 1. The SymSlide provides visual feedback on weight distribution during closed-chain knee exercises (A). To increase resistance on the SymSlide, the angle of inclination of the sled portion can be increased. In this case, the patient is putting more force through the right foot, as demonstrated by the ball drifting toward the right side of the target area (B).

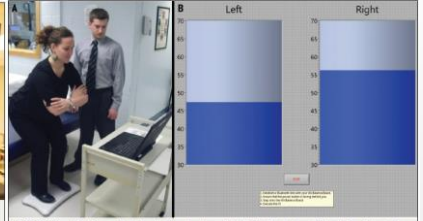
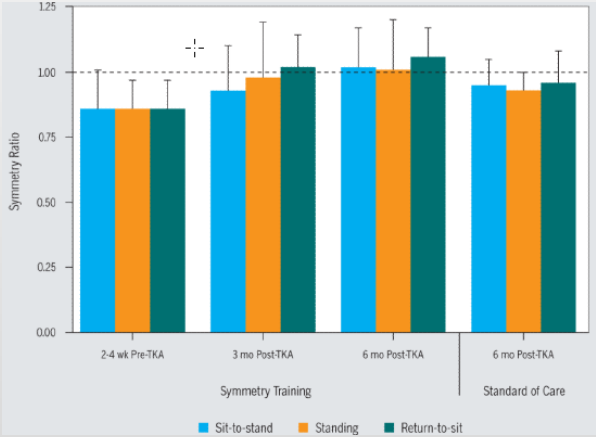
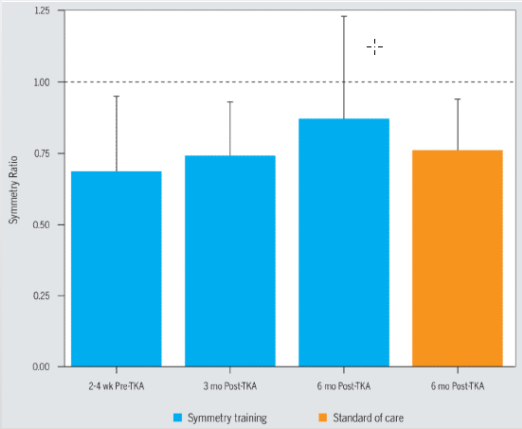


FIGURE 2. The patient is provided with visual feedback on weight distribution between limbs during sit-to-stand functional retraining exercises (A). In this case, the patient's weight is shifted over her right limb during the movement (B).





- Utilized a custom Wii balance board program, SymSlide, verbal/tactile cues, and progressive strengthening
- 2-3x/week for 6-10 weeks
- Led to noted improvements in standing, sit to stand and gait

JOSPT 2013

Limitations of Prior Studies

- Small sample size
- Short intervention period
  - Pronounced asymmetry still present at end of intervention
- Constraints of the Wii System
  - Lack of ability to give feedback during more dynamic activities such as gait and stair climbing
  - Lack of control over feedback schedule and mode of feedback (auditory, tactile, verbal)
  - Games are not rehabilitation specific
    - Score is tracked but not difficulty of task
    - Focus on BMI
    - Rating of 'Unbalanced'
- Lack of incorporation of motor learning principles
- Unknown how this effects contralateral progression

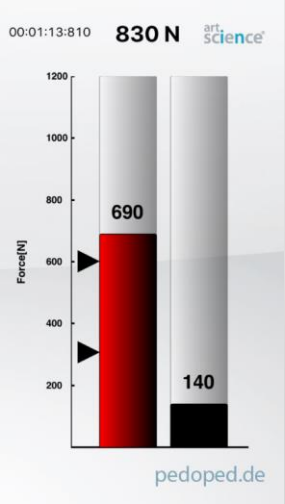
Advances in Biofeedback Devices

Several companies now make commercially available, consumer-oriented biofeedback insoles

- RPM^2
- Andante Smart Step
- OpenGo Science Moticon
- Novel Loadsol

Novel Loadsol (formerly Pedoped)

- Relative low-cost ($2500)
- Reusable and Durable
- Thin and flexible (works with orthotics and most shoes)
- Excellent app interface (iOS and Android) – patient friendly
- Very accurate (2-5%)
- Good data capture length (limited to device storage)
- Data processing built into the app (easy to use in the clinic and at home)
- Can alter feedback parameters (audio/visual, thresholds)
- Can utilize during dynamic activities and free-living environments
- Can assess real-time response to cuing strategies
- Can detect asymmetries not visual to the naked eye

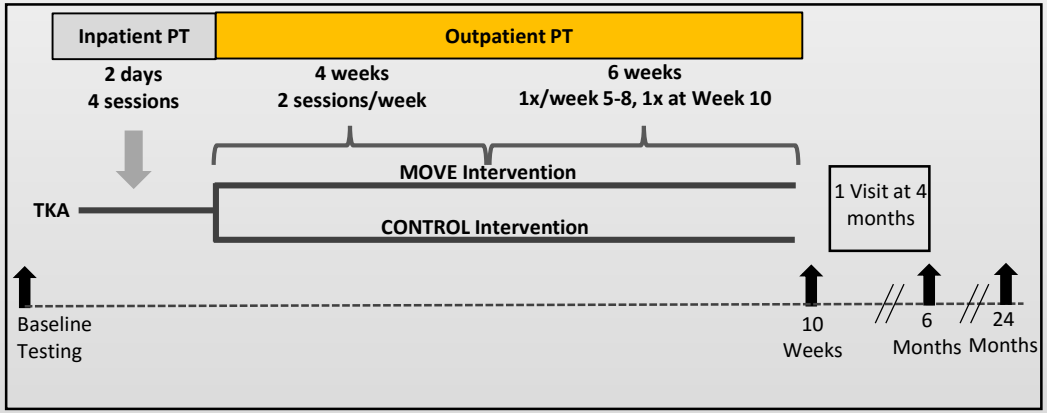


Loadsol Example

Movement Pattern Biofeedback Training after Total Knee Arthroplasty – NCT03325062

Purpose:

1. To determine if the addition of a novel movement pattern training program (MOVE) to contemporary rehabilitation improves movement pattern quality more than contemporary rehabilitation alone
2. To determine if MOVE improves long-term physical function and lessens contralateral knee OA progression



Swelling after Total Knee Arthroplasty

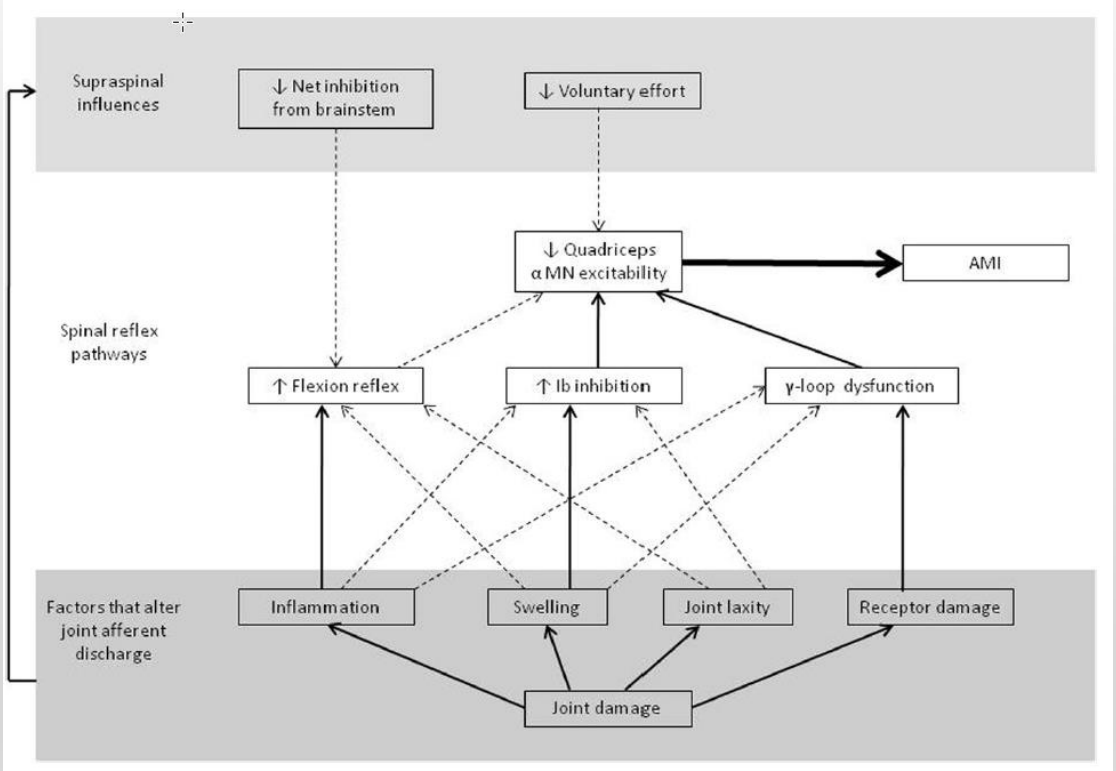
Michael Bade, PT, PhD, OCS, FAAOMPT

Joel Carmichael, DC, PhDc

Brian Loyd, DPT, PhD

Why is Swelling Important?

- Major complaint of patients
- Related to the development of complications (DVT)
- Potential mechanism for arthrogenic muscle inhibition (AMI)
- Alters energy availability in muscle and can cause mechanical damage
- Related to pain, ROM, quadriceps strength, and functional performance



Rice and McNair 2010, Loyd in press

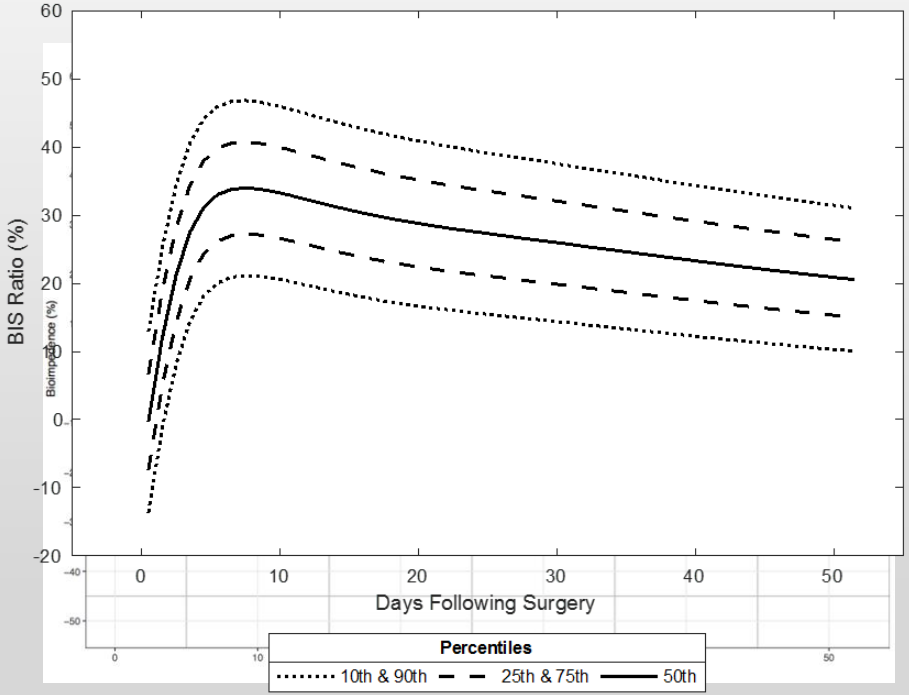
How can we measure it clinically?

- Volumetric?
  - Not realistic given wound healing and burden
- Circumferential?
  - Questions regarding reliability and validity
  - Can be confounded due to muscle atrophy and bandaging
- Ultrasound?
  - Questions regarding reliability and operator error
- Bioelectrical Impedance
  - High reliability (ICC > 0.80)
  - Good responsiveness (SEM = 2%)
  - Limitations – not joint specific and cost (~$2000)

Jakobsen 2010,Pichonnaz 2015, Loyd in review

What is “normal” swelling recovery?

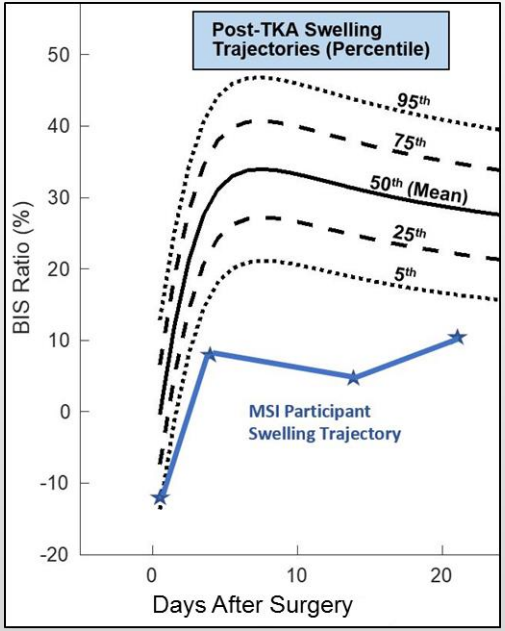
- Can peak anywhere from POD1-7
  - Mean swelling – 36% increase
- Swelling can persist chronically
  - Mean swelling at POD90 – 10% above baseline
  - 26% at 3 years have felt swelling in the knee in the last 30 days
- Currently working on the development of personalized reference charts for swelling recovery



Pua 2015, Nam 2016, Loyd in press

Future Directions

- Multimodal Swelling Intervention
  - Use of an adjustable compressive garment
    - Circaid Juxtafit Essentials compression garment (20-50 mm gradient pressure worn during the day)
  - Use of frequent AROM/AAROM
    - 1 min of ankle pumps can increase blood flow for up to 30 minutes
  - Use of manual lymph drainage massage
    - Performed daily at home by patient
    - Effective at pain control
    - Unknown if effective at swelling reduction
- Will also examine the relationship between activity levels and swelling recovery



Funding

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CORRT Comprehensive Opportunities in Rehabilitation Research Training
A Multi-Center K-12 Career Development Program for Physical and Occupational Therapists

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PhD in Rehabilitation Science

What is Rehab Science?

- Interdisciplinary field of study
- Integrates knowledge from basic and clinical sciences
- Goal: to Improve our understanding of human movement, physical function, and disability across the lifespan

The Work We Do

- Clinical rehabilitation trials
- Health services research
- Translational research
- Exercise science research
- Implementation science research

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