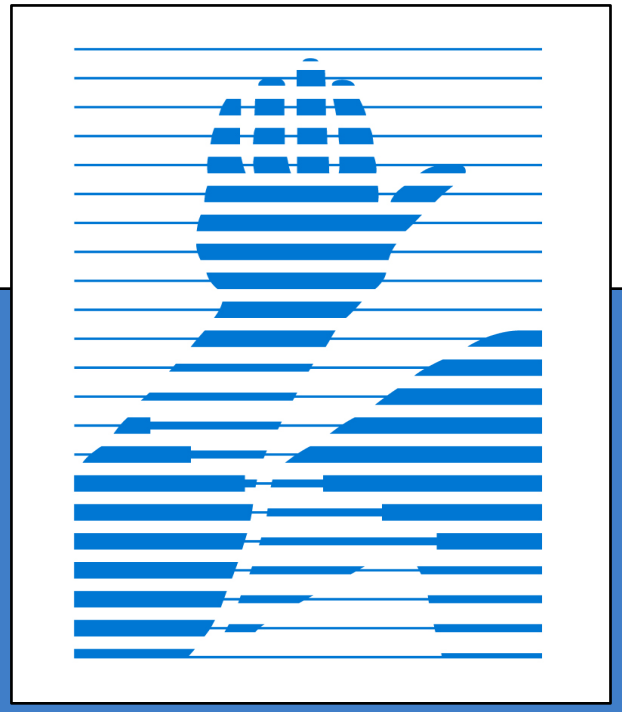
Collaboration and Technology in Heath Research and Practice



ROTH | McFARLANE
HAND & UPPER LIMB CENTRE
ST. JOSEPH'S HEALTH CARE LONDON

GREAT collaborative TEAMs

- Focus on solving a problem
- Work with people who are committed, have complementary skills and you trust to do good work
- Respect and foster diversity in approach (disciplines, genders, age, cultures, perspectives, skills, roles)
- Be adaptable; find the win-win solutions
- Do the right thing- the rest will follow

Context at HULC

- Orthopedic and Plastic Surgeons, PT and OT clinicians
- We see 40,000 patient visits each year
- We have 4 research
  - Bioengineering
  - Mechatronics
  - Cellular
  - CLINICAL
- We have 20-30 Masters and PhD students from working in our labs
- Fellows

The Arthritis Society

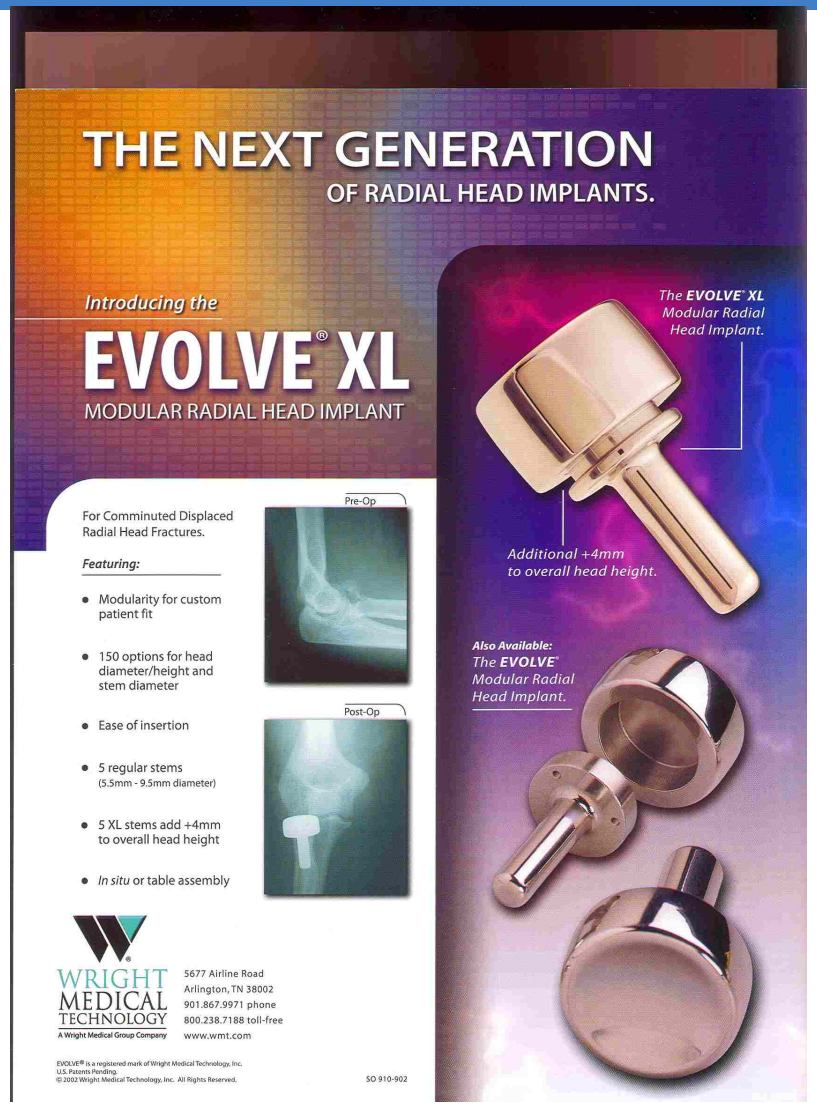
Western Bone and Joint Institute

St Joseph's Health Care London

Our research.....

- Is productive
  - 50-80 publications/year from our labs
  - All 4 labs funded by federal grants
  - Lots of trainee successes

- Innovations
  - Joint implants
  - Surgeries
  - Rehabilitation interventions



Why we need technology in health

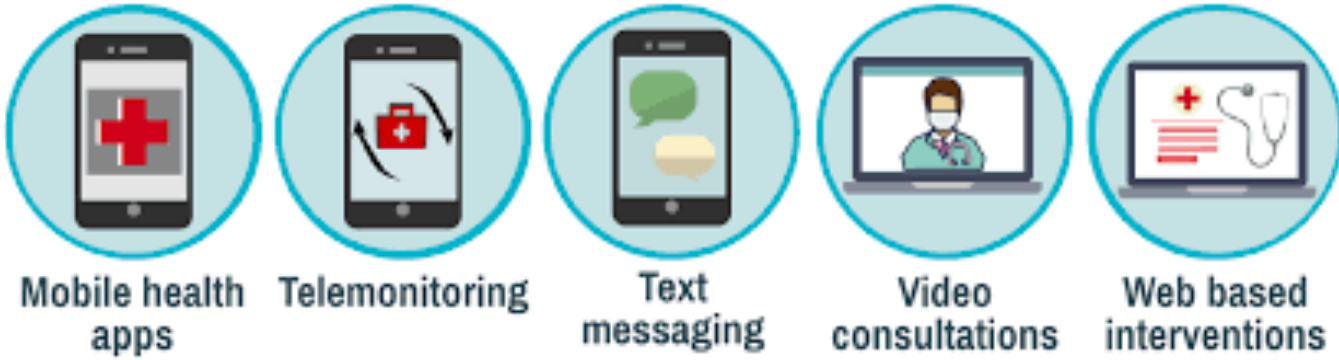
- To be more accurate/smarter-make better decisions
- To be faster- more productive and manage volumes
- To provide immediate feedback
  - Safety and health
- To improve patient experience
- To save money

Roles for technology in mobility

- To provide more accurate monitoring and feedback of physiologic or functional status and clinical outcomes
- To provide information more efficiently, accurately and clearly
  - Lower cognitive and literacy demands
  - Processing complex information
- To provide new therapies or augment current programs
  - Distance
  - Virtual or augmented reality
  - Multiple learning pathways
- Adherence Monitoring

Technologies we can leverage

- Apps
- Gaming devices
- Video movement analysis software
- Educational software / apps
- Virtual/augmented reality
- Wearables devices
- Smart materials
- Web- based
- Lots more…



Wii™ habilitation

Background of the Wii

- Made commercially available in 2006
- Infra red remote responds to movement in three axis and acceleration
- Feedback – visual, auditory,

  tactile
- “Non gamer” target market
- Active & social

Wii Balance = $$ device

Dovepress
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Clinical Interventions in Aging
Dove Medical Press | This Article | Suscribe | Submit a Manuscript | Search | Follow

Clin Interv Aging. 2014; 9: 1803–1813.
Published online 2014 Oct 23. doi: 10.2147/CIA.S69673
PMCID: PMC4211857
PMID: 25364238

Does a Wii-based exercise program enhance balance control of independently functioning older adults? A systematic review

Yocheved Laufer, Gali Dar, and Einat Kodesh

Author information ► Copyright and License information ► Disclaimer

Technology is not stable enough

- Where is Wii now?

- Infrastructure costs
- Maintaining
- Compatibility across platforms
- What can patients access/afford/

- How many times can learn new ways
- Do we need 5 versions

Innovation

- Totally new approach
- New ways of doing same thing
- New methods for existing applications
- Context is everything
- Right size the technology – need users involved

BEFORE

AFTER

3 Current Projects at HULC

- Joint Protection Programs for People with Arthritis
- Firefighter MSK Health
- Clinical Trial

Frequency of hand osteoarthritis detected over a period of 9 years in Framington.

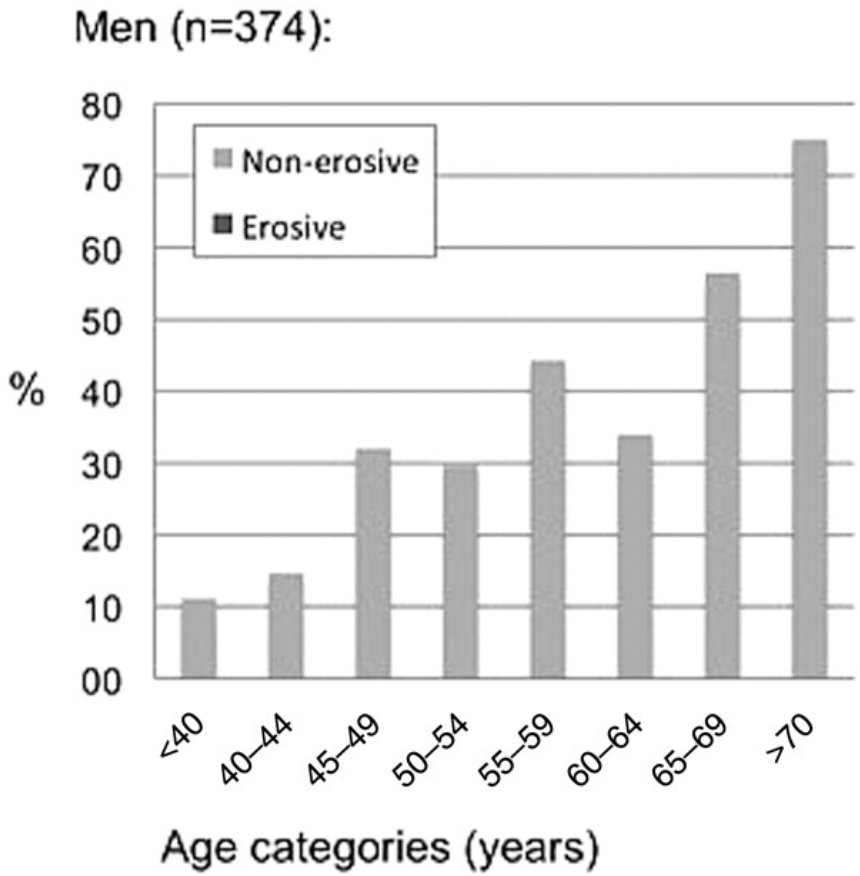
RESEARCH ARTICLE

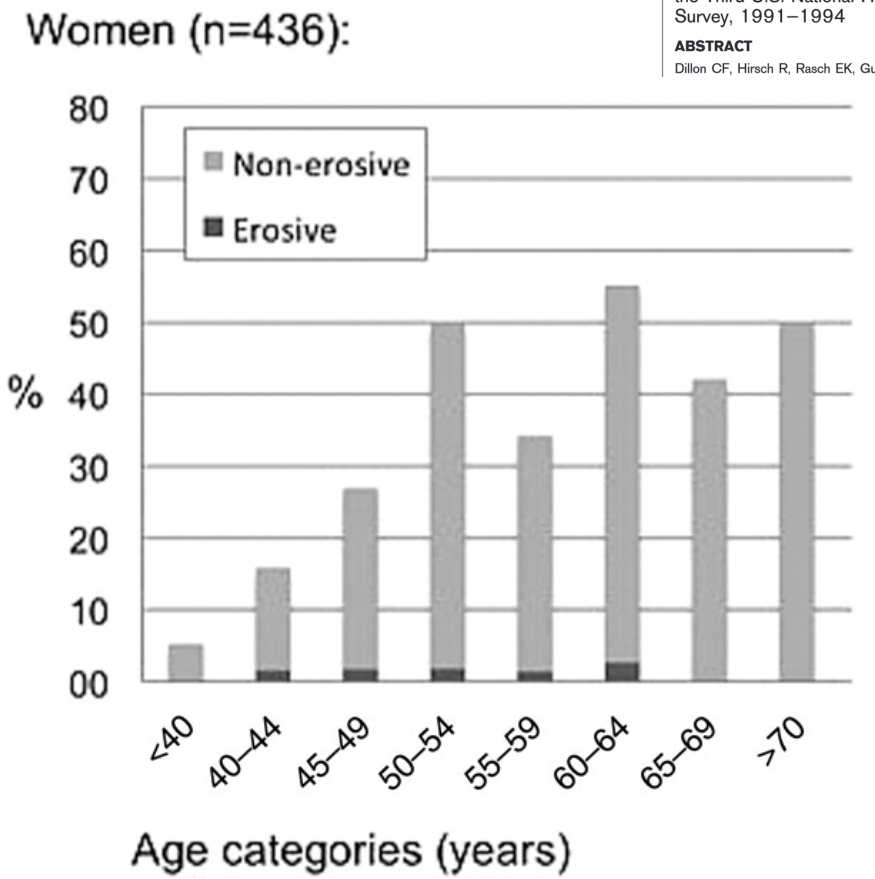
Symptomatic Hand Osteoarthritis in the United States

Prevalence and Functional Impairment Estimates from the Third U.S. National Health and Nutrition Examination Survey, 1991–1994

ABSTRACT

Dillon CF, Hirsch R, Rasch EK, Gu Q: Symptomatic hand osteoarthritis in the





Ida K Haugen et al. Ann Rheum Dis 2011;70:1581-1586

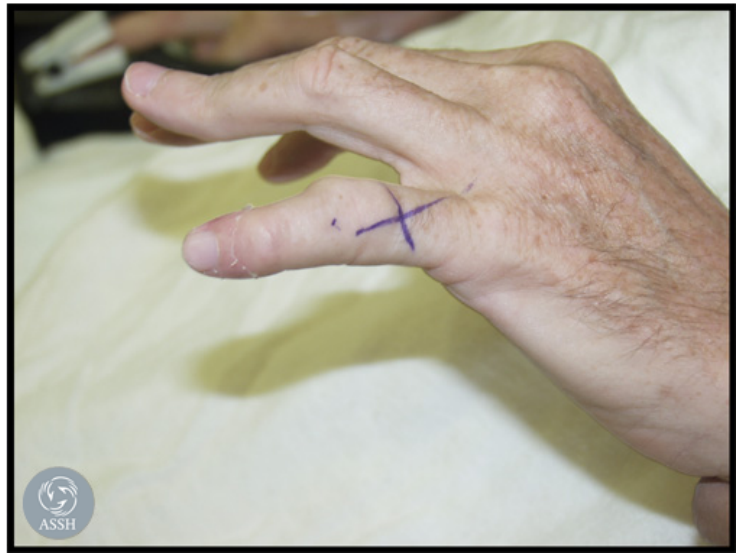
ARD

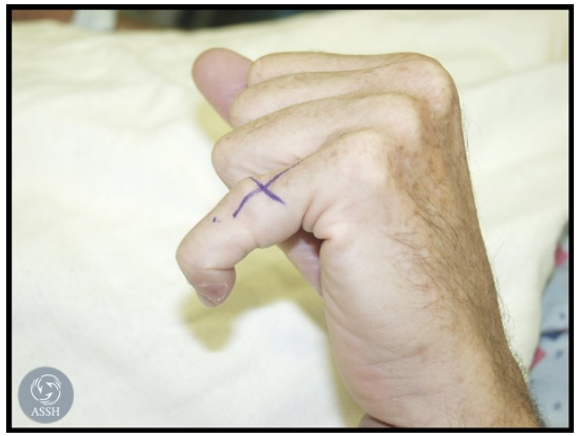
Prognosis – 6 year progression

- 50% deteriorated
- High levels of functional limitations
- Most genetic of all OA presentations

- Bijsterbosch J, Watt I, Meulenbelt I, Rosendaal FR, Huizinga TW, Kloppenburg M. Clinical and radiographic disease course of hand osteoarthritis and determinants of outcome after 6 years. *Ann Rheum Dis* 2011;70(1):68-73

Severe hand OA

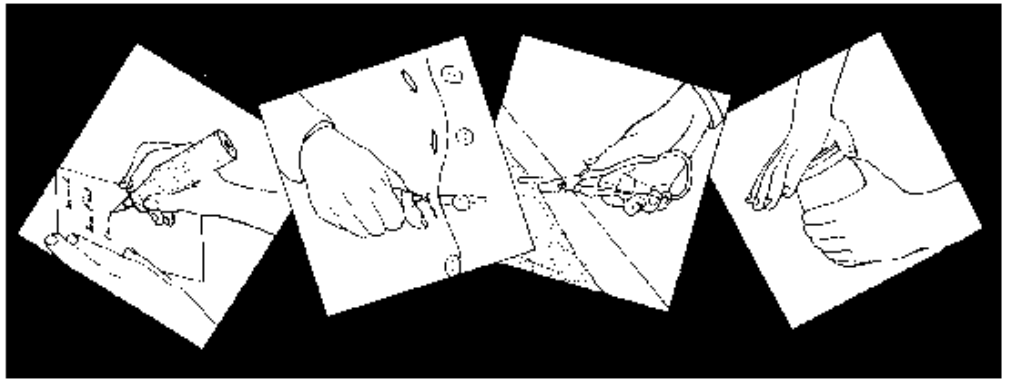




What is Joint Protection?

- Self-management strategy
- Preserve Joint function
- Reduce pain

Joint Protection Program Handbook



For Persons with Arthritis

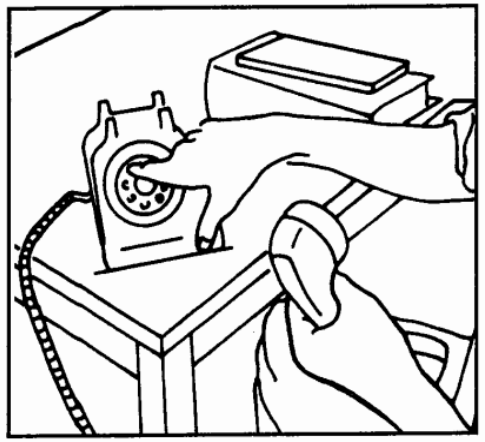
Kleinert INSTITUTE

KLEINERT KUTZ
Hand Care Center

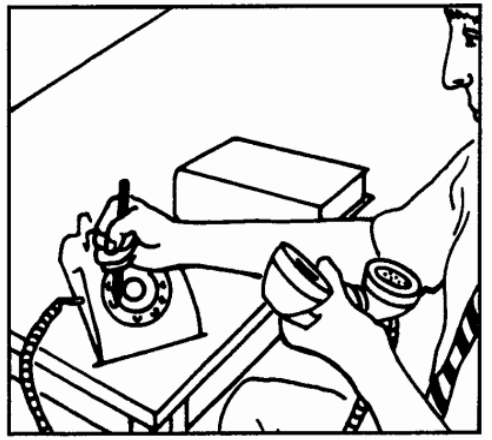
(502) 561 HAND (4263)
1 800 477 HAND (4263)

Downtown Louisville, Kentucky
East Louisville, Kentucky
Lexington, Kentucky
New Albany, Indiana

Problems with current (JPP)



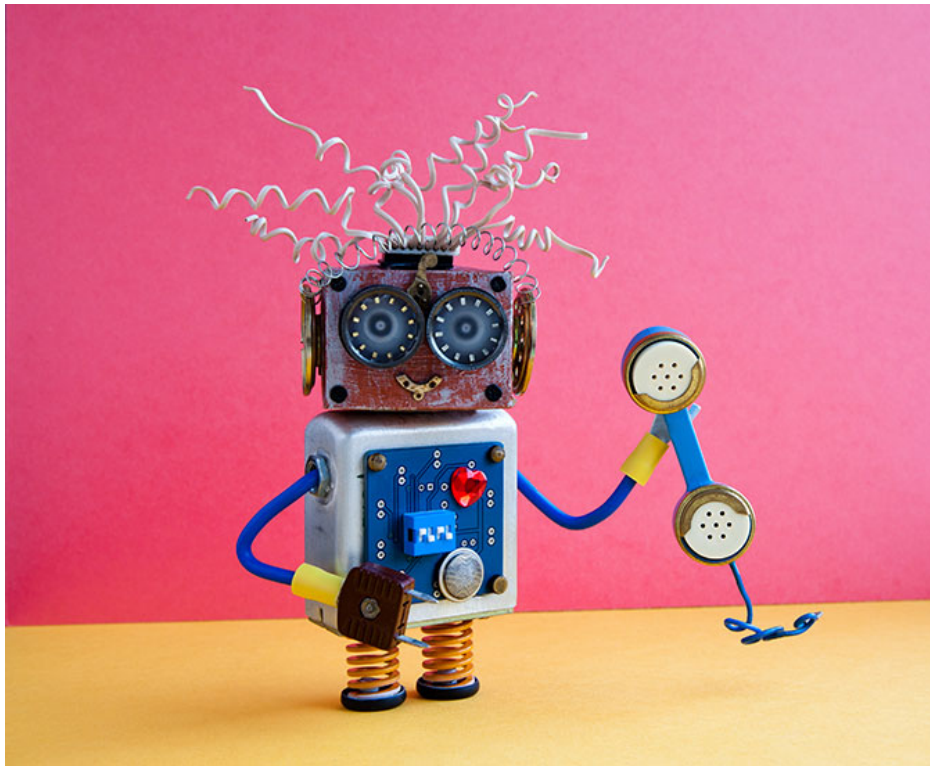
If you have a dial phone, keep a pen or pencil next to it to use instead of your finger when dialing.



- Current JPP are outdated
  - Do not account for how tasks of daily life have changed
- Weak empirical evidence exists
- Not definitively described in literature or prescribed clinically
- Widespread compliance issues (40-60%)

Our domains of JPP

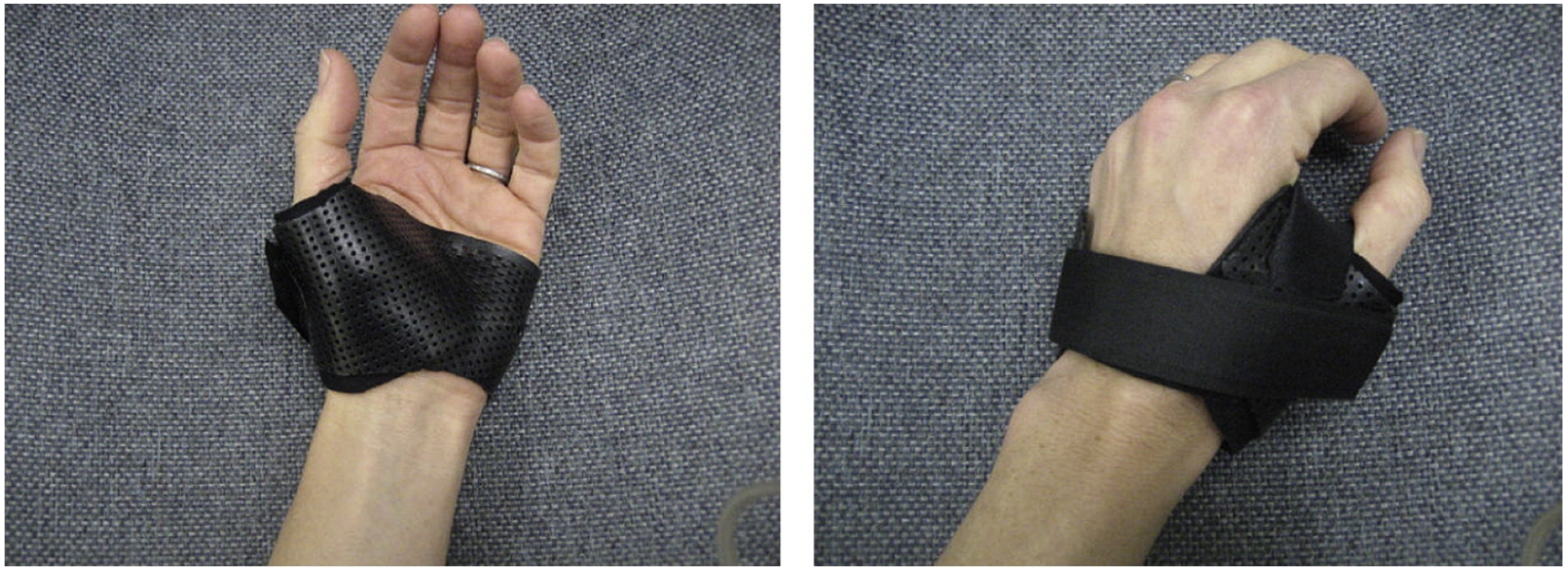
- Changing how tasks are done
  - Biomechanical principles
- Using adaptive devices/tools
  - and orthoses
- Work organization
  - Pacing and task efficiencies
- Exercise to improve stability
- Getting help
- Building problem-solving skills ; adaptation



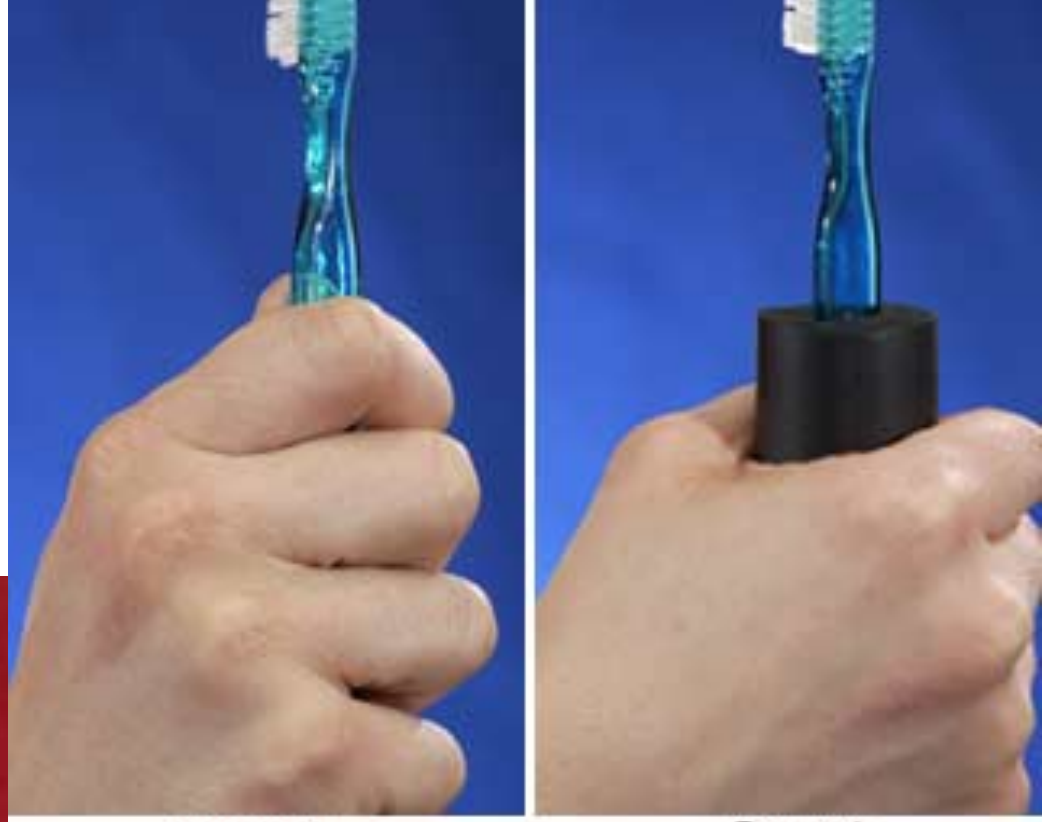
More is not always better

Better pain relief

Figure 2

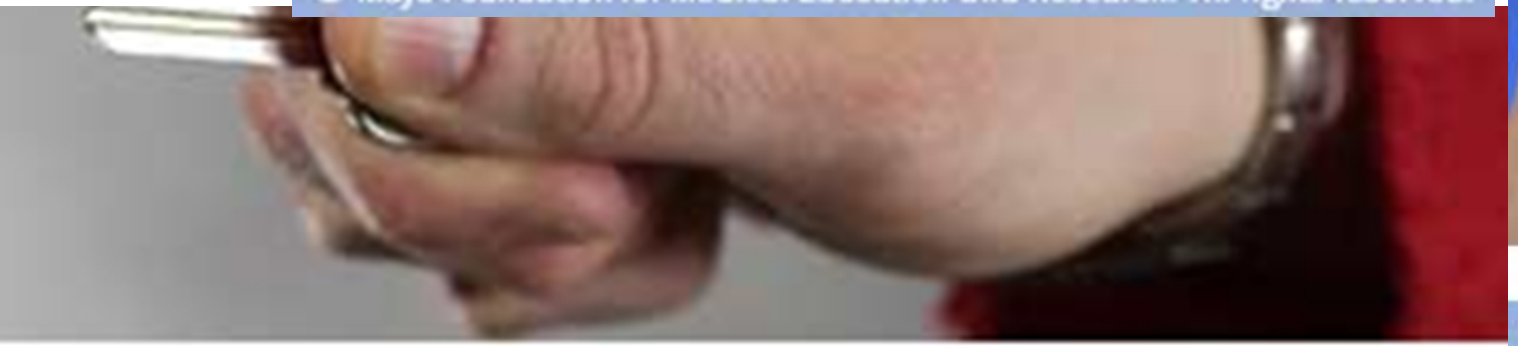


Journal of Hand Therapy 2011 24, 216-226DOI: (10.1016/j.jht.2010.12.004)



Incorrect

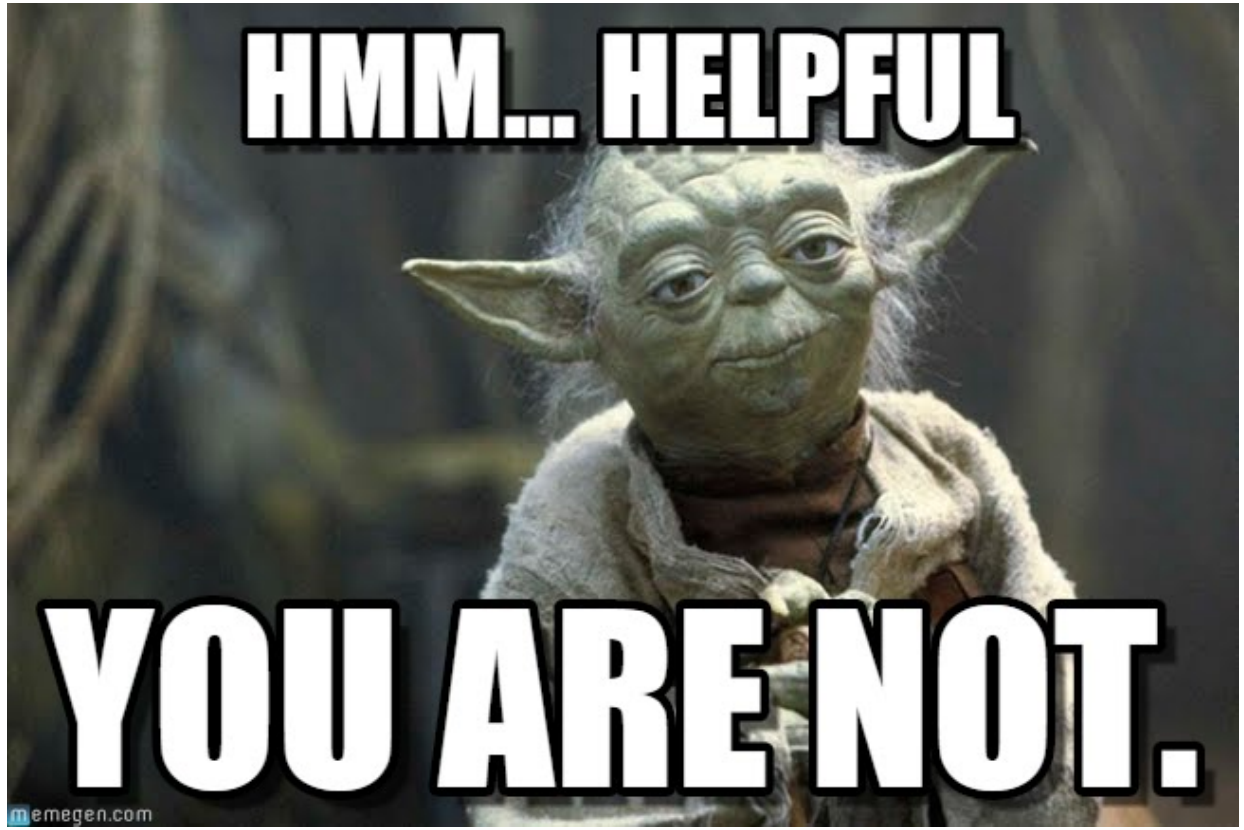
Correct



Incorrect

Our systematic review of current evidence

- Most studies on RA
- 2 RCTs on OA
  - Conflicting conclusions
- 3 publications
- No clear guidance



Future Directions

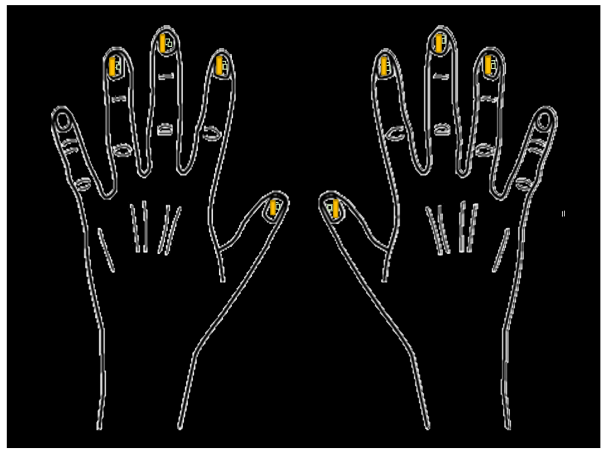
Technology-based innovation

- Wearable technology is a tactile sensor attached to an acrylic nail prosthetic
- Measures force data that captures the applied force measured at the fingertips
- Examine finger motion pathway (kinematics) using electromagnetic tracking

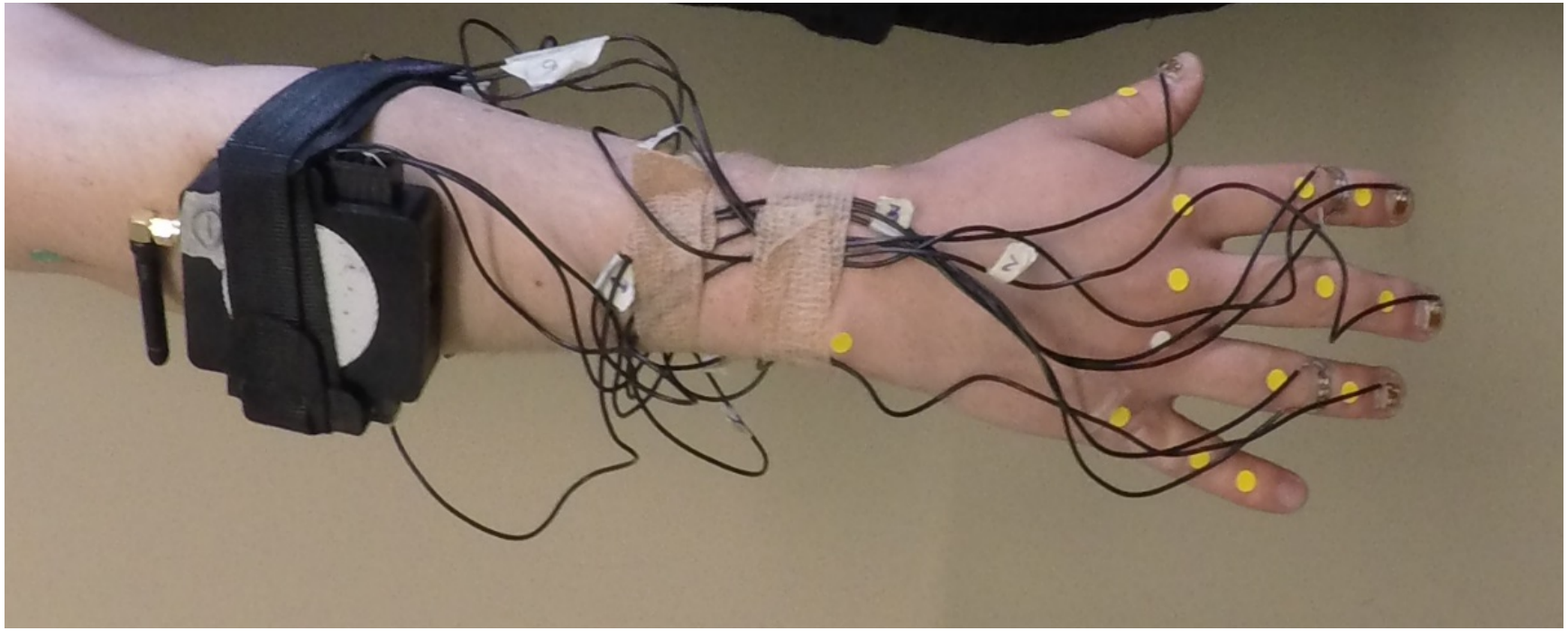
Electromagnetic Tracker Placement (1.6 x 4 mm)

Tactile Finger Sensor Placement

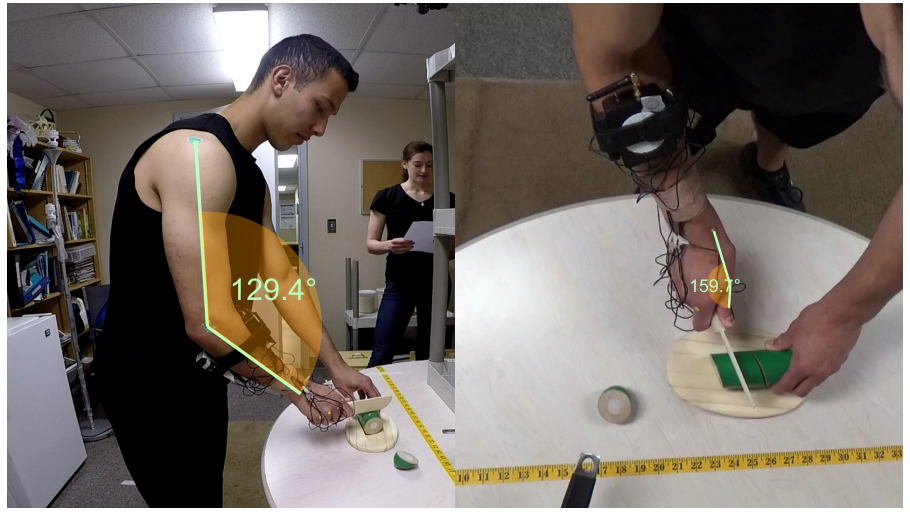
Wire connecting to Receiver (on forearm)



Using Engineering design



Activity 6: Cutting a Cucumber

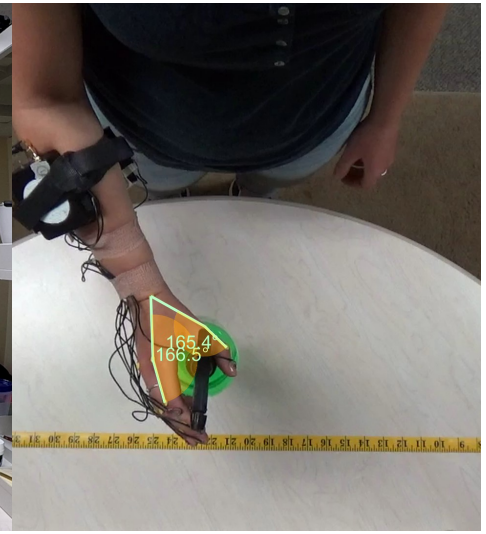


Minimum Angle

Maximum Angle

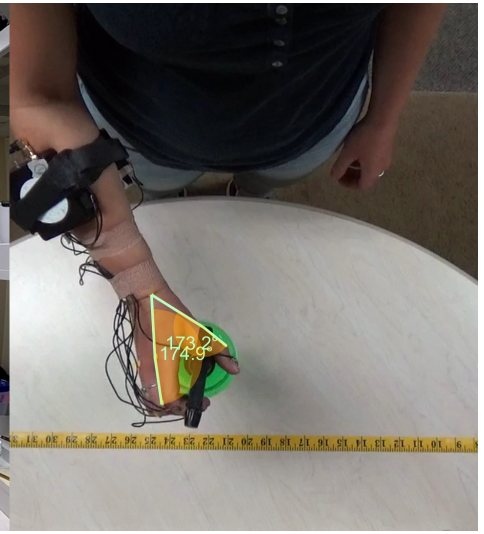
Activity 7: Spray Bottle

Maximum angle



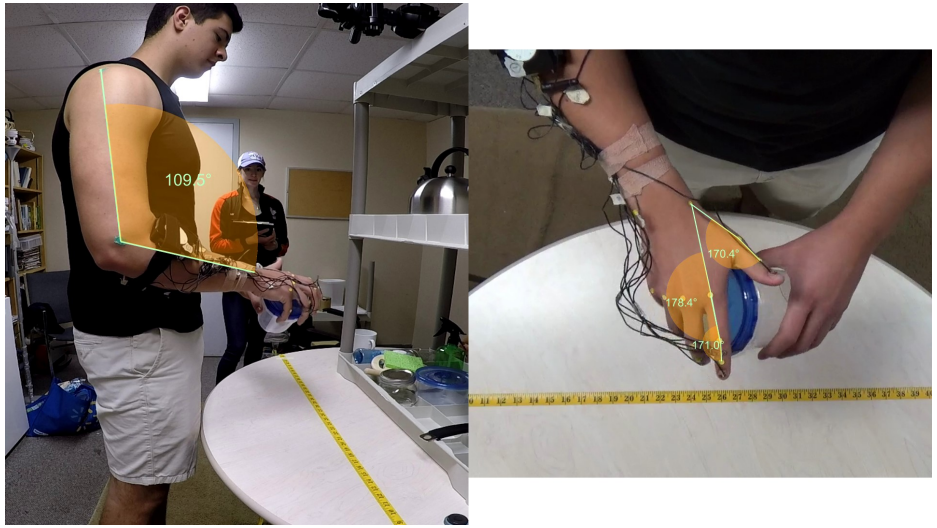
Minimum angle

Minimum angle

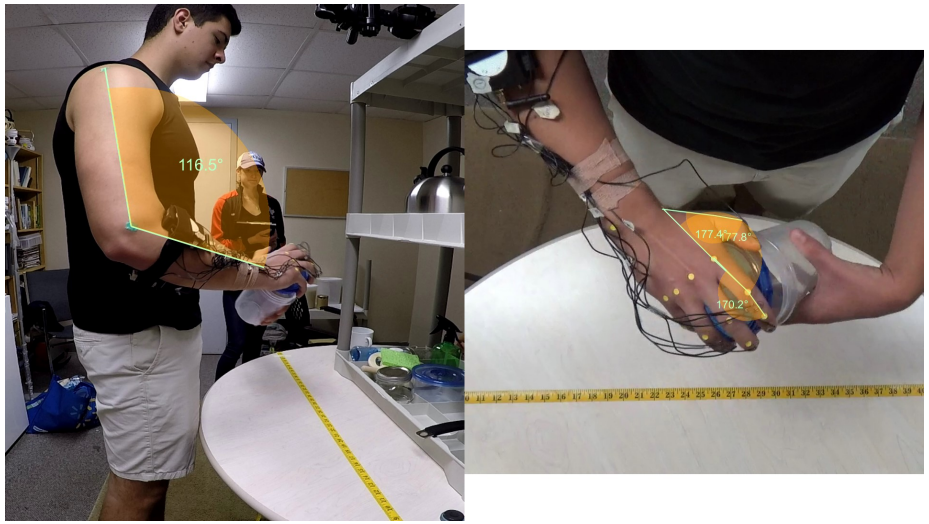


Maximum angle

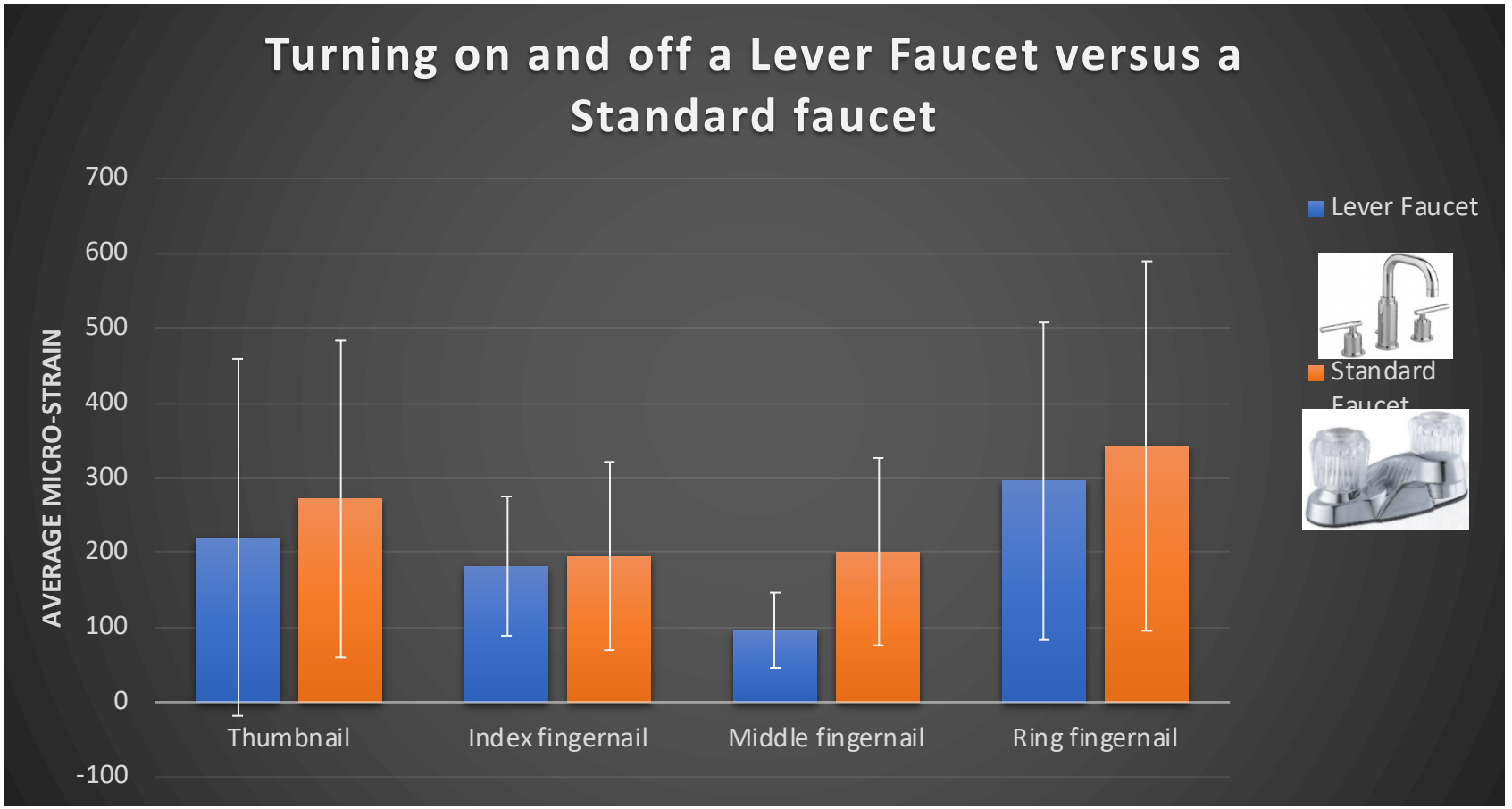
Activity 9: Twist lid container



Minimum angle



Maximum angle



Average Micro-strain measured in the fingernails and phalanges of 7 patients when performing the task of turning on and off a lever faucet and a standard faucet. Average Micro-Strain in the fingernails of the patients when turning a standard tap was higher than the average strain in the fingernails when turning a lever faucet with a significant difference in strain measured in the fingernail of the middle finger.

This project

- 2 engineers
- a PT and clinical epidemiologist

- Trainees from engineering, PT, health promotion

- Patient partner

- Technology: sensors, video-movement analysis

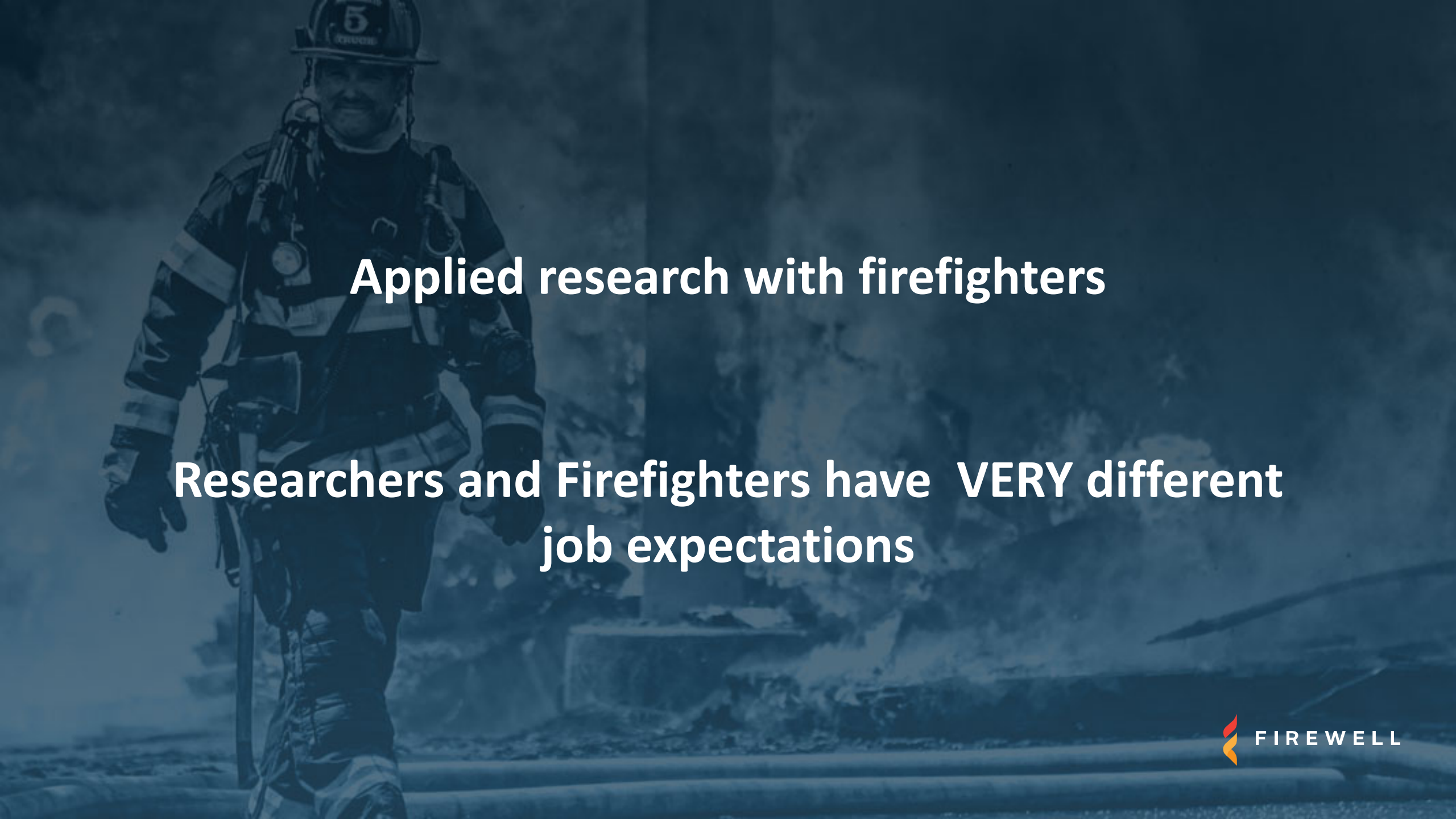
- Worked funded by Arthritis Society

- 3 evidence reviews completed (2 published)
- 1 survey patients needs, practices and preferences

- Multiple engineering papers on technology
- Clinical trial on formats of delivery

Knowledge Translation

- Clinicians prefer it to be free or close
- We have to work to disseminate new methods
- Devices not reliable, not wireless- cannot use at home
- Development costs - research

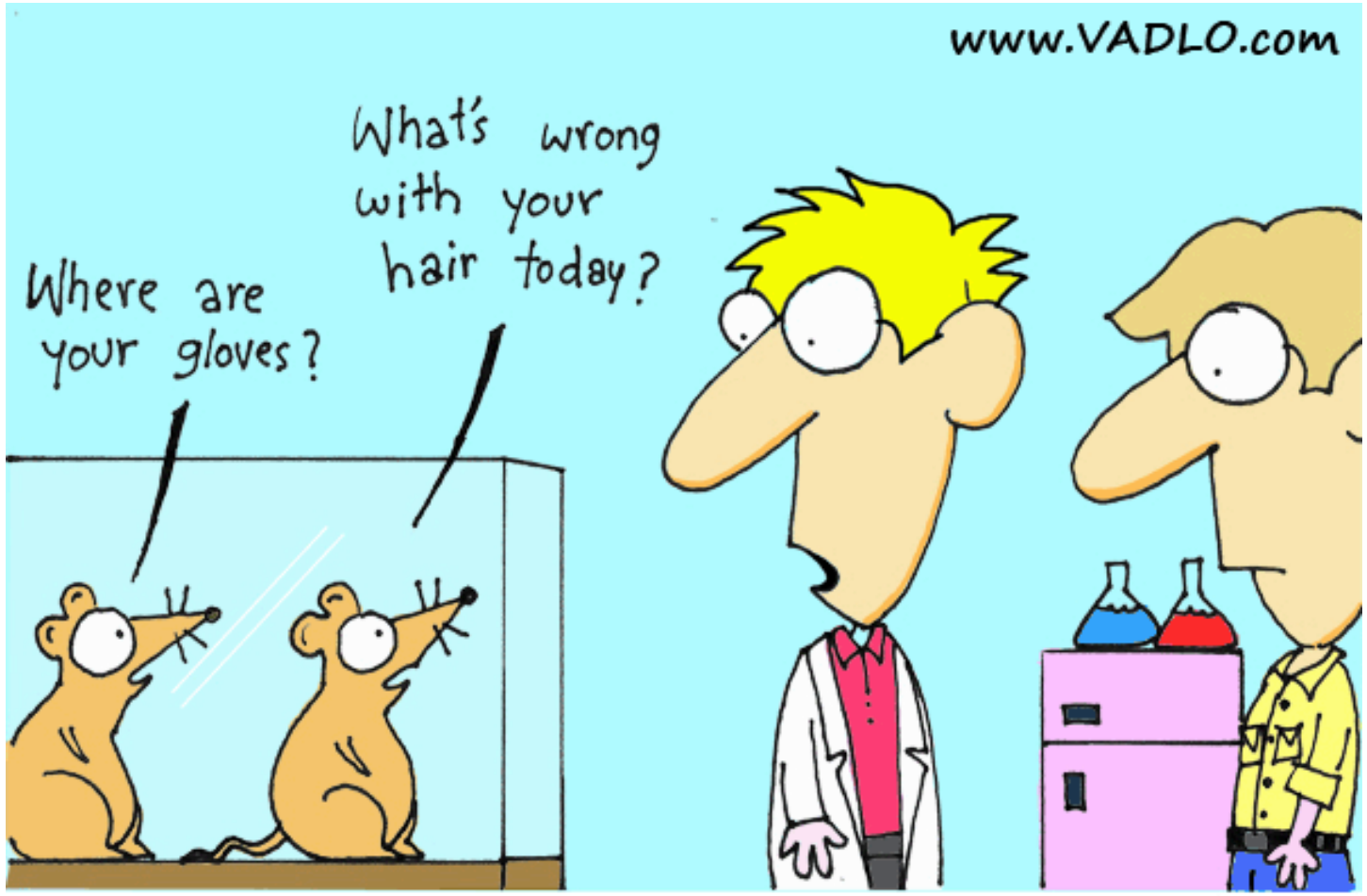


Applied research with firefighters

Researchers and Firefighters have VERY different job expectations

FIREWELL

Challenges working with researchers

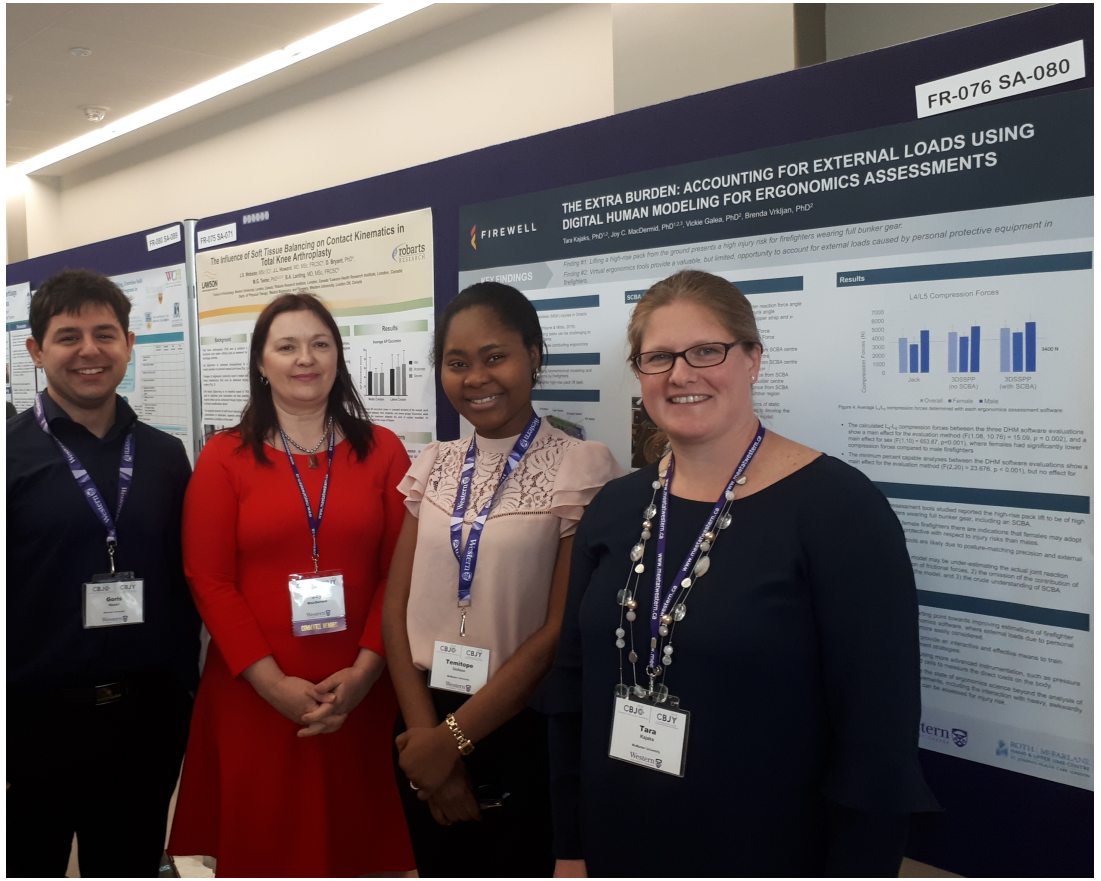


"At first I was happy I made smart transgenic mice.."

Different cultures, timeframes and expected outcomes

How we work together

- Meet, talk… shared learning
- Shared exploration of problems…. Leading to research questions
- Shared execution
- Discussion and of findings

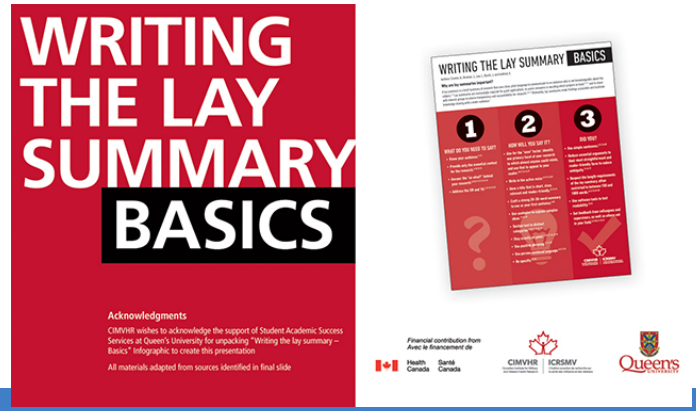


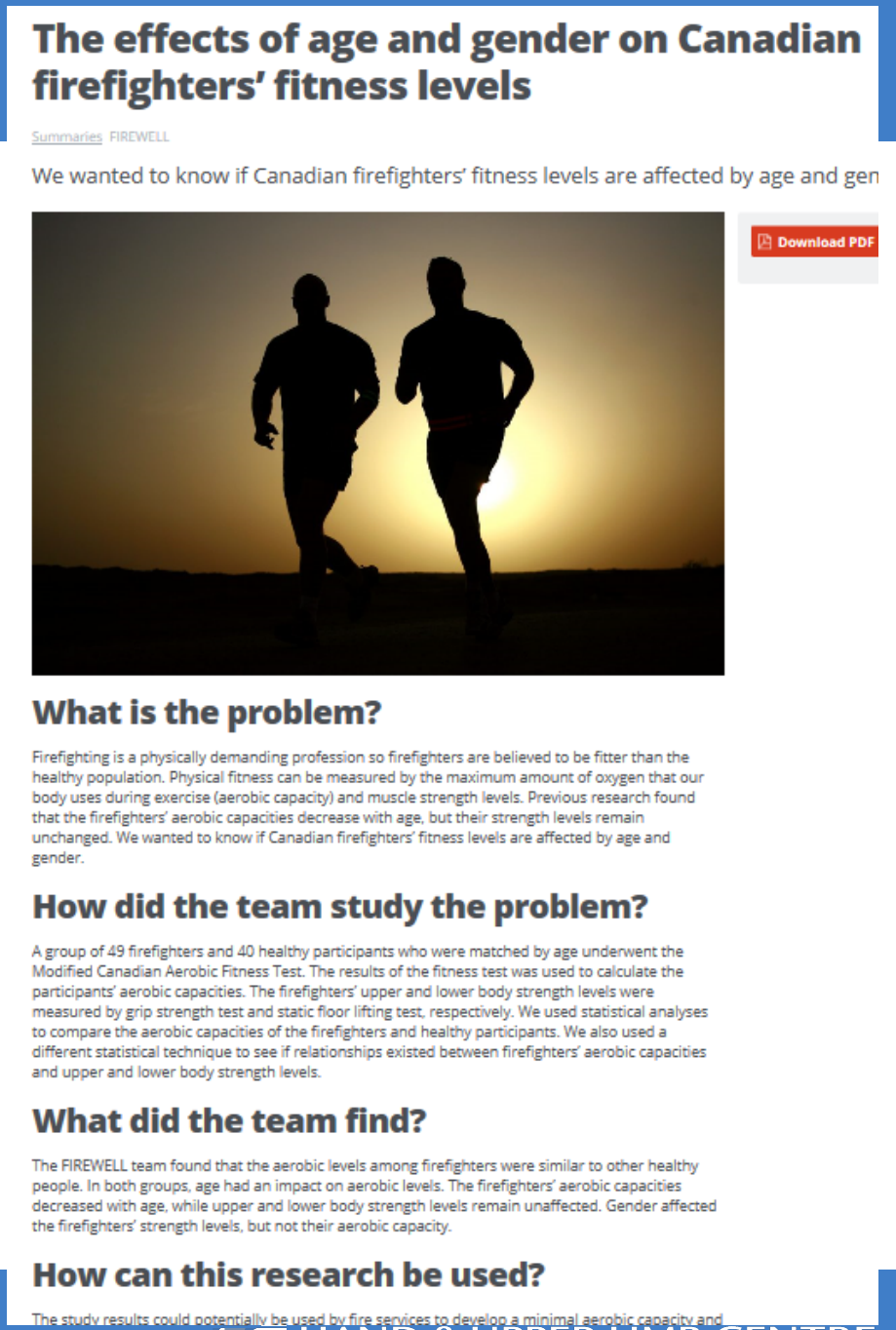
Western

ROTH | McFARLANE HAND & UPPER LIMB CENTRE

Lay Summaries

- Use “normal” language
- Avoid technical terms
- Do not overstate





So in 2008-09 with no money….. Still wanted to do somethings

- What are the experiences of female firefighters?

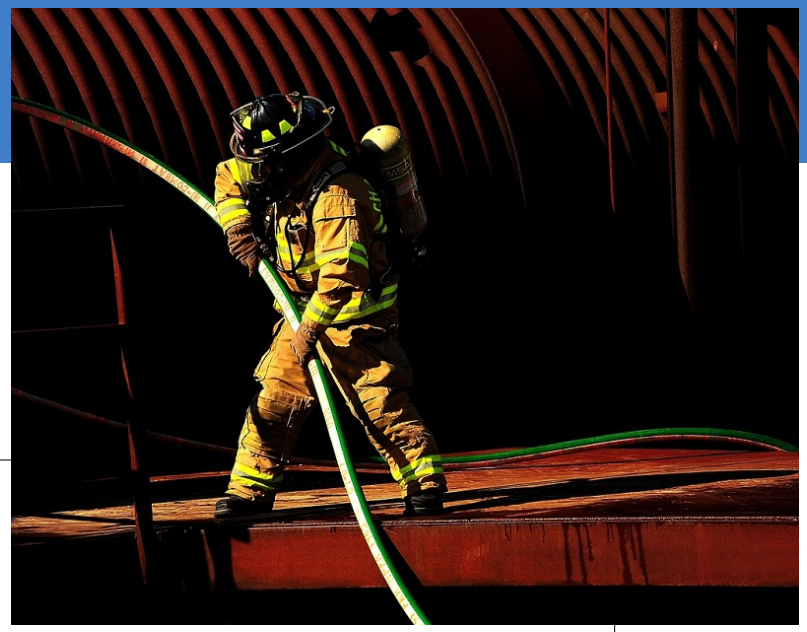
Work. 2013;45(1):97-105. doi: 10.3233/WOR-121549.

A qualitative study on the experiences of female firefighters.

Sinden K[1], MacDermid J, Buckman S, Davis B, Matthews T, Viola C.

Author information

Themes



- ***Physical Demands/Difficulties***
- "Firefighting] is a very physically demanding job and part of my responsibility was to maintain my physical abilities."
- **Gender Related Physiological [Differences**
- "Females are already 20% not as strong as their male counterparts…so you really have to maintain that, or you're going to be weaker."
- "I've been told that women generally have a lower VO2 max than men."

- **Compensatory Strategies**
  - "Body mechanics more than anything…the guys can usually manhandle things, I had to learn to use my body a bit more effectively."

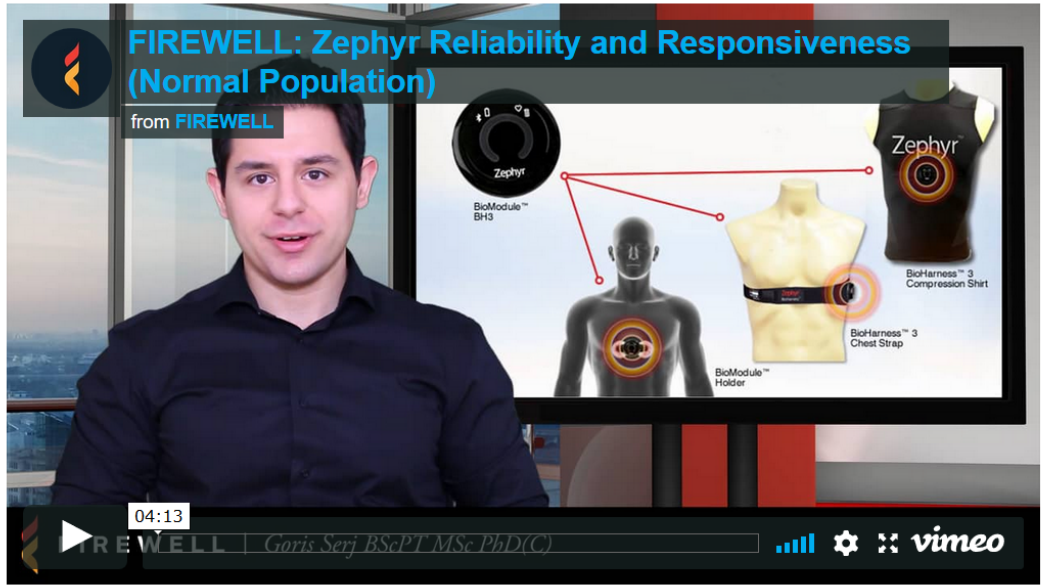
- **Equipment Mal-adaptation**
  - "The boots are always too big on me and bunker pants…everything is just kind of big and fits more loosely because it's suited more for a man."

Testing the Zephyr

The Reliability and Responsiveness of the Zephyr in Normal Populations

Presentations FIREWELL

A study that evaluated the Zephyr BioHarness' heart rate measurements of healthy males and females while they completed a fitness test.

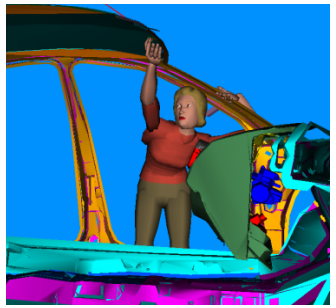


Functional Screen

Hose Drag Task

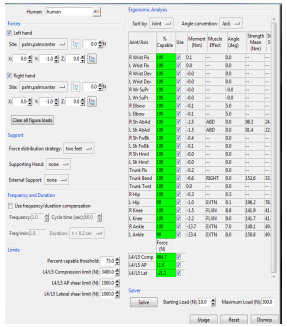
Stair climbing with High Rise pack

Background: Virtual Ergonomics Practices



Virtual Environment

Digital Human Model

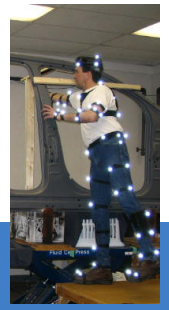


Ergonomic Tools

Traditional
Static Method

Current
Motion Capture Method

Future
Posture Prediction Method



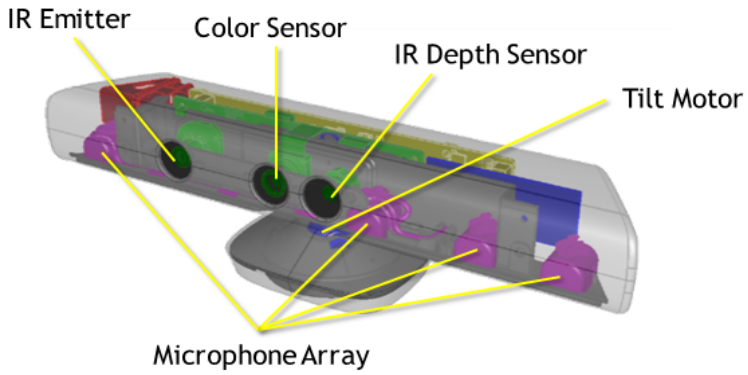
Methods

Participants:

- 12 full-duty Hamilton Firefighter Association firefighters (6 female)

Equipment:

- Microsoft Kinect® Motion Capture System,
- 3DSSPP DHM software (University of Michigan, Ann Arbor, MI, USA),
- Jack DHM software (Siemens PLM, Plano, TX, USA)



Microsoft Kinect® components

Methods

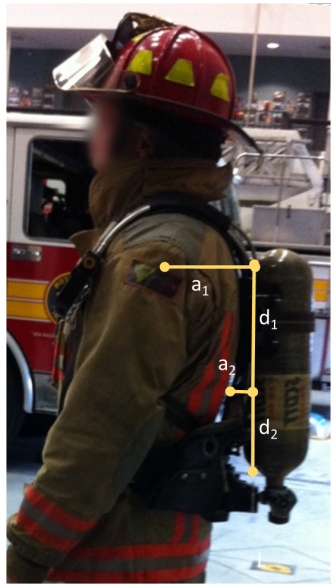
Protocol:

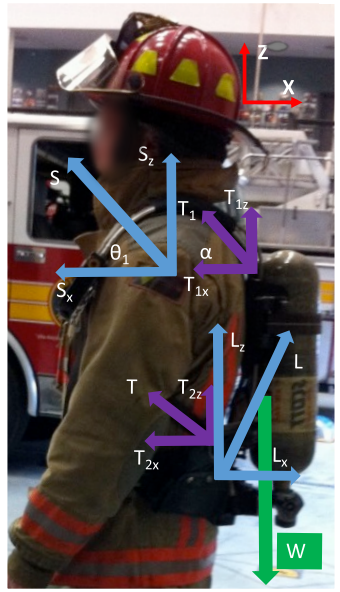
Each firefighter performed the high-rise pack lift and carry task one time while wearing full bunker gear including a helmet and SCBA (bunker gear without SCBA: 8.3 kg, SCBA: 17.5 kg, high-rise pack: 19.5 kg).

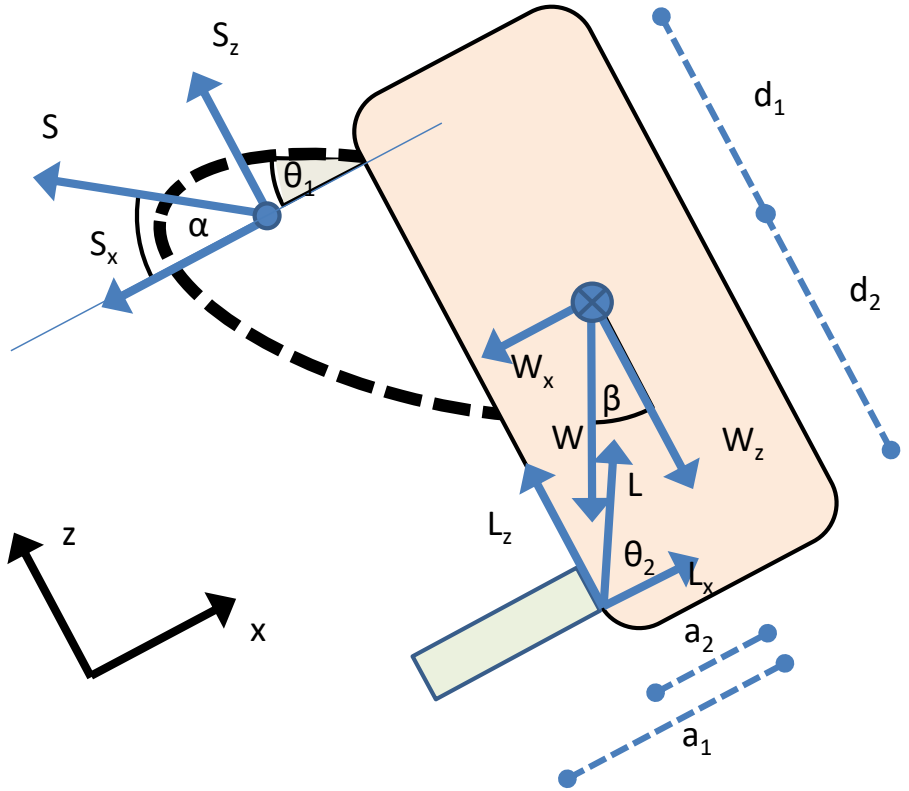
Methods

Biomechanical Modeling:

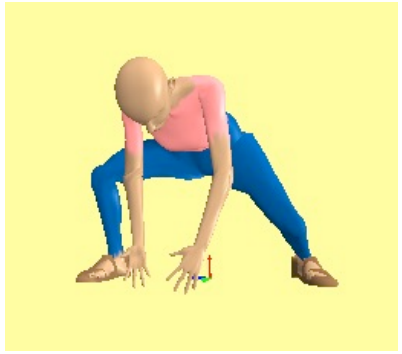
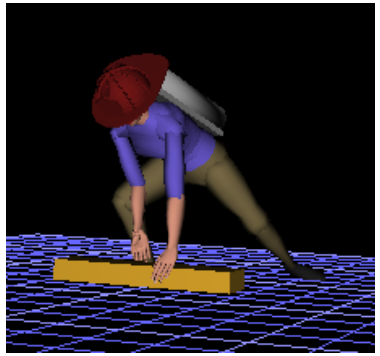
Biomechanical modeling was used to estimate the external loads caused by the SCBA. (adopted from Pelot et al., 2000)





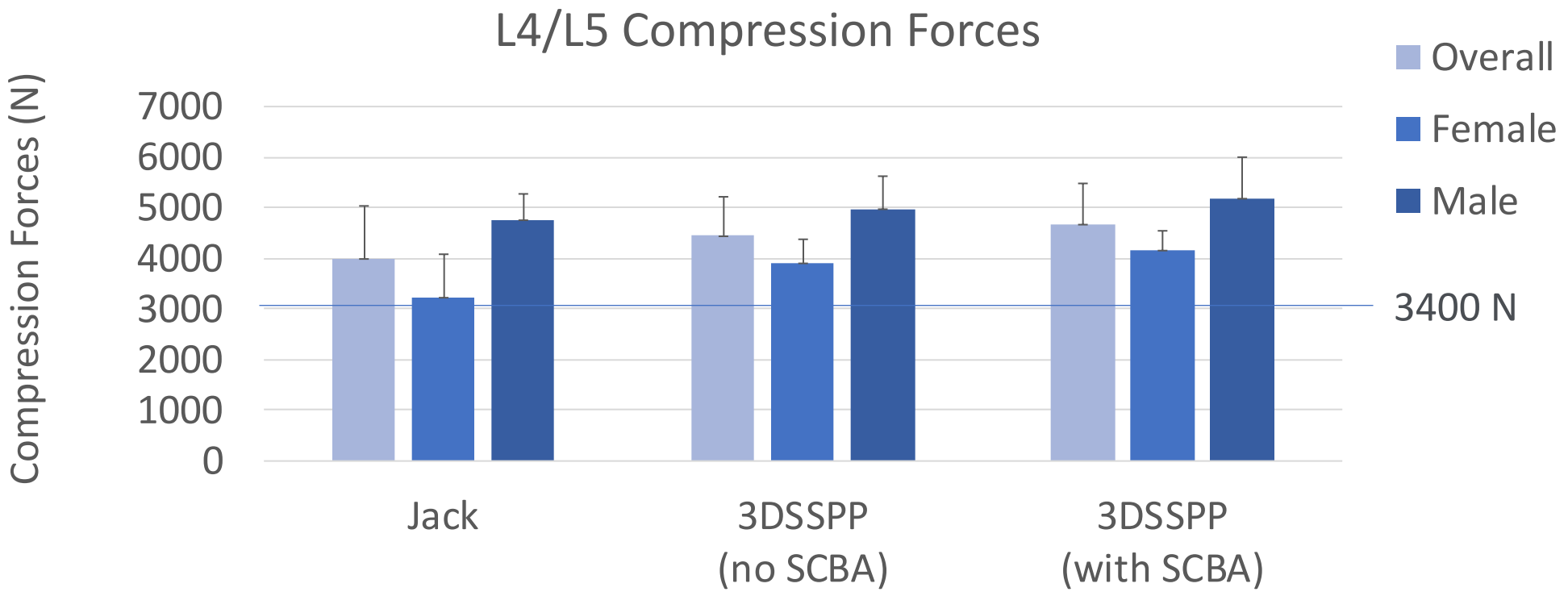


Methods

	Manual OWAS Evaluation	3DSSPP Simulation	Jack Simulation
Simulation Strategy	• N/A	• Manual	• Hybrid (Manual and Kinect MoCap)
			

Results

- Average L_4/L_5 compression forces determined with each ergonomics assessment software

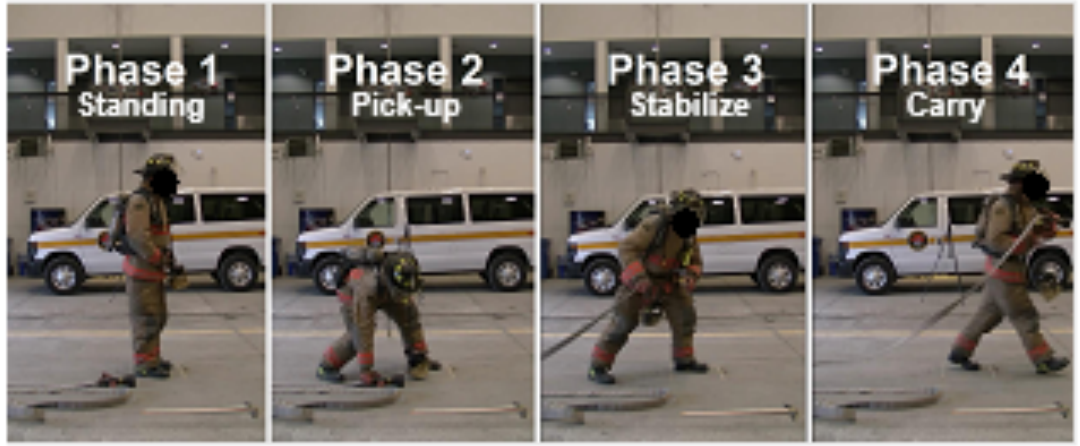


Identifying musculoskeletal injury risk for application in injury prevention tool development for professional firefighters

Sara T. Sayed[1]; Kathryn E. Sinden[1], R.Kin., PhD; Tim Hurley[2]; Kerri Zalan[2]; Jeff Wang[2]; Ewa Habrowski[2]; Joy C. MacDermid[3], PT, PhD; FIREWELL[4]

Results

- The standing and carry phases were associated with a low MSK injury risk while the pick-up and stabilize phases were associated with a high MSK injury risk.
- The hose drag task is a moderately high risk task.

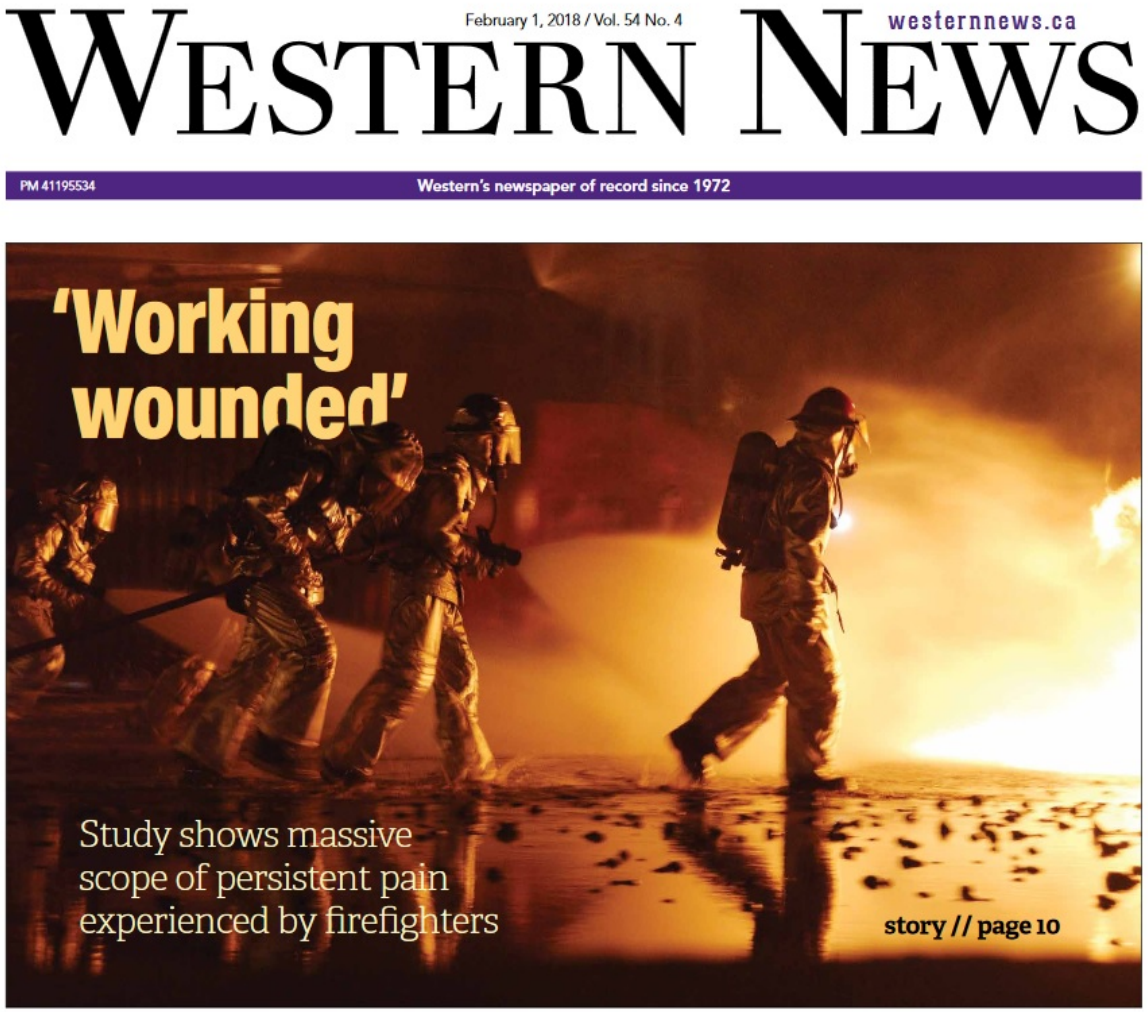


OWAS* Scores			
Median = 1; IQR = 1, 2.5	Median = 4; IQR = 0	Median = 4; IQR = 1, 3.8	Median = 1; IQR = 1, 3.8
Low Risk	High Risk	High Risk	Low Risk

Composite OWAS Score for Hose Drag Task
Median = 2.6; IQR = 1, 3.8

Figure 3: TEAM-Feedback Utility Survey Responses – Q1

Awareness…. PR mostly good



February 1, 2018 / Vol. 54 No. 4 westernnews.ca

WESTERN NEWS

PM 41195534 Western's newspaper of record since 1972

'Working wounded'

Study shows massive scope of persistent pain experienced by firefighters

story // page 10

Government of Canada invests more than $11 million in research into post-traumatic stress injuries in public safety personnel

February 8, 2019

From: Canadian Institutes of Health Research

News release

The Canadian Institutes of Health Research is supporting research to better understand, treat, and prevent PTSI in public safety occupations.

We miss opportunities too….

Study Flow Diagram

Preoperative Screening (n=954)
- 59 Eligible non-consenting
- 10 Missed
- 411 Ineligible
- 474 Eligible and Consenting

Ineligible at Pre-Screening (n=411)
- 276 improved after adequate physiotherapy
- 18 complaint was <6 months old
- 23 patient did not want surgery
- 36 imaging says no full thickness tear
- 10 imaging says massive tear
- 2 <18 years of age
- 4 frozen shoulder
- 10 Grade 3 or 4 OA
- 17 rotator cuff arthropathy
- 3 Bankart/Hills Sachs present
- 19 previous shoulder surgery or trauma
- 11 concurrent major medical illness
- 12 could not undergo required MRI
- 2 had to be open surgery (body habitus)
- 6 not a rotator cuff problem
- 4 mental illness
- 2 no fixed address
- 6 non-English speaking

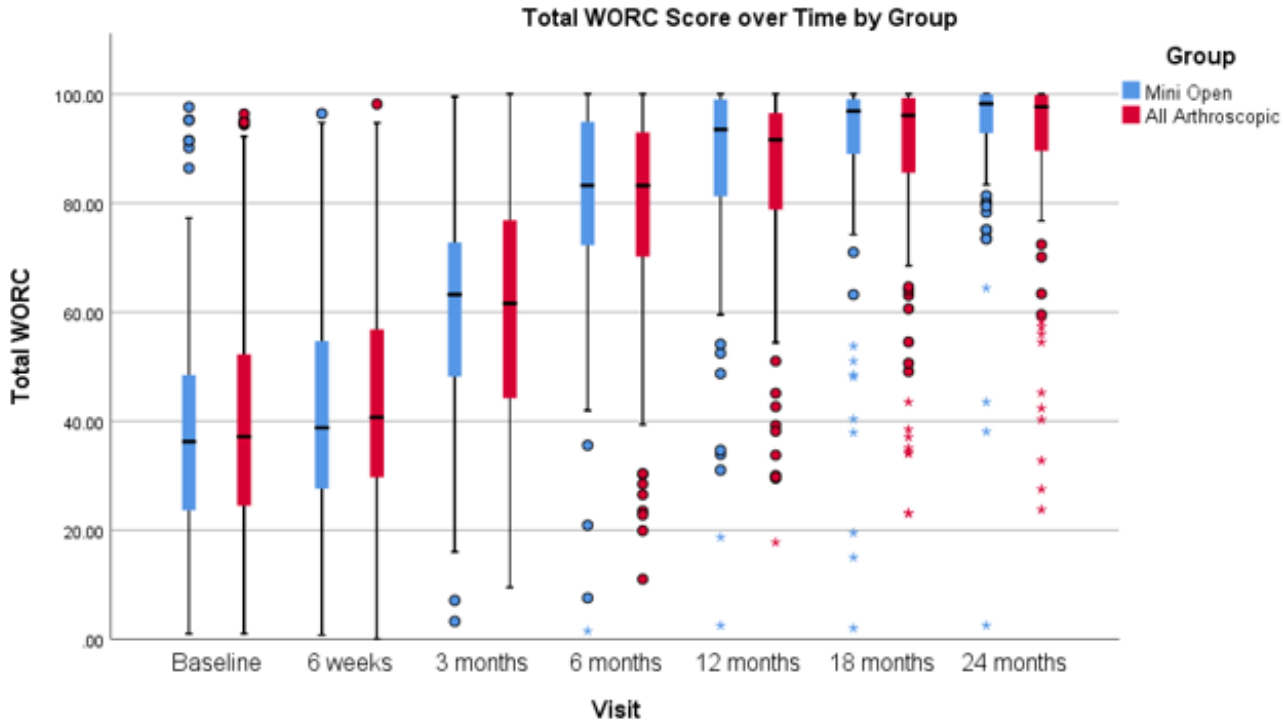
Eligible and Consenting (n=474)
- 1 died
- 7 major medical issue
- 8 withdrew consent
- 17 study closed

Screened at Surgery (n=449)
- 175 ineligible

Ineligible at Surgical Screening (n=175)
- 24 no visible tear
- 51 thinning, partial or focal full thickness tear
- 61 tear >3cm
- 6 tear included subscapularis
- 18 subscapularis or teres minor only
- 5 rotator cuff arthropathy
- 8 biceps repair
- 2 SLAP repair

All Arthroscopic (n=138)
- 4 withdrew consent (4 females)
- 11 lost to follow-up (4 females, 7 males)
- 133 included in non-imaging analysis
- 97 included in MRI analysis

Mini-Open (n=136)
- 2 withdrew consent (2 males)
- 7 lost to follow-up (4 females, 3 males)
- 134 included final non-imaging analysis
- 97 included in MRI analysis



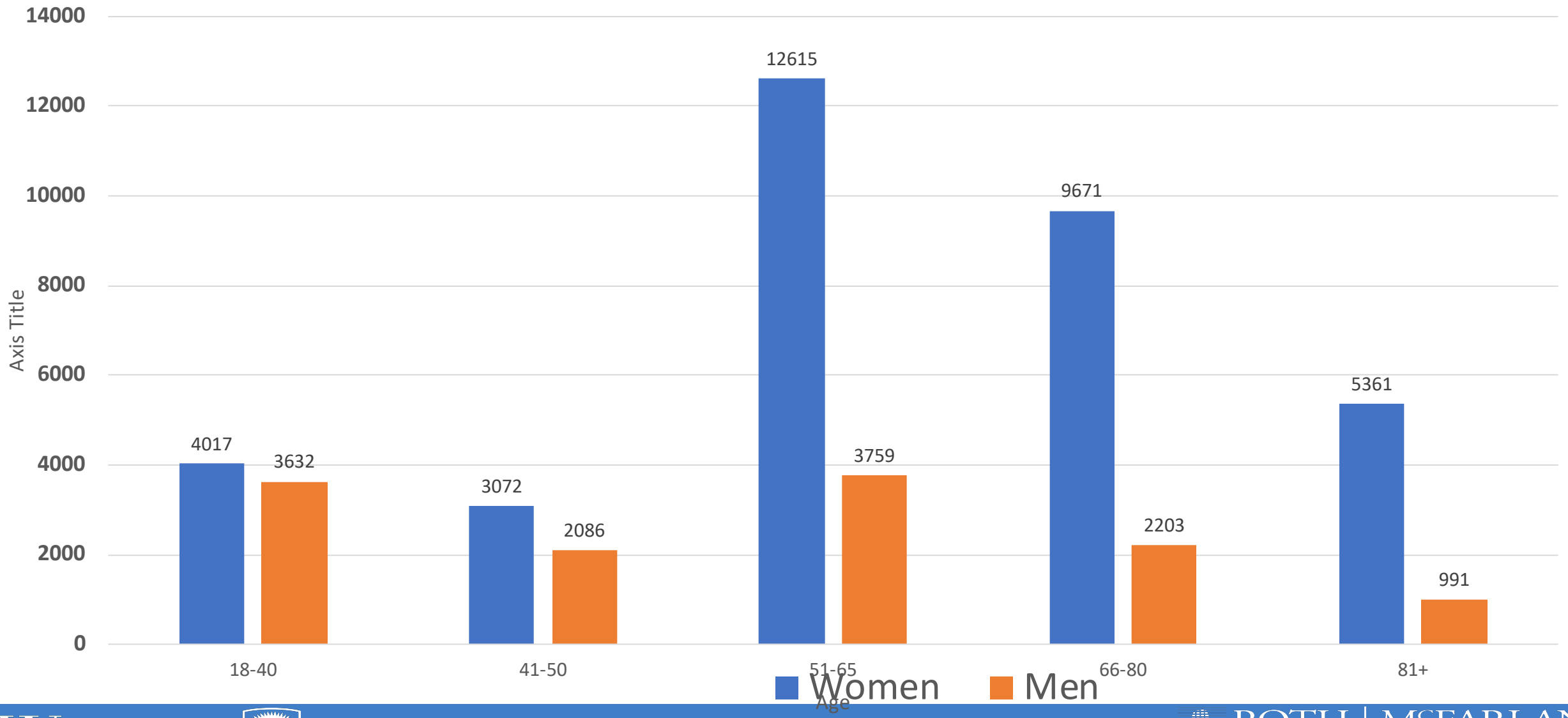
Technology could have helped

- Adherence
  - Less than 50% of therapists returned info on adherence or Rx
- Basic science questions
- Consistent rehab protocols
- Platform to test technology applications across Canada

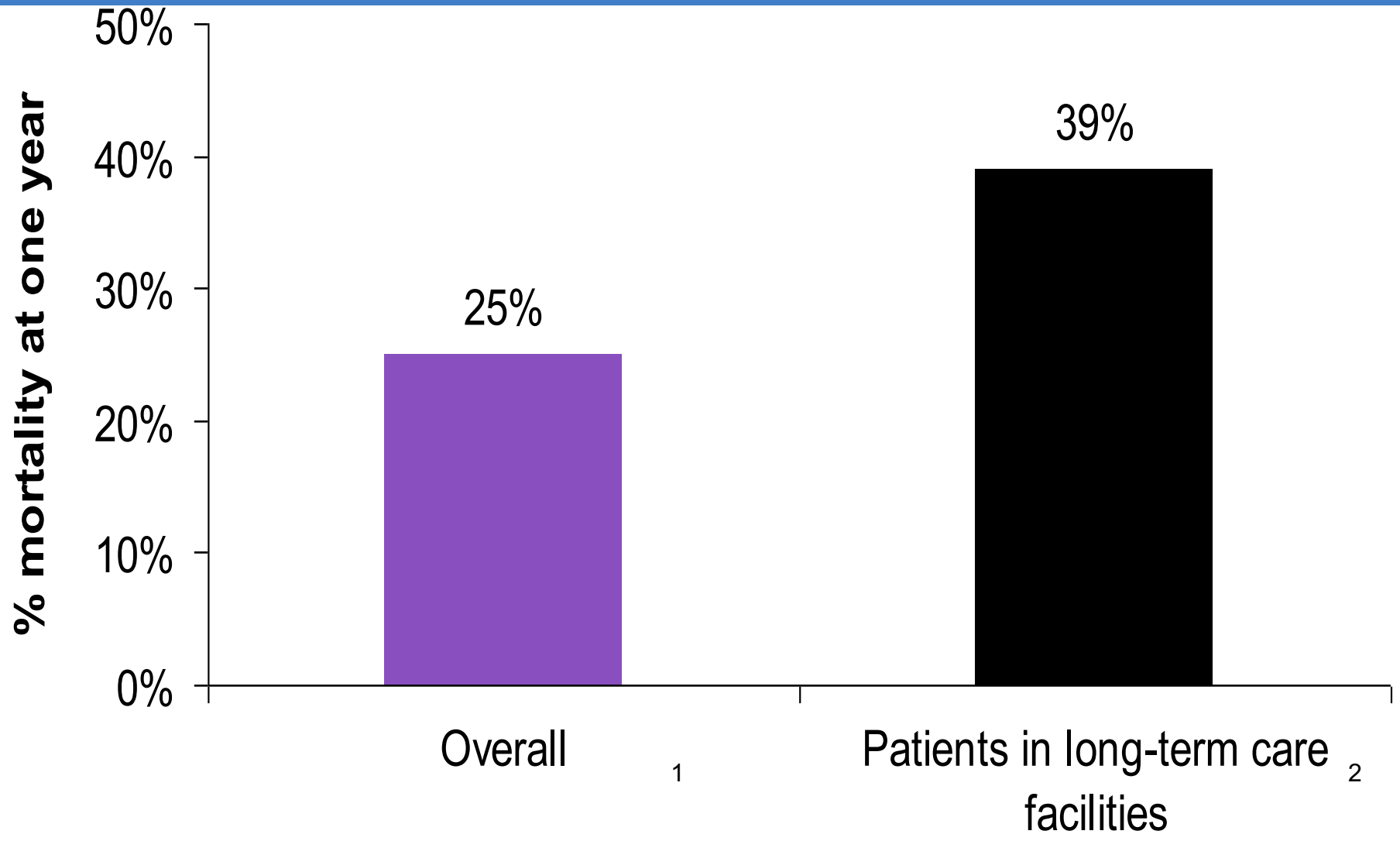
Challenges – where we can add value

- Aging population
  - Mobility a major issue
    - Diseases: OP, arthritis
    - Falls/fractures
    - Stroke
  - Comorbid Health
  - Mental and Physical health decline
  - Loss of QoL and independent living

Distal radius fractures in Ontario 2013-17



One-year Mortality Risk after Hip Fracture



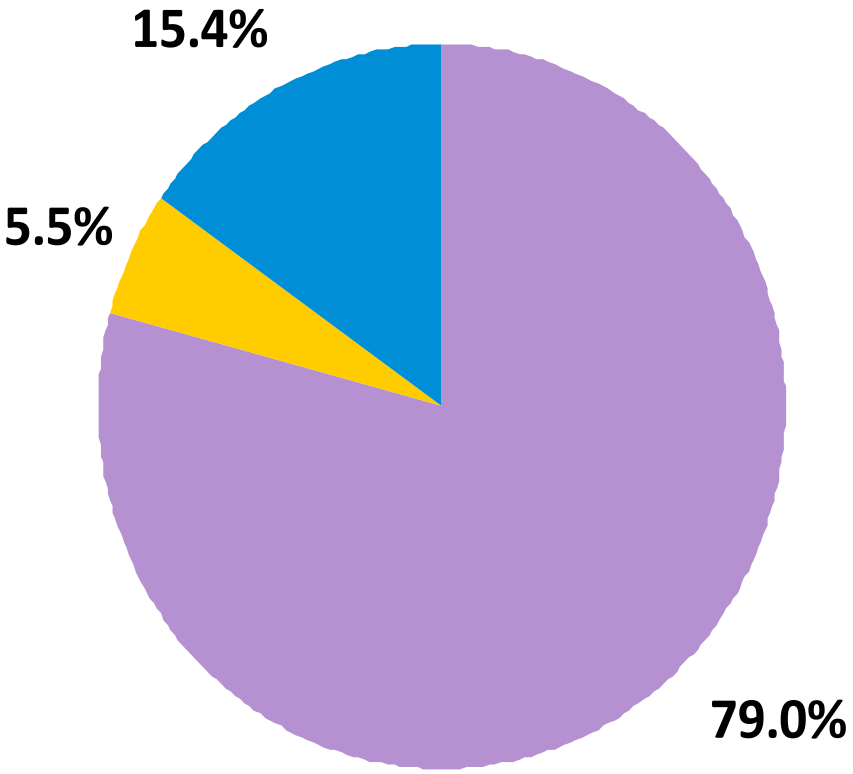
1. Ioannidis G, et al. *CMAJ* 2009; 181(5):265-271.
2. Papaioannou A, et al. *J SOGC* 2000; 22(8):591-597.

Impact on Function and Quality of Life

- Loss of confidence and fear of falling have been reported with all types of fractures
- < 40% of those who experience a hip fracture return to their prior walking abilities[1,2]
- Clinical fractures negatively affect self-care and mobility, and are associated with chronic pain[3]

1. Cranney A, et al. *J Rheumatol* 2005; 32(12):2393-2399.
2. Pasco JA, et al. *Osteoporos Int* 2005; 16(12):2046-2052.
3. Papaioannou A, et al. *Osteoporos Int* 2009; 20(5):703-715.

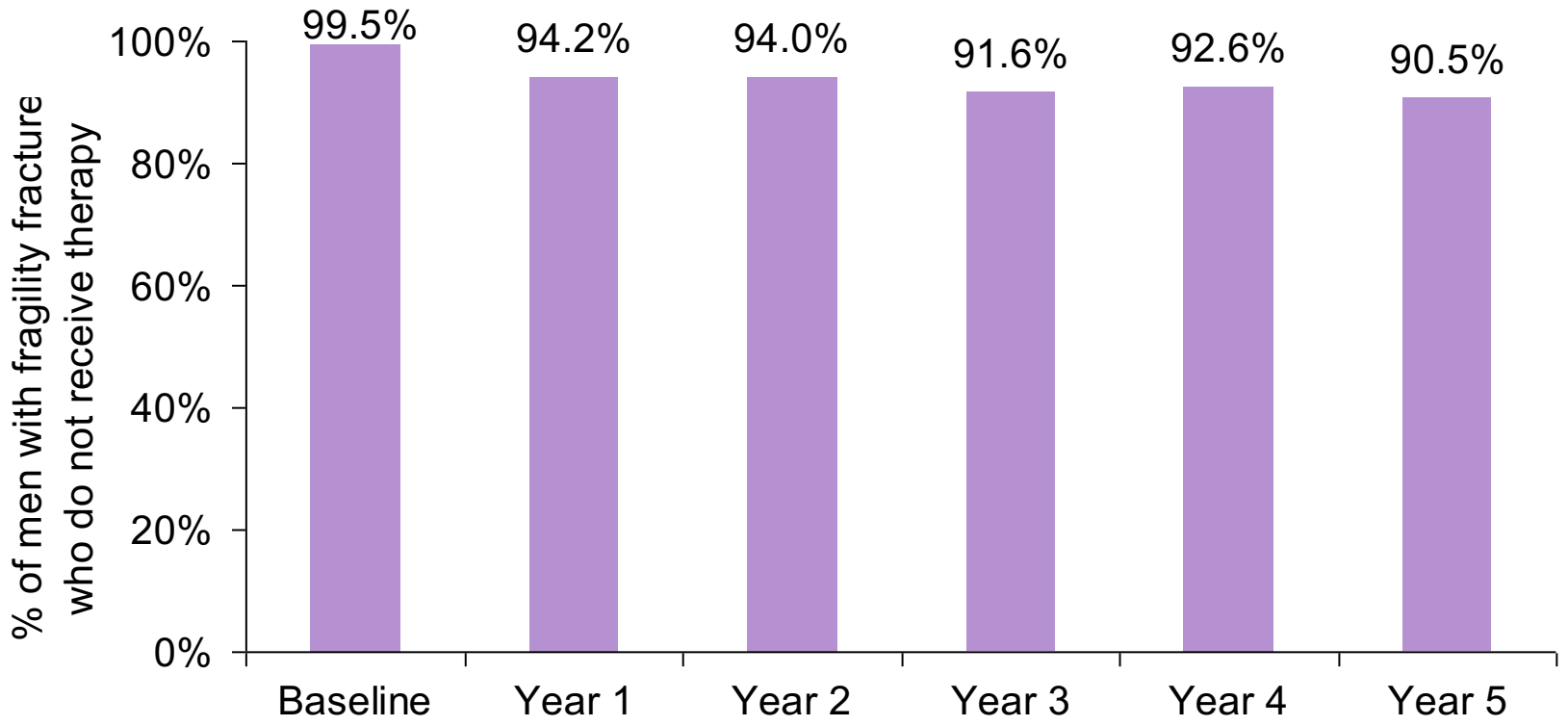
Undertreatment of Osteoporosis Post Fracture in Women[1]



A fracture is to osteoporosis what a heart attack is to cardiovascular disease.
BUT... The treatment gap is far wider post fracture than post MI.[1,4]

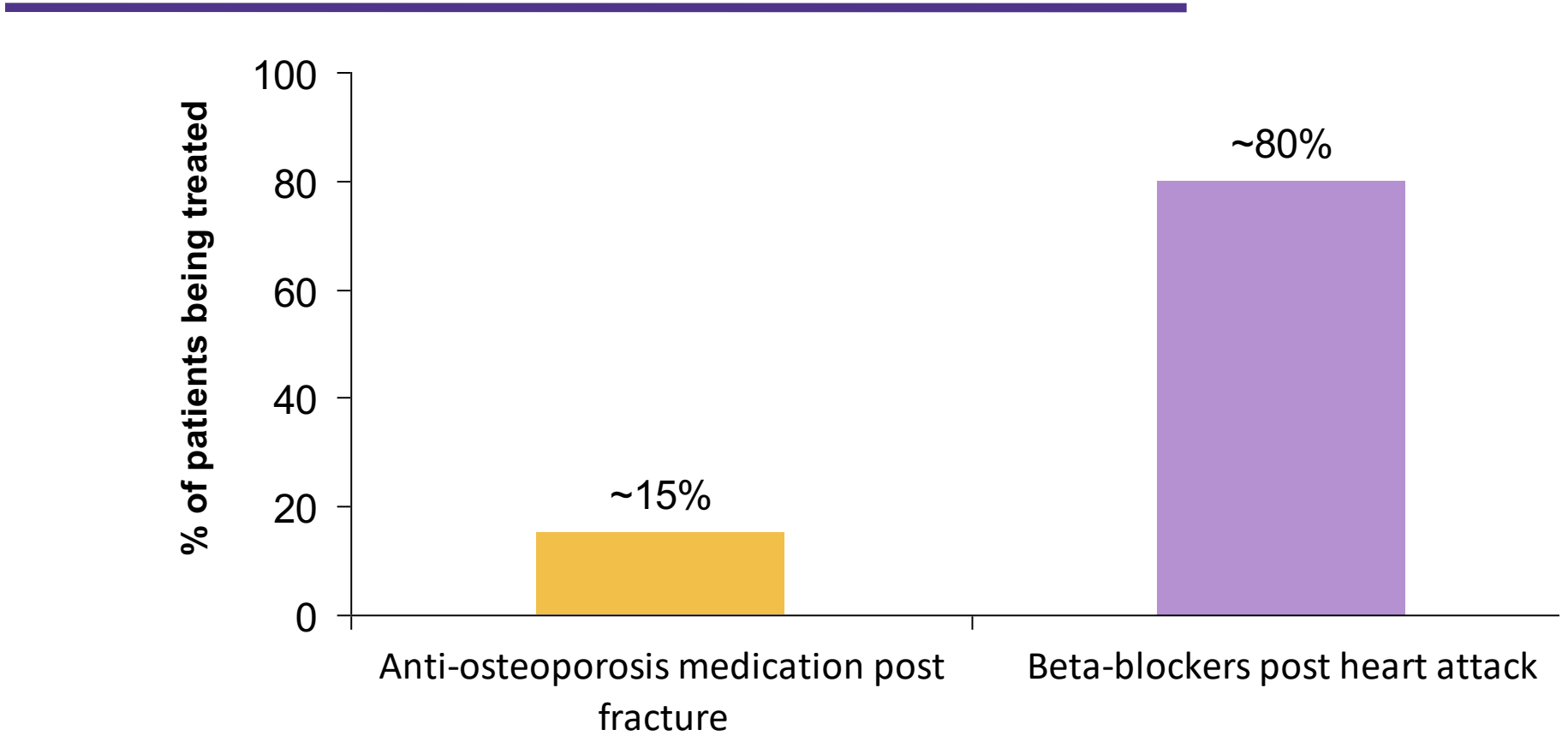
1. Bessette L, et al. *Osteoporos Int* 2008; 19:79-86.
2. Papaioannou A, et al. *Osteoporos Int* 2008; 19(4):581-587.
3. Giangregorio L, *Osteoporos Int* 2009; 20(9):1471-8.
4. Austin PC, et al. *CMAJ* 2008; 179(9):901-908.

Therapeutic Care Gap: Most Men Do Not Receive Treatment for Osteoporosis after Fracture



Papaioannou A, et al. *Osteoporos Int* 2008; 19(4):581-587.

Post-fracture Care Gap: Comparison with Heart Attack



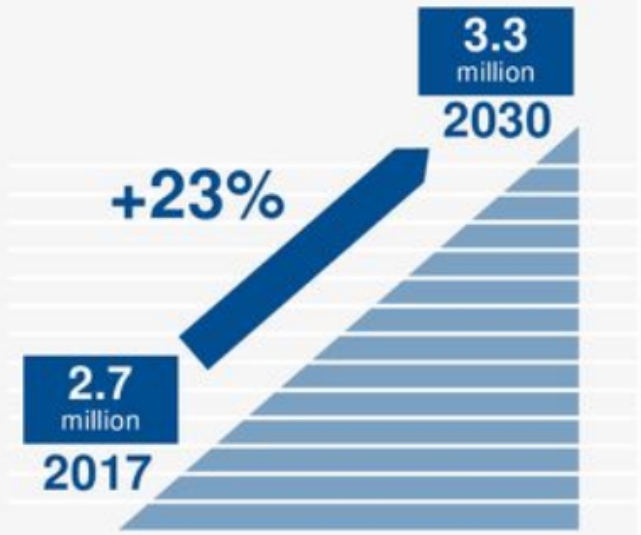
1. Bessette L, et al. *Osteoporos Int* 2008; 19:79-86.
2. Austin PC, et al. *CMAJ* 2008; 179(9):901-908.

Technology and mobility

- Most injuries happen at home or in the community
  - Prevention
    - Example GoPro home inspection
  - Monitoring
    - Falls, Physiologic Status
    - SMART homes
- Most recovery happens at home
  - Remote monitoring
  - Remote treatment from consultation, to surgery to rehab
- NOT ENOUGH $ FOR IN-HOSPITAL CARE

WITH THE AGEING OF THE POPULATION, THE BURDEN OF FRAGILITY FRACTURES WILL INCREASE

Incidence of fragility fractures[9]



Fracture-related costs[9]

The greatest increases in costs are expected to be seen in:[9]

Spain **(30.6%)**

The UK **(30.2%)**

Broken bones, broken lives: A roadmap to solve the fragility fracture crisis in Europe

Collaboration is the key to success