UPDATES IN FOOTWEAR SAFETY

Yue Li, PhD

Pouya Ahmadian, Wayne Cheng, Sanja Hulec, Nidhi Patel, Kayla Morrone, Benjamin Leaker, Danny Cen, Bagheri Zahra, Prasann Pandya, Melnard De Leon, Gordon Wong, Roger Montgomery, Susan Gorski, Barry Westhead, Geoff Fernie

iDAPT, Toronto Rehabilitation Institute - University Health Network

Annual End Falls This Fall Conference, October 3, 2017
<table>
<thead>
<tr>
<th>TORONTO REHABILITATION INSTITUTE - UNIVERSITY HEALTH NETWORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiopulmonary Exercise Technician</td>
</tr>
<tr>
<td>Chiropodists:</td>
</tr>
<tr>
<td>Communication Disorders Assistants</td>
</tr>
<tr>
<td>Dental Hygienists</td>
</tr>
<tr>
<td>Dietitians/Diet Technicians:</td>
</tr>
<tr>
<td>Exercise Leaders</td>
</tr>
<tr>
<td>Nurses</td>
</tr>
<tr>
<td>Occupational Therapists/OT Assistants</td>
</tr>
<tr>
<td>Pharmacists/Pharmacy Technicians</td>
</tr>
<tr>
<td>Psychiatrists</td>
</tr>
</tbody>
</table>
RESEARCH @ TRI-UHN

#1 Rehab Research Centre in the world

$26M Research Awards for 2017

44 Scientists

227 Graduate Students and Post-Doctoral Fellows

Over 449 Publications
11 TEAMS
1. Acquired Brain Injury & Society
2. Cardiorespiratory Fitness
3. Sleep Science
4. Mobility
5. Neural Engineering & Therapeutics
6. Swallowing Science
7. Brain Discovery & Recovery
8. Communication
9. Home, Community & Institutional Environments
10. Artificial Intelligence & Robotics for Rehabilitation
11. Optimization of Rehabilitation Systems

DAILY MISSION
- Scientific Research Performance & Standards
- Academic Development, Guidance & Mentorship
- Laboratories & Workshops
- Operations & Business Development

STRATEGIC THEMES
1. Preventing Illnesses & Accidents
2. Restoring Function
3. Enabling Independence

OUTCOMES
- Policies & Standards
- Treatments
- Products & Services
OUR STATE-OF-THE-ART FACILITIES
FOOTWEAR RESEARCH @ TRI-UHN

STRATEGIC THEMES
1. Preventing Illnesses & Accidents
2. Restoring Function
3. Enabling Independence

OUTCOMES
- Policies & Standards
- Treatments
- Products & Services
SLIPS AND FALLS ON ICE

https://www.youtube.com/watch?v=WDCwMfUhv24
THE PROBLEM
- Global

4,071 Deaths due to falls, Canada, 2010

THE PROBLEM - Canada

• 16% of fall-related injury among age 65+ during 2009/10 was due to walking on snow or ice and represented 41,091 seniors (Government of Canada, P.H.A. of C., 2014. Seniors’ Falls in Canada: Second Report - Public Health Agency of Canada)

• Falls were the leading cause of overall injury costs in Canada in 2010, accounting for $8.7 billion or 32% of total costs.

• Falls on ice or snow could result in an injury cost of $1.4 billion. (Parachute. (2015). The Cost of Injury in Canada. Parachute: Toronto, ON)
THE PROBLEM
- Ontario

<table>
<thead>
<tr>
<th>HOW RESPONDENT FELL: who reported an injury due to a fall that occurred in the past 12 months that was serious enough to limit normal activities</th>
<th>ONTARIO 2000/2001</th>
<th>ONTARIO 2003</th>
<th>ONTARIO 2005</th>
<th>ONTARIO 2009/2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>While skating, skiing, snowboarding, in-line skating or skateboarding</td>
<td>66,000</td>
<td>73,200</td>
<td>70,700</td>
<td>N/A</td>
</tr>
<tr>
<td>While skating, skiing or snowboarding</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>87,900</td>
</tr>
<tr>
<td>While engaged in other sport or physical activity (including school activities or running)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>148,400</td>
</tr>
<tr>
<td>Going up or down stairs/steps (icy or not)</td>
<td>50,700</td>
<td>50,300</td>
<td>61,100</td>
<td>60,400</td>
</tr>
<tr>
<td><strong>Slip, trip or stumble on ice or snow</strong></td>
<td><strong>63,800</strong></td>
<td><strong>77,200</strong></td>
<td><strong>80,100</strong></td>
<td><strong>71,000</strong></td>
</tr>
<tr>
<td>Slip, trip or stumble on any other surface</td>
<td>225,400</td>
<td>214,500</td>
<td>187,300</td>
<td>190,600</td>
</tr>
<tr>
<td>From furniture (e.g. bed, chair)</td>
<td>14,400</td>
<td>11,200</td>
<td>8,100</td>
<td>11,900</td>
</tr>
<tr>
<td>From elevated position (e.g. ladder, tree)</td>
<td>50,800</td>
<td>53,300</td>
<td>29,300</td>
<td>29,900</td>
</tr>
<tr>
<td>Due to health problems (e.g. faint, weakness, dizziness, hip/knee gave out, seizure)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>15,900</td>
</tr>
<tr>
<td>Other</td>
<td>15,600</td>
<td>42,300</td>
<td>140,100</td>
<td>38,300</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>486,600</strong></td>
<td><strong>522,000</strong></td>
<td><strong>576,800</strong></td>
<td><strong>654,300</strong></td>
</tr>
</tbody>
</table>

6) Environmental factors
(extrinsic factors: cold climate, lighting, etc.)

5) Human factors
(intrinsic factors)

4) Human gait biomechanics

3) Footwear (sole)/ice interaction
(tribophysics)

2) Icy and snowy surfaces

1) Footwear

THE CHOICE
Maximum Achievable Angle Test

Winterlab & single-axis platform

General Specifications:
Tilt: 0 to 15 deg
Max Payload: 15,500 lbs
Max speed: 0.5 deg/s
Max accel: 0.085 deg/s^2
Total time to ramp to maximum speed and tilt 15 degs = 33 secs
### Why 7°

<table>
<thead>
<tr>
<th>Maximum Slope (ratio)</th>
<th>Maximum Slope (%)</th>
<th>Maximum Slope (angle)</th>
<th>Maximum Length (m)</th>
<th>Maximum Rise (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:20</td>
<td>5%</td>
<td>2.9°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:16</td>
<td>6%</td>
<td>3.6°</td>
<td>8.00</td>
<td>0.50</td>
</tr>
<tr>
<td>1:14</td>
<td>7%</td>
<td>4.1°</td>
<td>5.00</td>
<td>0.35</td>
</tr>
<tr>
<td>1:12</td>
<td>8%</td>
<td>4.8°</td>
<td>2.00</td>
<td>0.15</td>
</tr>
<tr>
<td>1:10</td>
<td>10%</td>
<td>5.7°</td>
<td>1.25</td>
<td>0.12</td>
</tr>
<tr>
<td>1:08</td>
<td>13%</td>
<td>7.1°</td>
<td>0.50</td>
<td>0.06</td>
</tr>
</tbody>
</table>

--- Ramp?
THE RESULTS - 2016
The results have been published on www.ratemytreads.com for the first time, consumers will have winter slip resistance ratings available when they purchase winter footwear.

<table>
<thead>
<tr>
<th>RANK</th>
<th>CASUAL BOOT</th>
<th>NAME</th>
<th>RATINGS</th>
<th>MAA SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SPERRY MEN'S COLD BAY VIBRAM ARCTIC GRIP BOOT</td>
<td>🚬 🚬 🚬</td>
<td></td>
<td>10.0</td>
</tr>
<tr>
<td>2</td>
<td>CATERPILLAR STICTION HIKER ICE+ WATERPROOF TX BOOT</td>
<td>🚬 🚬 🚬</td>
<td></td>
<td>9.0</td>
</tr>
<tr>
<td>3</td>
<td>SPERRY WOMEN'S POWDER VALLEY ARCTIC GRIP WINTER BOOTS</td>
<td>🚬 🚬 🚬</td>
<td></td>
<td>9.0</td>
</tr>
<tr>
<td>4</td>
<td>WINDRIVER MEN'S YUKON XL WINTER BOOT</td>
<td>🚬 🚬 🚬</td>
<td></td>
<td>9.0</td>
</tr>
</tbody>
</table>

Walking in the winter can be colder than any other season.
THE LAUNCH

OVER 200 INTERNATIONAL MEDIA HITS!
THE STATISTICS

Number of Hits

Number of Visits
THE TESTIMONIALS

“Congratulations to the TO Rehabilitation Institute for conducting a review of winter boots and their safety efficacy. This is brilliant.” – Nadia R., Nov 2016

“I am so happy to hear that your group is rating boots for slipping! I love to walk but, as I age, have come to fear winter walking. In part this is because I can’t trust my boots! So glad to hear that someone is finally taking safety on!” – Marjorie C., Nov 2016

“Great and practical research topic for Canada... I hope that manufacturers will use your facility to test materials during the design phase.” – Alrick H., Nov 2016

“Hi -- I came across your ratings and want to thank you for telling me about Sperry arctic grip boots. I'm an older woman with osteoporosis and very afraid of slipping when I walk the dogs.” – Toby F., Salt Spring Island, BC
THE RESULTS - 2017
EVALUATE FOOTWEAR IN THE FIELD

http://710keel.com/winter-weather-arrives-in-shreveport-bossier/
FIRST ARTIFICIAL NEURAL NETWORK SET

First ANN set

Raw Force Data

Segmented Force Data

Segmented Velocity Data
SECOND ARTIFICIAL NEURAL NETWORK SET

Segmented Velocity Data

Second ANN set

Heel Slip

Toe Slip

Normal
WINTER FOOTWEAR EVALUATION PROGRAM

- Systematically study footwear slip resistance properties on ice and snow
- Develop informative product labeling and have it adopted by retailers
- Launch an easily understood website to help consumers choose safer winter footwear
- Further validate the MMA method
- Implement the MAA method as a standard
JOIN US!

BOGS

Columbia

ICEBUG

KEEN

KODIAK

Mark's

Vibram
SLIPS AND FALLS IN BATHROOM
>235,000 people over age 15 visit ER due to injuries suffered in the bathroom every year in USA

https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6022a1.htm
## THE PROBLEM

<table>
<thead>
<tr>
<th>Hazards</th>
<th>n</th>
<th>%</th>
<th>Average number per house</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enumerable hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All steps</td>
<td>2,008</td>
<td>79.4 of houses</td>
<td>4.44</td>
</tr>
<tr>
<td>All rugs/mats</td>
<td>6,430</td>
<td>100 of houses</td>
<td>14.23</td>
</tr>
<tr>
<td><strong>Rooms with hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cords</td>
<td>742</td>
<td>9.0 of all rooms</td>
<td>1.64</td>
</tr>
<tr>
<td>Floor conditions unsafe</td>
<td>202</td>
<td>2.5 of all rooms</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Slippery floors (dry)</strong></td>
<td>2,797</td>
<td>34.5 of all rooms</td>
<td>6.19</td>
</tr>
<tr>
<td>Lighting deficient</td>
<td>937</td>
<td>11.6 of all rooms</td>
<td>2.07</td>
</tr>
<tr>
<td>Obstacles</td>
<td>448</td>
<td>5.5 of all rooms</td>
<td>0.99</td>
</tr>
<tr>
<td>Stepovers*</td>
<td>3,129</td>
<td>38.6 of all rooms</td>
<td>6.92</td>
</tr>
<tr>
<td><strong>Bathroom floor slippery when wet</strong></td>
<td>551</td>
<td>96.7 of all rooms</td>
<td>1.22</td>
</tr>
<tr>
<td><strong>Safety of specific furniture and fixtures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed height</td>
<td>66</td>
<td>11.6 of subjects</td>
<td>0.15</td>
</tr>
<tr>
<td>Chair safety</td>
<td>378</td>
<td>66.3 of subjects</td>
<td>0.84</td>
</tr>
<tr>
<td>Toilet height</td>
<td>40</td>
<td>7.0 of subjects</td>
<td>0.09</td>
</tr>
</tbody>
</table>

THE SOLUTION

- ENVIRONMENTAL MODIFICATIONS
  - putting non-slip strips in the tub or shower
  - adding grab bars inside and outside the tub or shower to reduce falls
  - installing grab bars next to the toilet
  - changing to non-slip flooring surfaces
  - ...

- INCREASING AWARENESS OF POTENTIALLY HAZARDOUS ACTIVITIES IN THE BATHROOM

  Develop standards to test those products
TESTING PLAN

WALKING WITH DIFFERENT INDOOR SHOES
• AS 4586-2013 Inclining Platform Test
• MAA (Maximum Achievable Angle) Test

PARTICIPANTS
• 10 young (20 to 30 year old)
• 10 older (60 to 70 year old)

SURFACES
• 4 ASTM F2508 - 16 reference surfaces
• 1 profiled tile surface
FALL PREVENTION MONTH

- **How to address winter fall risk** – Yue Li, PhD, TRI
- **Vision decline and falls** – Alison Novak, PhD, Scientist, TRI
- **Hearing loss and falls** – Sin Tung Lau, TRI
- **Diabetes and falls** – Patrick Antonio, MSc, TRI
- **Spinal cord injury and falls** – Kristin Musselman, PT PhD, Scientist, TRI
- **Why keeping active is as important as preventing falls** – Tilak Dutta, PhD, Scientist, TRI
- **COPD and risk for falls** – Marla Beauchamp, PT, PhD, Scientist, and Sachi O’Hoski, PT, West Park Healthcare Centre
- **Using moving platforms to study balance** – Hilary Whiting, BSc, TRI
- **Depression and falls** – Andrea Iaboni, MD DPhil FRCPC, Geriatric Psychiatrist, Assistant Professor, UofT, TRI
- **Exercise to reduce fall risk** – Avril Mansfield, PhD, Scientist, TRI
- **A portable balance assessment tool** – Anton Trinh, MSc, University of Waterloo
- **Medication and balance** – Andrea Iaboni, MD DPhil FRCPC, Geriatric Psychiatrist, Assistant Professor, UofT, TRI
- **Preventing falls on a hospital unit** – Monique Kroeker, PT, and Andrea Featherstone, OT, Toronto Western Hospital
- **How stair design can reduce falls** – Alison Novak, PhD, Scientist, TRI
- **A tool for encouraging hand rail use** – Simon Jones, MSc. P.Eng, Communications Specialist, TRI
- **The best handrail designs to prevent falls on stairs** – Vicki Komisar, MSc, PhD candidate, & Philippa Gosine, BEng, TRI
- **Bathroom safety** *1 hour webinar, 12:00-1:00* – Alison Novak, PhD, Scientist, TRI & Emily King, MASc, PhD candidate, TRI
- **How to set up your home to prevent falls while staying active** – Vicki Komisar, MSc, PhD candidate, TRI
- **Tips from an OT & PT to reduce fall risk** – Amanda Longfield, OT, and Carmen Carmazan, PT, Saint Elizabeth
THANK YOU!

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