Hip Protectors: How to Make Them Work in Your Facility

Dr. Fabio Feldman
Manager, Seniors Falls and Injury Prevention, Fraser Health Authority
Adjunct Professor, Simon Fraser University

Dr. Vicky Scott
Senior Advisor, BC Injury Research and Prevention Unit
BC Ministry of Health Services

Dr. Stephen Robinovitch
Professor and Canada Research Chair
Simon Fraser University
Vicky Scott, Ph.D.
Senior Advisor for Falls & Injury Prevention, British Columbia Injury and Research and Prevention Unit and Office of Injury Prevention - Ministry of Health, Victoria, BC
Hip Fractures among Canadian Seniors

Over 26,000 Canadians aged 65+ fractured their hip in 2010

% of hip fractures are caused by falls

Annual health care cost = over $1 Billion

Numbers and related costs will increase as our population ages
Population 65+, Canada (projected)

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<thead>
<tr>
<th>Year</th>
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<tr>
<td>2001</td>
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<td>2061</td>
<td>25.5%</td>
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</table>
Those at Greatest Risk

• Those at greatest risk for falls and hip fractures are residents of long term care facilities

• Although only 7% of adults aged 65 and over live in residential care, this group accounts for more than 25% of all hip fractures due to falls, and an estimated $250 million in annual medical costs
Hip fractures in long-term care

• 30 to 50% fall annually
• 40% experience recurrent falls
• Account for 52% of all fall-related hospital admissions
• Less than 15% regain pre-injury physical function
Residents especially susceptible

4 to 10.5 times more likely to fracture a hip due to:

- Poor cognition
- Frailty
- Inadequate protective responses
Hip Protectors (HP)

• wearable pad or shield typically embedded in an undergarment or pant
• reduces fracture risk by attenuating the force applied to the proximal femur at impact
• “active” form of injury prevention; site-specific
• effectiveness depends on acceptance and adherence among users in wearing the device, and biomechanical performance of the device
CADTH Review of Hip Protectors in LTC

WHAT ARE HIP PROTECTORS?
- Hip protectors are garment-like undergarments with pockets for protective pads that protect the hips in the case of a fall.
- The pads can be made in fabric or "soft-shell" material.
- In the event of a fall, the pads absorb or disperse the force away from the hip.

KEY MESSAGES
1. Hip protectors should be considered as one element of effective institutional, regional, or provincial/territorial injury prevention strategies for seniors in long-term care facilities.
2. Hip protectors benefit some long-term care residents more than others. Specific criteria should be applied to determine which seniors would benefit most (e.g., residents with previous falls or fractures, multiple co-morbid conditions, cognitive impairment, women over 70, and where hip protectors will not greatly interfere with activities of daily living).
3. Long-term care staff and caregivers need to work closely with long-term care residents and their families to determine which type of hip protector best suits the needs of the resident. The preference of the resident must be considered.
4. To allow for consistent use by residents in long-term care facilities, an adequate number of hip protectors need to be provided.

www.CADTH.ca/HipProtectors
CADTH Review of Hip Protectors in LTC

- HP are effective in preventing hip fractures in elderly residents of LTC facilities when worn at the time of a fall
- HP can save lives, health care dollars, and improve quality of life
- Information on which HP are more effective could increase the cost-effectiveness
- Typical HP rates of compliance are only about 56%
Challenges

The greatest challenges to a hip protector program are convincing the staff of the benefits and encouraging the resident to wear them.
Two factors primarily determine clinical effectiveness:

- User Compliance
- Biomechanical Effectiveness

Clinical Effectiveness
An overview of clinical and laboratory results for hip protectors

Stephen N. Robinovitch, Ph.D.
Canada Research Chair in Injury Prevention and Mobility Biomechanics
Department of Biomedical Physiology and Kinesiology, and
School of Engineering Science
Simon Fraser University
Conflict of interest statement:

S.N. Robinovitch is a paid consultant to Tytex A/S, manufacturer of the Safehip line of wearable hip protectors.
An overview of results from clinical trials of hip protectors
A. HIP PROTECTOR EFFECTIVENESS (INTENTION-TO-TREAT)

• Gillespie et al. Cochrane-review 2010 & Parker BMJ-review 2006

• * 16 randomized trials included
• * CONCLUSIONS:

• 1. Making hip protectors available to frail older people in nursing care facilities may reduce the risk of fractures (Pooled RR = 0.81, 95%CI: 0.66-0.99)
• 2. Hip protectors are ineffective for community-dwelling older adults (Pooled RR = 1.14, 95%CI: 0.83-1.57)

• 1. The low user compliance in the negative protector trials

  “We may deem the content of the intervention ineffective, when the truth may be that there was only insufficient effort to implement the intervention”

• 2. All kinds of hip protectors were combined into one meta-analysis

  “Since various hip protector models differ considerably by their force attenuation capacity, and probably by their user compliance as well, it is not very rational to combine their results into one analysis” (Kannus P: BMJ e-letters March 15, 2006)
Oliver et al. BMJ meta-analysis 2007. (HIP PROTECTOR EFFECTIVENESS IN CARE HOMES)

• 11 trials included (10 randomized)
• CONCLUSIONS:
• There is some evidence that use of hip protectors in care homes prevents hip fractures (Rate Ratio = 0.67, 95% CI 0.46 0.98)

- only 4 randomized trials included
- CONCLUSIONS:
  - Hip protectors decrease the risk of hip fracture in elderly nursing home residents (pooled Odds Ratio = 0.40, 95% CI 0.25-0.61)
B. HIP PROTECTOR EFFICACY
(RISK OF HIP FRACTURE IN PROTECTED VS. UNPROTECTED FALLS)

- Kannus et al. N Engl J Med 2000 (KPH Hip protector): Adjusted RH = 0.13, 95% CI 0.03-0.50

- Cameron et al. Injury Prev 2003 (Safehip protector): RR = 0.23, 95% CI 0.08-0.67

- Forsen et al. Injury Prev 2004 (Safehip protector): Adjusted OR = 0.31, 95% CI 0.13-0.75
C. HIP PROTECTOR EFFICACY
(RISK OF HIP FRACTURE IN A PROTECTED VS. UNPROTECTED HIP DURING A FALL, THE UNILATERAL HIP PROTECTOR STUDY)

- Kiel et al. JAMA 2007 (Fallgard protector)
- When the residents wore the unilateral hip protector at the time of the hip fracture, there were 13 hip fractures in protected hips vs. 7 fractures in unprotected hips
- Thus, the risk for a hip fracture at the protected side = 13/7 = 1.86 (N.S.)
Problems in Kiel et al. JAMA 2007:

1. Poor biomechanical performance of the Fallgard hip protector. Not assessed independently, withdrawn from the market.

2. Small number of fractures while individuals were wearing the hip protectors (only 32% were >80% compliant).

3. Falls were 3-times more likely to occur on the padded than unpadded side (violates assumptions in analysis).
Summary of clinical findings

• clinical efficacy is established: if worn at the time of a fall, hip protectors reduce fracture risk by 69-83%

• clinical effectiveness (based on intention to treat) is established for frail adults in nursing care facilities (17% reduction in risk), but not for community-dwelling older adults

• poor compliance, and lack of consistency in product selection, are important limitations to meta-analyses examining clinical effectiveness
Biomechanical Testing of Hip Protectors
Biomechanical effectiveness differ across mechanical test systems

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Biomechanical effectiveness measured by mechanical test systems

Robinovitch et al. 1995

Kannus et al. 1999

Derler et al. 2005

van Schoor et al. 2006

Nabhani & Bamford, 2002
Hip protectors: recommendations for biomechanical testing—an international consensus statement (part I)

S. N. Robinovitch · S. L. Evans · J. Minns · A. C. Laing · P. Kannus · P. A. Cripton · S. Derler · S. J. Birge · D. Plant · I. D. Cameron · D. P. Kiel · J. Howland · K. Khan · J. B. Lauritzen

Table 2 Recommended design parameters of biomechanical test systems for measuring the force attenuation provided by hip protectors

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RECOMMENDED VALUE OR TYPE</th>
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<tbody>
<tr>
<td>Basic design</td>
<td>Impact pendulum or drop tower</td>
</tr>
<tr>
<td>Effective (drop) mass</td>
<td>28 kg (acceptable range, 22-33 kg)</td>
</tr>
<tr>
<td>Effective pelvic stiffness</td>
<td>47 kN/m (acceptable range, 39–55 kN/m)</td>
</tr>
<tr>
<td>Soft tissue covering</td>
<td>Polyethylene or polyurethane foam rubber⁴</td>
</tr>
<tr>
<td>Minimal thickness of soft tissue covering over the greater trochanter</td>
<td>18 mm</td>
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<tr>
<td>Impact velocity</td>
<td>3.4 m/s⁵</td>
</tr>
<tr>
<td>Peak compressive force in unpadded case</td>
<td>3.5-4.5 kN⁶</td>
</tr>
<tr>
<td>Time to peak compressive force in unpadded case</td>
<td>30-50 ms</td>
</tr>
<tr>
<td>Filtering of force signals</td>
<td>Low pass recursive, cut off frequency = 50 Hz</td>
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</table>

Notes:

⁴ The anatomy and surface geometry of the pelvic model should mimic the pelvic anatomy of older adults.
⁵ Impact velocities of 2 m/s and 4.5 m/s can be used to simulate a soft fall and a more severe fall, respectively. Peak force will scale accordingly.
⁶ It is likely that in severe sideways falls of tall individuals, or in falls from considerably greater than standing height (e.g., down stairs), the peak force applied to the proximal femur will exceed 4.5 kN. However, the group’s philosophy was to assess the protective value of hip protectors when worn by a typical older woman, falling from standing height.
Impact force ($F$) depends on contact velocity ($u$), effective mass ($m$), and effective stiffness ($k^*$)

\[ F \sim u \sqrt{mk^*} \]

\[ k^* = \frac{kk_f}{k + k_f} \]
Test system must be “biofidelic” to correctly accurately estimate protective value

\[
\begin{align*}
\text{peak force (N)} & = 6000, 4000, 2000, 0 \\
\text{impact velocity} & = 3 \text{ m/s} \\
\text{mean fracture force} & = 3472 \text{ N (SD=1534)} \\
\text{hip protectors stiffness } k_f & \text{(kN/m)}
\end{align*}
\]
“Pelvis release experiments” measure the effective mass, stiffness, and damping of the body during impact to the hip.

Average values:

\[ m = 34.5 \pm 11.2 \text{ kg} \]
\[ k = 40.2 \pm 16.1 \text{ kN/m} \]
\[ b = 640 \pm 408 \text{ N-s/m} \]
Simon Fraser University Hip Impact Simulator

Source: Laing and Robinovitch, ASME J Biomech Eng, 2008

N = 15
BMI = 23.6 ± 2.1 kg/m²
Age = 77.5 ± 8.5 yrs

Source: Laing and Robinovitch, ASME J Biomech Eng, 2008
Measuring the biomechanical effectiveness of 26 available hip protectors

Source: Laing et al., J Biomechanics, 2011
Geometric and material properties influence force attenuation

- force attenuation ranged from 40% (HipEase) to 2% (Impactwear®)

- shell type (hard versus soft) did not associate with performance - best performance from two soft shell (HipEase, Pelican Soft) and two hard shell products (KPH®, HIPS)

- hip protector used in a recent clinical trial (“Fallguard,” Kiel et al., JAMA, 2007) ranked in the bottom quartile in our tests
Effect of hip protector placement on force attenuation

Percent attenuation in peak femoral force relative to the unpadded condition
Hip protectors reduce peak pressure twice as much in low as high BMI individuals

Source: Choi et al., Clinical Biomechanics, 2010
Some hip protectors do not cover the greater trochanter

Figure 2. Position of the GT marker on the top row-hard shells (from left to right): Remploys Caresse, FallGuard, KPH, SafeHip. Bottom row-soft pads (from left to right) HipShield, HipSaver, PoseyHipsders, Lyds, Sanavida.

Source: Minns et al., Age and Ageing, 2007
Summary of biomechanical test results

- wide range of performance among available hip protectors (force attenuation between 2-40%)
- soft shell and hard shell perform equally well
- force attenuation increases with product thickness and surface area
- poor-fitting or displaced products are problematic
- hip protectors provide more protection for low BMI than high BMI individuals
- testing standards are being developed to support market regulation
Acknowledgements

• Fabio Feldman, Ph.D.
• Andrew Laing, Ph.D.
• Joseph Choi, PT, M.Sc.
• Priyanka Deshmukh, B.A.Sc.
• Colin Russell, M.A.Sc.
• Jimmy Tsai, M.A.Sc.
• Dawn Mackey, Ph.D.

Funding:
CIHR
NSERC
MSFHR
CFI
Tytex A/S
Systematic Review

Barriers and facilitators to hip protector compliance

Fabio Feldman, Ph.D.
Manager, Seniors Falls and Injury Prevention, Fraser Health, BC
Adjunct Professor, Department of Biomedical Physiology and Kinesiology, Simon Fraser University
“The effect of hip protectors is obviously linked to where the protector is, whether it is on the hip or in the drawer.”

(Ekman et al. 1997)
Definitions

Acceptance
Defined as the percentage of potential users who initially agree to wear hip protectors

Adherence
Defined as the percentage of time that hip protectors are worn by study participants in accordance with the study recommendations
Overall Study Objectives

1. Synthesize available research evidence
2. Interpret the findings to identify the best strategies
3. Package and disseminate the findings
Selection of Studies

• Studies focusing specifically on hip protectors as an intervention or part of multi-factorial intervention or thematic subgroup

• Outcomes: acceptance and adherence

• Participants: older adults 65 years and over, family caregivers, or health care professionals
Literature Search Results

Unique abstracts identified through database search (n=1085)

Studies included for more detailed evaluation (n=202)

Studies included for full text review (n=111)

Studies meeting criteria from all settings (n=42)

Studies included in systematic review (n=26)

Studies excluded for obvious inclusion/exclusion criteria (n=883)

Studies excluded for being opinion articles (n=91)

Studies excluded for not having compliance data as primary or secondary outcomes (n=71)

Studies excluded for not being in a LTC setting (n=16)
   11: community setting
   5: acute care setting
<table>
<thead>
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<th>Categories of evidence</th>
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<tbody>
<tr>
<td>6</td>
<td>Class I</td>
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<td>Evidence from at least one randomized controlled trial or a meta-analysis of randomised controlled trials.</td>
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<td>2</td>
<td>Class II</td>
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<td>Evidence from at least one controlled study without randomisation or evidence from at least one other type of quasi-experimental study.</td>
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<td>16</td>
<td>Class III</td>
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<td>Evidence from non-experimental studies, such as comparative studies, correlation studies and case-control studies.</td>
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<tr>
<td>2</td>
<td>Class IV</td>
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<tr>
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<td>Evidence from expert committee reports or opinions and/or clinical experience of respected authorities.</td>
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Findings

• Acceptance rates:
  – ranged from 37% to 85%

• Adherence rates
  – ranged from 11% to 93%

• Measures of acceptance and adherence are not standardized
Findings

Factors influencing hip protector acceptance and adherence occurred at 4 different levels:

• Organizational-level characteristics
• Staff-level characteristics
• Resident-level characteristics
• Hip protector-level characteristics
Organizational-level characteristics

Facilitators

- organizational commitment
- enthusiastic leadership
- dedicated champion
- positive reinforcement of staff
- professional training
Organizational-level characteristics

Barriers

• lack of physician referral for hip protector use
• high turnover among managerial staff
• high turnover among front line staff
Staff-level characteristics

Facilitators

• positive attitudes, motivation and commitment towards hip protectors

• knowledge among staff of the benefits of hip protectors
Staff-level characteristics

Barriers

• poor understanding of hip protectors purpose and effectiveness

• inability to communicate with cognitively impaired residents

• increase workload
Hip protectors cannot prevent fracture in all circumstances:

- use of hip protectors with poor biomechanical performance
- incorrect placement
- very week bones
- impact other then directly to the hip
- spontaneous fractures without obvious impact
Resident-level characteristics

Facilitators

• highest association among residents with:
  – high dependency or cognitive limitations
  – high risk for falls or prior history of falls and fractures
  – urinary incontinence
  – diagnosis of osteoporosis, hypertension and Parkinson’s disease

• knowledge about the benefits of hip protectors

• support from family members or other residents
Resident-level characteristics

Barriers

• lack of insight in the usefulness of hip protectors
• fatalistic view of life
• poor understanding of fracture risk
• deteriorating health resulting in non-ambulatory status
• depression/mood symptoms
• difficulty putting on/off
Hip Protector-level characteristics

Facilitators

• ease of use by staff
• laundering process
• variety of models
• soft pad hip protector (higher adherence over 24 hours)
Hip Protector-level characteristics

Barriers

- discomfort
- style and appearance
- unwanted side effects
  - pain/swelling
  - soreness
  - itchiness
  - heat
Key messages

✓ Organizational commitment
✓ Dedicated champion to motivate, mentor, and monitor
✓ Involve everyone responsible for resident safety
✓ Staff education of the benefits and correct use
✓ Engage and educate residents and families
✓ Choose from hip protector models with proven efficacy
✓ Put in place protocols for ensuring adequate supply, variety of models, correct fit, and laundering
Future research priority

• Impact of cost on hip protector acceptance

• Staff education

• Success vs. Fail

• New designs of hip protector pads and garments
The Bottom Line

• Hip protectors **are effective** for those in LTC facilities

• Not all hip protectors are equally effective

• User compliance heavily influences their clinical effectiveness

• Many actions can be taken in LTC facilities to enhance compliance
Acknowledgements

**Research Team:**
Fabio Feldman, PhD
Vicky Scott, PhD
Michael Wasdell
Alex Korall
Roslyn Gillan
Donna Ross
Tracey Thompson-Franson
Pet-Ming Leung
Lisa Lin

**Special Thank you:**
Barbara Greenwood Dufour
Ann Vosilla
Crystal Stranaghan
Izabela Bzymek

Project supported by a grant from the Canadian Institute for Health Research (KRS-102080)

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