A Serious Side of Gravity: Preventing Falls and Fall-Related Injuries

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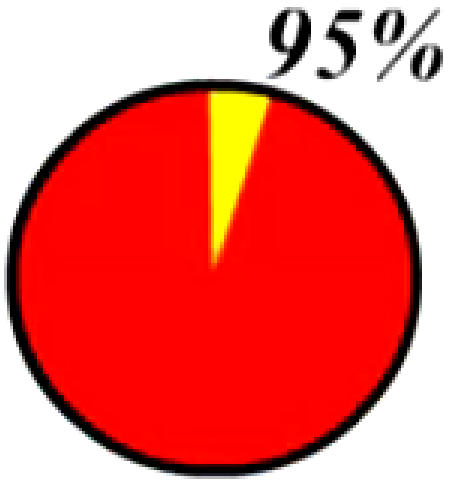
Size of the Problem

- **For 65+ populations, falls are responsible for:**
  - **60** % of all injury-related deaths
  - **84** % of all injury-related hospitalizations
  - 38 % of hospital admissions related to falls are for **hip fractures**
  - 1 in **4** older adults hospitalized for hip fractures die within the first year.
  - 90% of traumatic brain injuries (TBI). **50** % of all injury related death are due to TBI.

Hip Fractures among Canadian Seniors

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

% of hip fractures are caused by falls



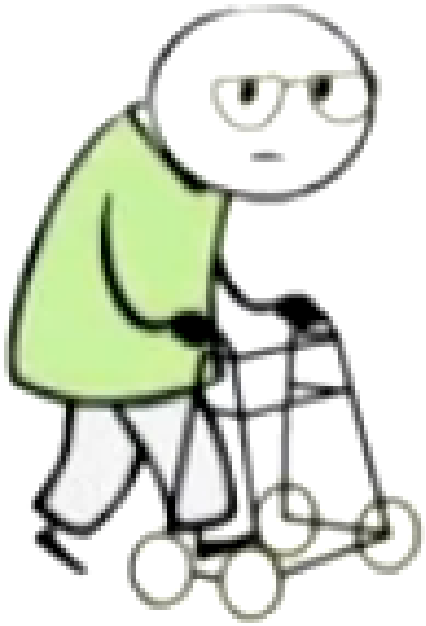
Annual health care cost = over $1 Billion

Numbers and related costs will increase as our population ages

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

technology for injury prevention in seniors

tips

CIHR IRSC

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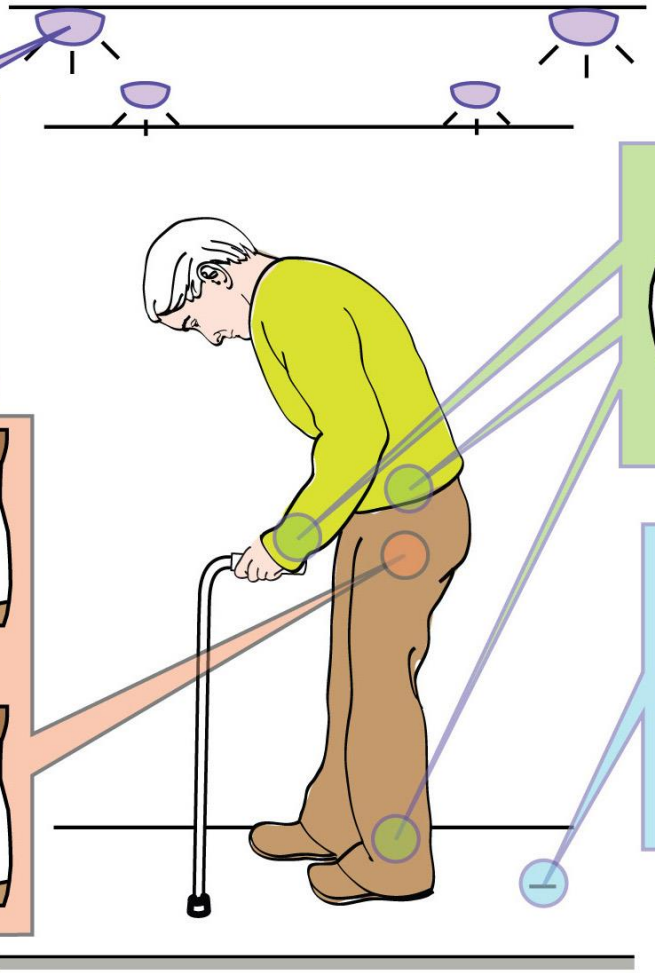
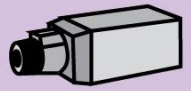
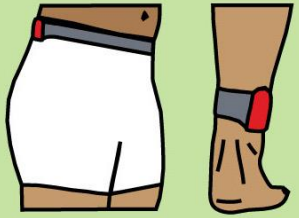


Video capture of falls

- 270 cameras in common areas
- capture 160 falls per year
- cause and circumstances of falls and fall injuries
- real-time evaluation of interventions



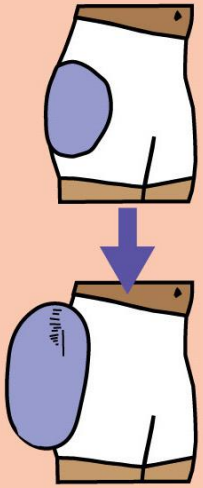
Wearable fall sensors



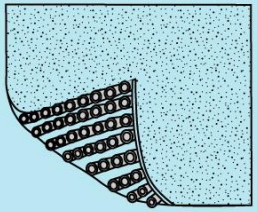
- unobtrusive
- occurrence, cause, and circumstances of falls, regardless of where they occur
- information logged or transmit wirelessly to care providers
- real-time evaluation of interventions

Next-generation hip protectors

- integrated into pant, skirt, or undergarment
- incorporate airbags activated by fall sensor
- attenuate impact force by 95% (four times more than existing devices)
- low profile during normal wear
- sensors monitor adherence in wearing device, positioning, impact occurrence



Compliant flooring



- passive protection (not reliant on user compliance)
- attenuate impact force by 40%
- negligible effect on balance and mobility
- optimised for use in care facilities (hygiene, durability, rolling resistance of wheelchairs)

Collaborators

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Aleks Zecevic, PhD (Western U)
Heather McKay, PhD (CHHM)
Vicky Scott, RN, PhD (BCIRPU)
Ming Leung, PT, MSc (Fraser Health)
Gina Gaspard (Fraser Health)

Video-based recording of the cause and circumstances of falls in long-term care

- To record the cause and circumstances of real-life falls in residential care using networks of video cameras

- To provide insight on the mechanics of injurious versus non-injurious falls, role of bone fragility versus fall severity, etc.

Ethics

- approved by the Office of Research Ethics at Simon Fraser University
- secondary use of video data (owned by facilities)
- removal of facial (identifying) features


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Video capture of the circumstances of falls in elderly people residing in long-term care: an observational study

Stephen N Robinovitch*, Fabio Feldman*, Yijian Yang, Rebecca Schonnop, Pet Ming Lueng, Thiago Sarraf, Joanie Sims-Gould, Marie Loughin

THE LANCET

	Frequency*		Participants falling due to this cause†		Number of falls per participant†	
	Number	Percentage of falls captured	Estimated proportion, % (SE)	95% CI	Estimated count, n (SE)	95% CI
Incorrect transfer or shift of bodyweight	93	41%	51·2% (4·5)	42·5–59·8	0·72 (0·078)	0·59–0·90
Trip or stumble	48	21%	26·0% (3·9)	19·1–34·3	0·35 (0·054)	0·26–0·47
Hit or bump	25	11%	17·3% (3·4)	11·7–25·0	0·19 (0·040)	0·13–0·28
Loss of support with external object	25	11%	18·9% (3·5)	13·0–26·7	0·20 (0·041)	0·13–0·30
Collapse or loss of consciousness	24	11%	16·5% (3·3)	11·0–24·1	0·17 (0·039)	0·11–0·27
Slip	6	3%	4·7% (1·9)	2·1–10·2	0·047 (0·020)	0·021–0·11
Could not tell	6	3%	--	--	--	--

In descending order of frequency. *Of 227 total falls captured. †Of 215 falls analysed, after exclusion of cases for which the faller could not be identified (six), and cases for which the team could not identify the cause of the fall (six).

Table 2: **Estimated proportion of participants falling at least once, and average number of falls per participant, attributable to various causes of falling**

	Number of falls	Percentage*
Trip or stumble *while*		
Walking forward	23	11%
Initiation of walking	9	4%
Walking backward or sideways	6	3%
Incorrect transfer or shifting of bodyweight *while*		
Sitting down or lowering	16	8%
Getting up or rising	13	6%
Walking forward	12	6%
Initiation of walking	11	5%
Walking and turning	9	4%
Standing and turning	8	4%
Walking backward or sideways	7	3%
Standing quietly	7	3%
Standing and reaching	6	3%
Hit or bump *while*		
Standing quietly	10	5%
Collapse or loss of consciousness *while*		
Walking forward	9	4%
Standing quietly	6	3%
Loss of support with external object *while*		
Sitting down or lowering	7	3%
Getting up or rising	6	3%

Causes are shown as main headings in bold text. In descending order of frequency. *Of 212 total falls.

Table 6: **Combinations of cause and activity associated with six or more falls**

CMAJ Medical knowledge that matters

PREVALENCE AND FACTORS ASSOCIATED WITH HEAD IMPACT DURING FALLS IN OLDER ADULTS IN LONG-TERM CARE

Schonnop R., Yang Y., Feldman F., Robinson E. & Robinovitch S.N.

37% of falls caused head impact, unaffected by hand impact (which occurred in 71% of cases)

Explanatory variable	Head impact	No head impact	Probability of head impact (95% CI)	P-value
Initial fall direction [2]				**0.003**
Forward	33	24	0.58 (0.45-0.70)	
Backward	27	51	0.35 (0.25-0.46)	
Sideways	19	40	0.32 (0.21-0.45)	
Straight down	3	18	0.14 (0.05-0.37)	
Landing configuration [3]				**0.009**
Forward	18	16	0.53 (0.36-0.69)	
Backward	33	81	0.29 (0.21-0.38)	
Sideways	31	33	0.48 (0.36-0.61)	
Hand impact [4]				0.17
None	17	33	0.34 (0.22-0.48)	
Right hand/ forearm	19	38	0.33 (0.22-0.47)	
Left hand/ forearm	20	40	0.33 (0.23-0.46)	
Both hands/ forearms	24	22	0.52 (0.38-0.66)	

Head impact more likely in forward falls, no effect of hand impact

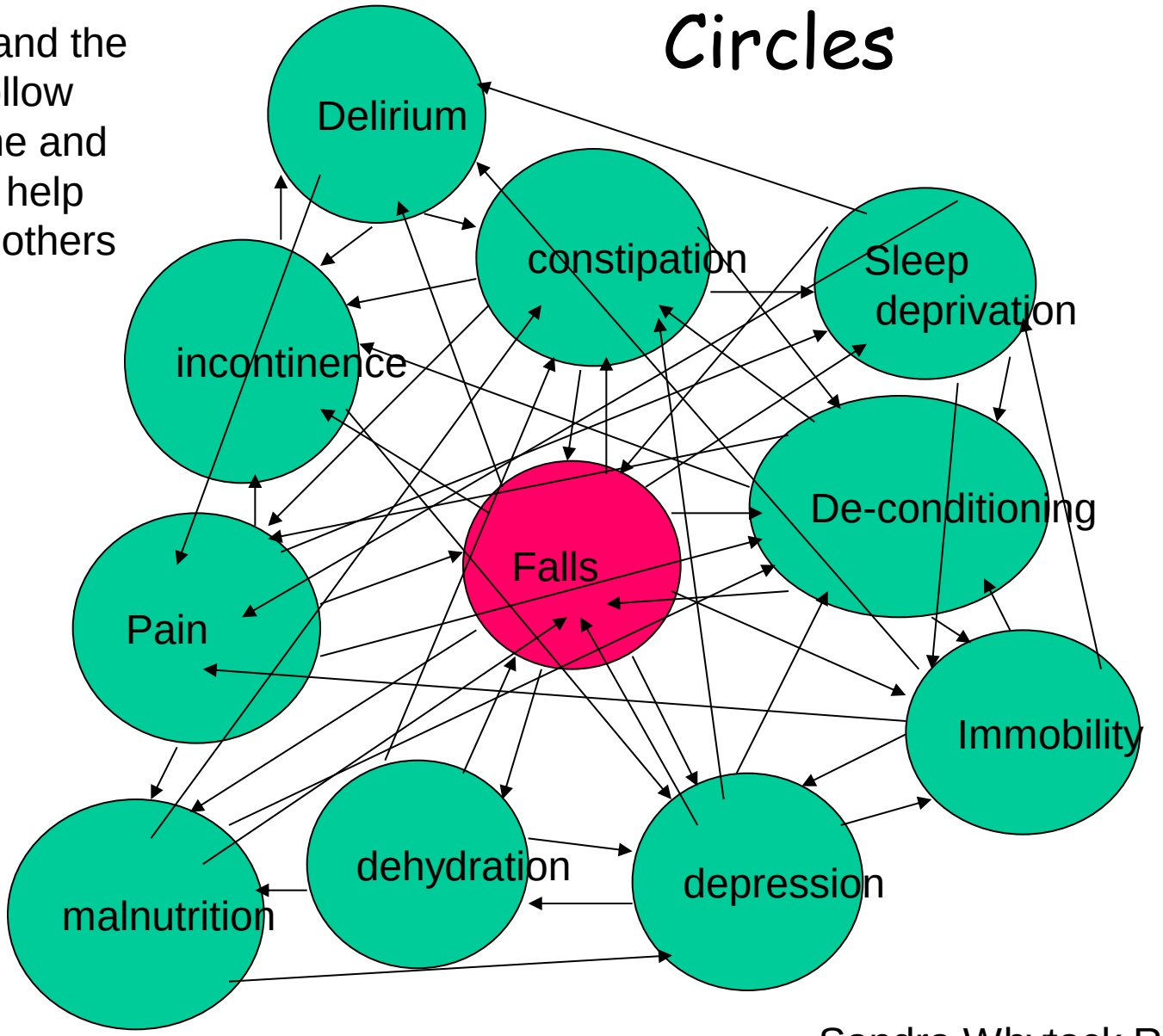
Supporting Knowledge for Injury Prevention in Seniors (SKIPS)

http://www.sfu.ca/tips/research/structured-program-knowledge-exchange/

Geriatric Vicious Circles

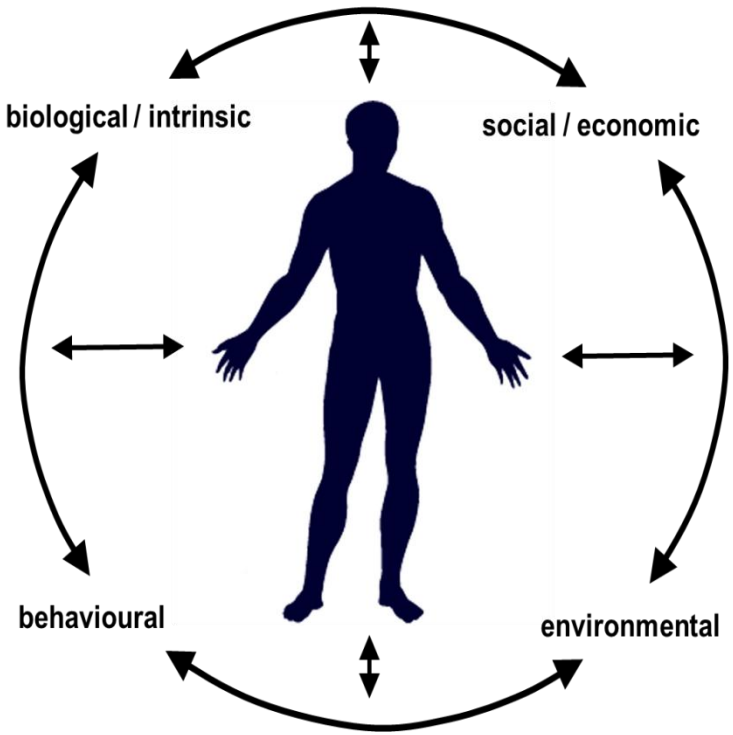
Principles of care:

- Leave one unattended and the others will follow
- Manage one and you will also help manage the others



Sandra Whytock RN MSN

Most Common Risk Factors

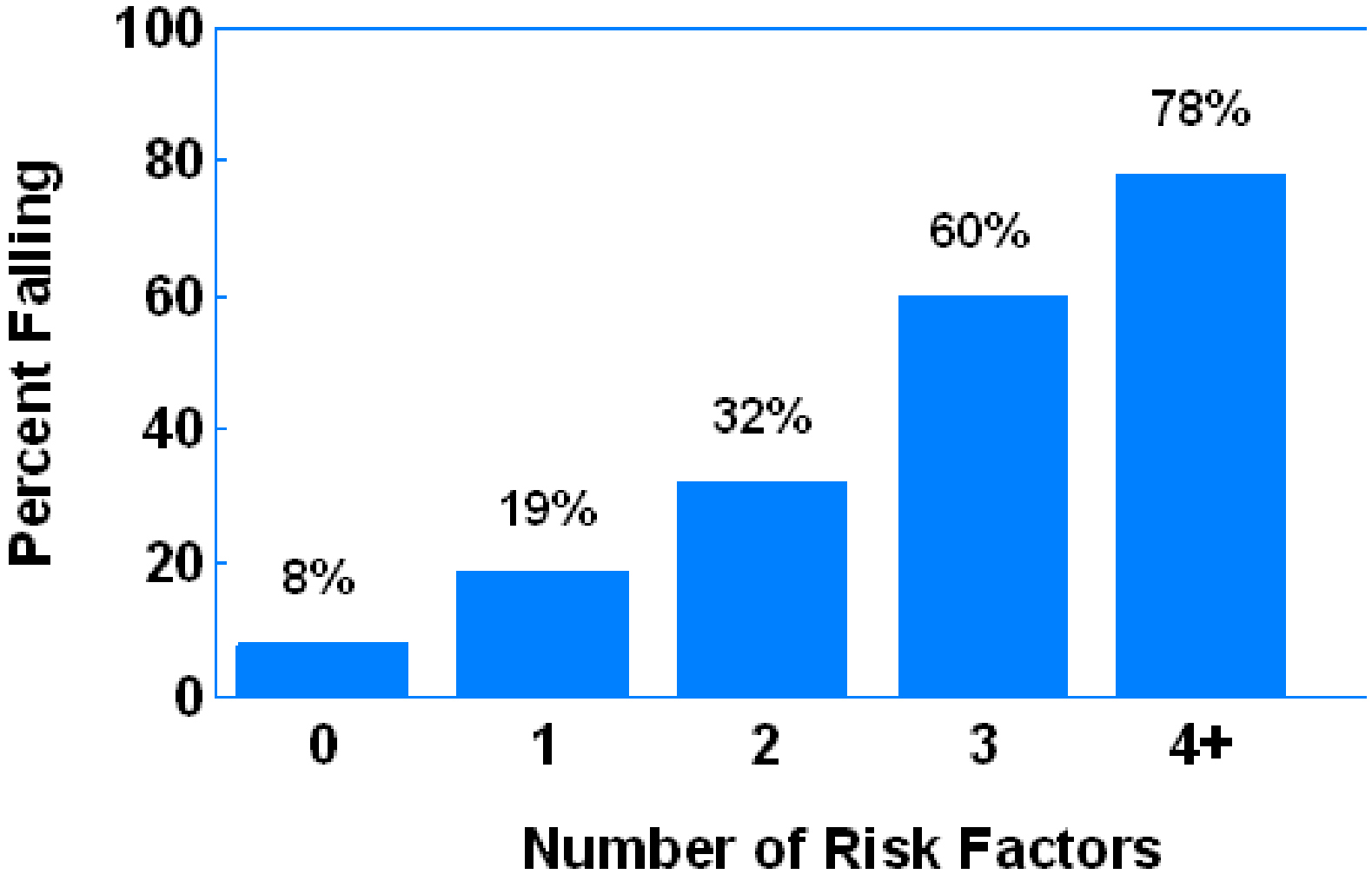


Risk Factor	RR
Muscle Weakness	4.4
History of falls	3.0
Gait deficit	2.9
Balance deficit	2.9
Use assistive device	2.6
Visual deficit	2.5
Arthritis	2.4
Impaired ADL	2.3
Depression	2.2
Cognitive impairment	1.8
Age >80	1.7

Risk factors for falls

- History of falls in the last 6 months
- Impaired balance, mobility, muscle weakness, co-ordination
- Impaired Safety Awareness – lack of insight/judgment
- Risk taking behavior
- Cognitive impairment e.g. memory loss, disorientation, delirium
- Agitation and restlessness
- Sleep disturbance
- Syncope and dizziness
- Use of Restraints
- Fear of falling
- Medication – dosage/recent changes
- Dehydration/malnourishment
- Incontinence/Bowel – urgency and frequency
- Poor proprioception and tactile sensation e.g. feet
- Vision/hearing impairment
- Use of mobility aid/wheelchair
- Footwear – incorrect fit and slip sole
- Poor physical environment

Probability of Having Falls



Understanding the Factors that Influence Clinical Effectiveness of Hip Protectors

An overview of results from clinical trials of hip protectors

A. HIP PROTECTOR EFFECTIVENESS (INTENTION-TO-TREAT)

Parker et al. Cochrane-review 2005 & BMJ-review 2006:

* 14 randomized trials included

* CONCLUSIONS:

  1. In institutions with high rates of hip fracture, the use of hip protectors may help to reduce the risk of hip fracture (Pooled RR = 0.77, 95% CI 0.62-0.97)

  2. Hip protectors are ineffective for community-dwelling older adults

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)

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** (Hornsby Healthy Hip?): RR = 0.23, 95% CI 0.08-0.67)
- **Forsen L et al. Injury Prev 2004** (Safehip): 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)

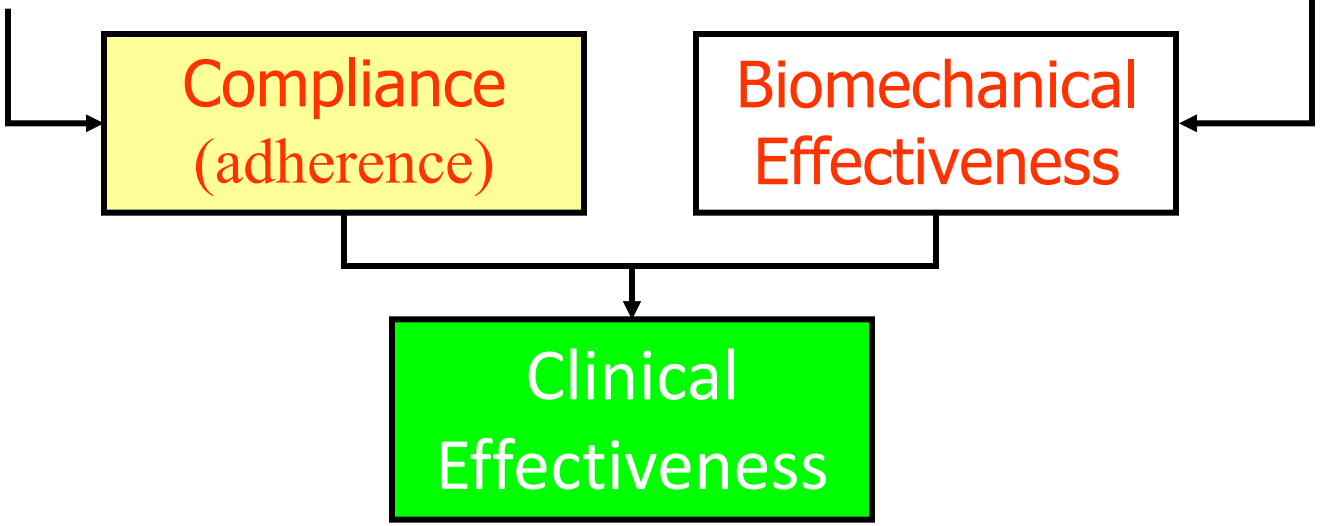
When the residents wore the unilateral hip protector at the time of the hip fracture, there were 13 hip fractures in protected hips vs. 7 fractures in unprotected hips

Thus, the risk for a hip fracture at the protected side = 13/7= 1.86 (N.S.)

Two factors primarily determine clinical effectiveness

- comfort
- appearance
- ease of putting on
- Laundering
- staff commitment

- geometry
- materials
- mis-positioning



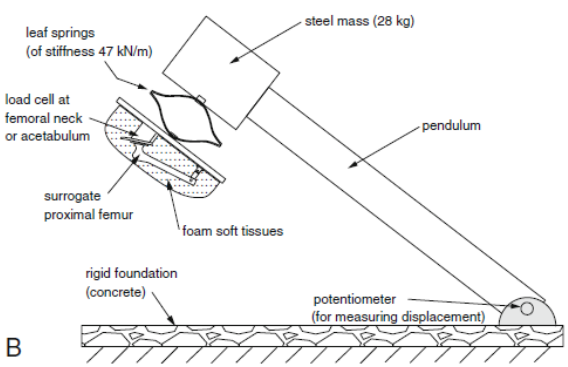
Biomechanical Testing of Hip Protectors

Osteoporos Int
DOI 10.1007/s00198-009-1045-4

CONSENSUS STATEMENT

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

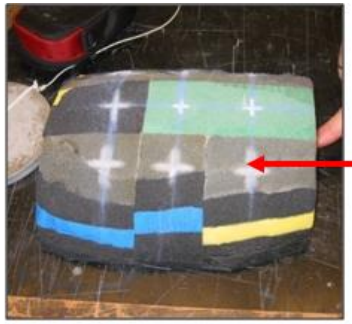


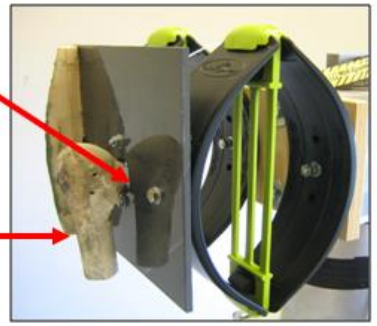
B

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

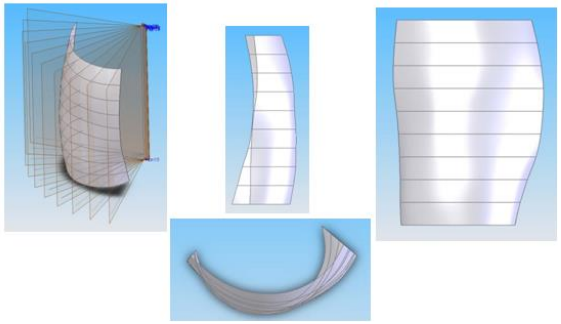
PARAMETER	RECOMMENDED VALUE OR TYPE
Basic design	Impact pendulum or drop tower
Effective (drop) mass	28 kg (acceptable range, 22–33 kg)
Effective pelvic stiffness	47 kN/m (acceptable range, 39–55 kN/m)
Soft tissue covering	Polyethelene or polyurethane foam rubber[a]
Minimal thickness of soft tissue covering over the greater trochanter	18 mm
Impact velocity	3.4 m/s[b]
Peak compressive force in unpadded case	3.5–4.5 kN[c]
Time to peak compressive force in unpadded case	30–50 ms
Filtering of force signals	Low pass recursive, cut off frequency=50 Hz

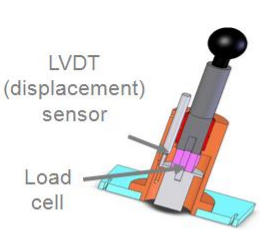
Simon Fraser University Hip Impact Simulator

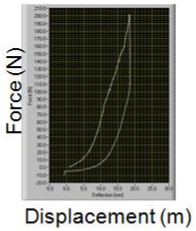


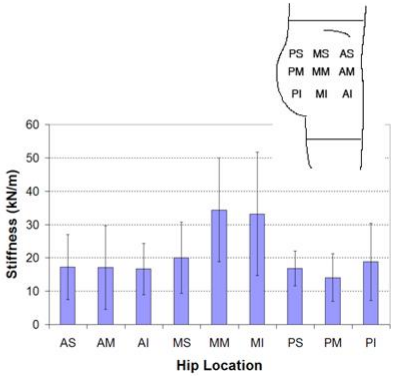


N = 15
BMI = 23.6 ± 2.1 kg/m^2
Age = 77.5 ± 8.5 yrs

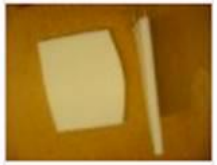








Alimed® Hip Shield



Anatech

Bort

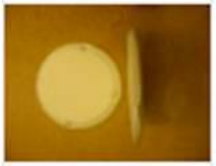
Caresse

FallGard

HipEase

Hip Guard

HIPS



Hipsaver®

Hip Shield

Hornsby Comfy Hips

Impactwear®

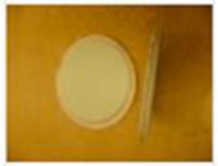
KPH®

LYDS

Pelican(179P)

Pelican Super Soft

Pelican Washable



Posey Regular

Posey Heavy Duty

ProtectaHip®

ProtectaHip+Plus®

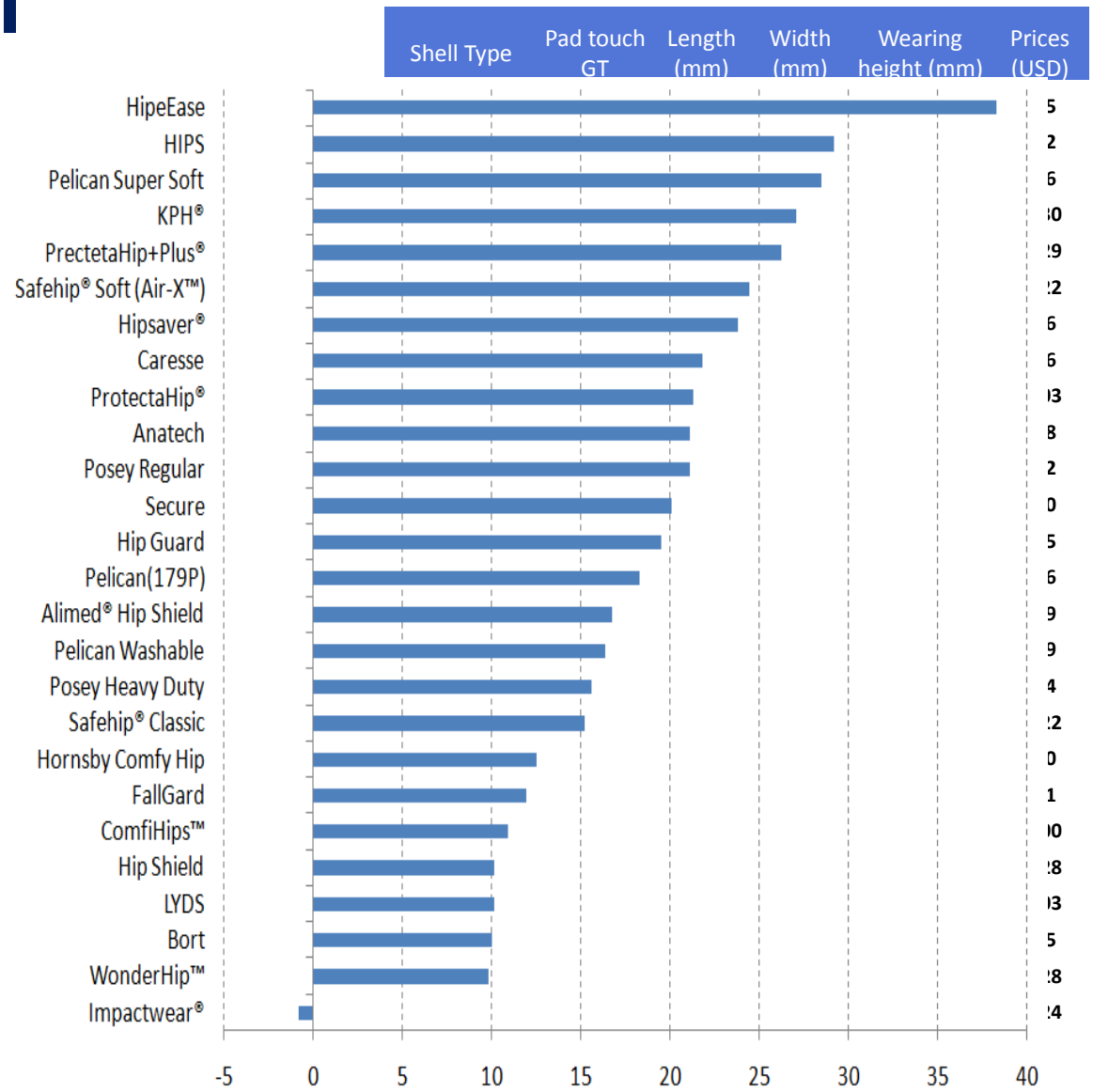
Safehip® Soft (Air-X™)

Safehip® Classic

Secure

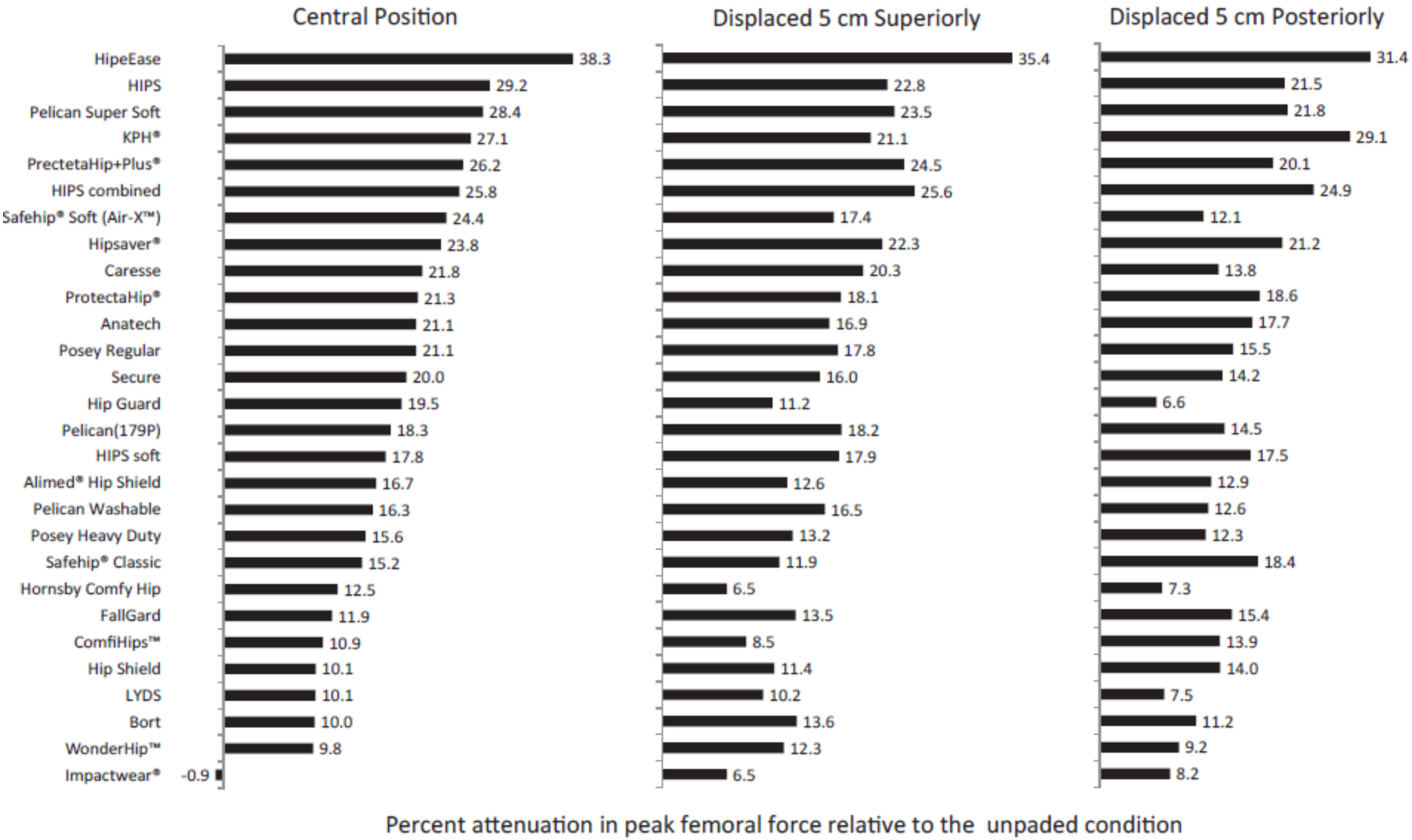
WonderHip™

Biomechanical Performance



Percent Femoral Force Attenuation with Respect to Unpadded Condition

Hip Protector Placement



Some hip protectors do not cover the greater trochanter

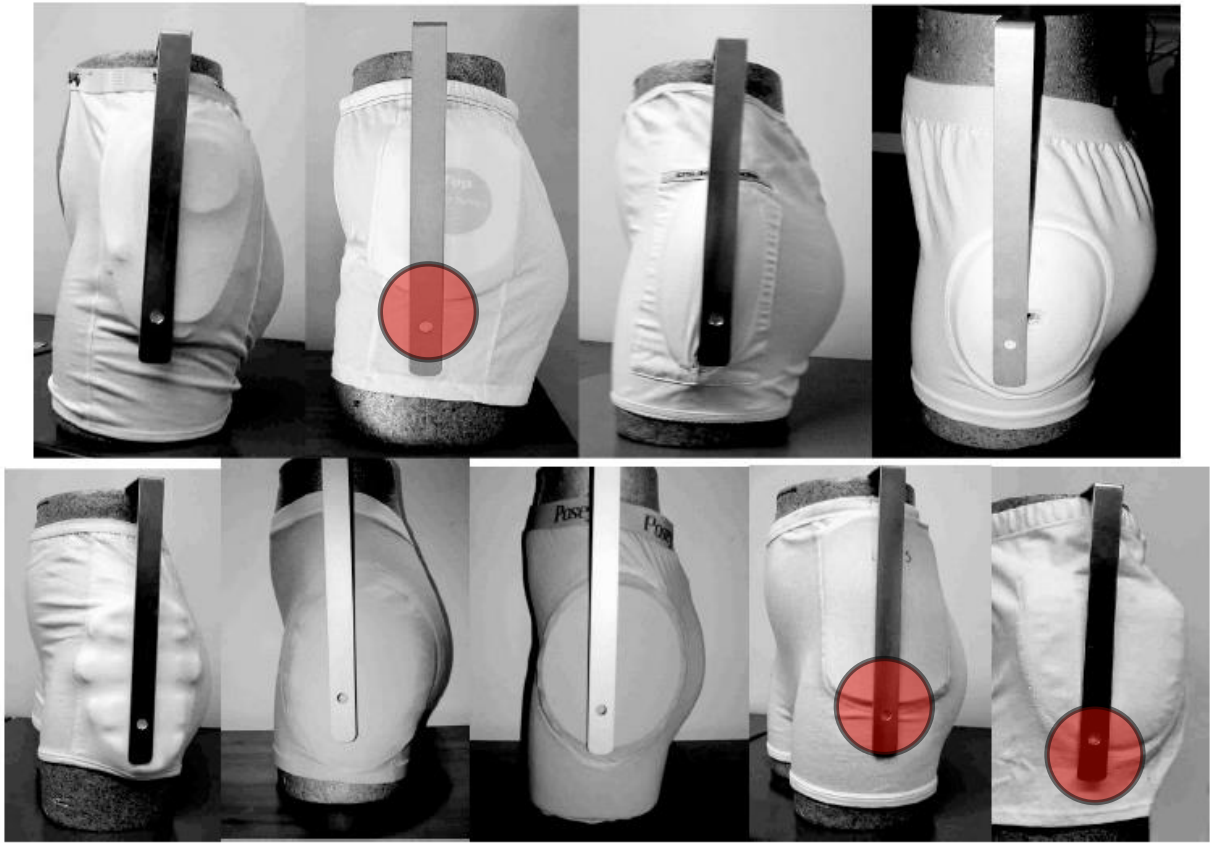


Figure 2. Position of the GT marker on the top row-hard shells (from left to right): Remploys Caresse, FallGuard, KPH, SafeHip. Bottom row-soft pads (from left to right) HipShield, HipSaver, PoseyHipsders, Lyds, Sanavida.

Source: Minns et al., Age and Ageing, 2007

"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)

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

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

Education about Hip Protectors

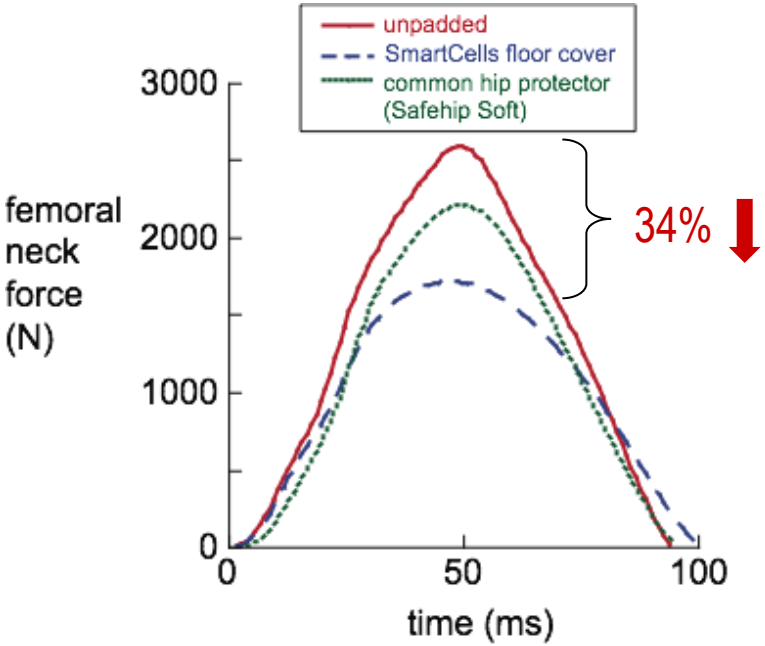
The Bottom Line

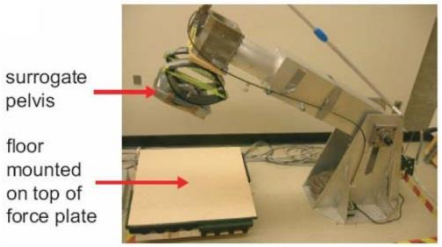
- Hip protectors **are effective** for those in LTC facilities
- Not all hip protectors are equally effective
- User compliance heavily influences their clinical effectiveness
- Many actions can be taken in LTC facilities to enhance compliance

www.agingisacontactsport.com

The Flooring for Injury Prevention (FLIP) Trial:
Can Compliant Flooring Reduce Injuries Due to Falls in Long-Term Care?

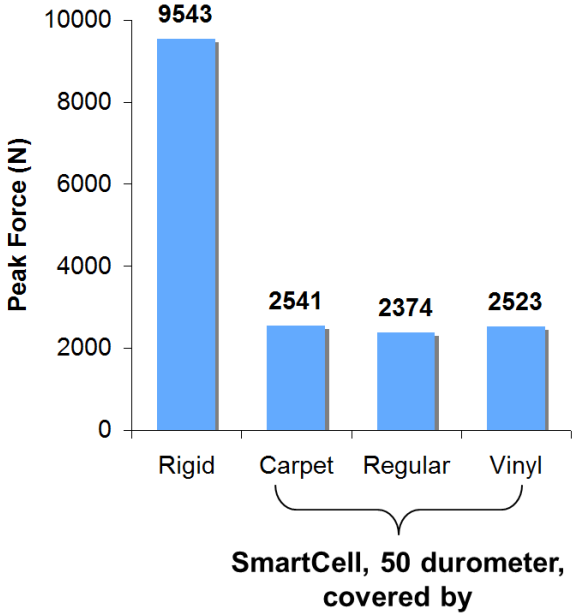
Force reduction provided by SmartCells during a simulated fall on the hip averaged 34%

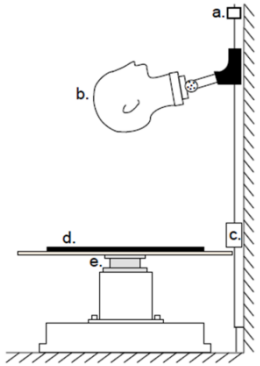




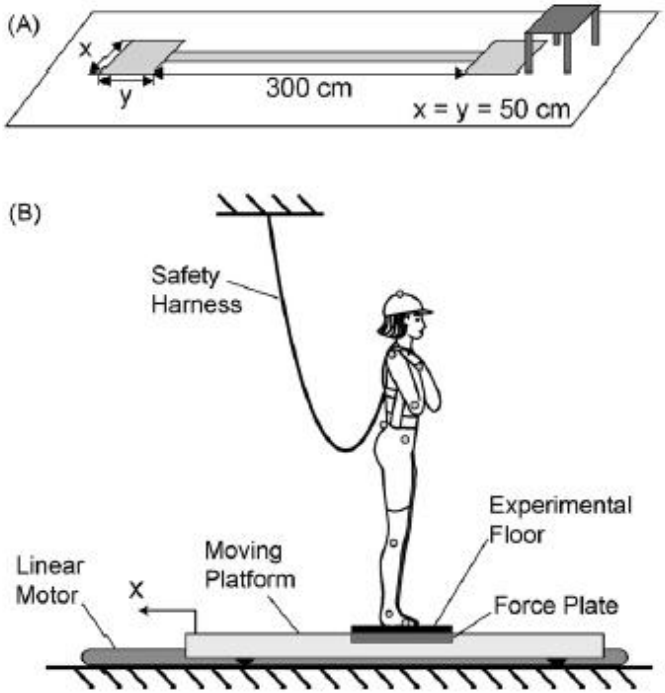
Laing et al., Accident Analysis & Prevention, 2009

Force reduction provided by SmartCells during a simulated fall on the head averaged 70%





Compliant floors reduce peak force with minimal influence on balance or mobility of older women



- 15 women ranging in age from 65 - 90 yrs (mean = 75, SD = 8)

	Rigid Floor	Approx **1" SmartCells**	Approx 4" Tile	Approx 4" Firm Foam	Approx 4" Soft Foam
Force attenuation %	0	25.4	47.2	76.6	52.4
GUG [balance test] time (seconds)	11.7	11.4	12.2	14	14
[balance] Recovery success	.79	.89	.79	.45	.67
Sway range (mm)	15.1	18.7	20.3	33.3	23.4
Sway velocity (mm/second)	8.0	9.1	9.3	20.3	12.8
Balance confidence	9.5	9.6	9.3	5.4	5.5
Practicality	9.1	8.5	8.2	2.6	1.9

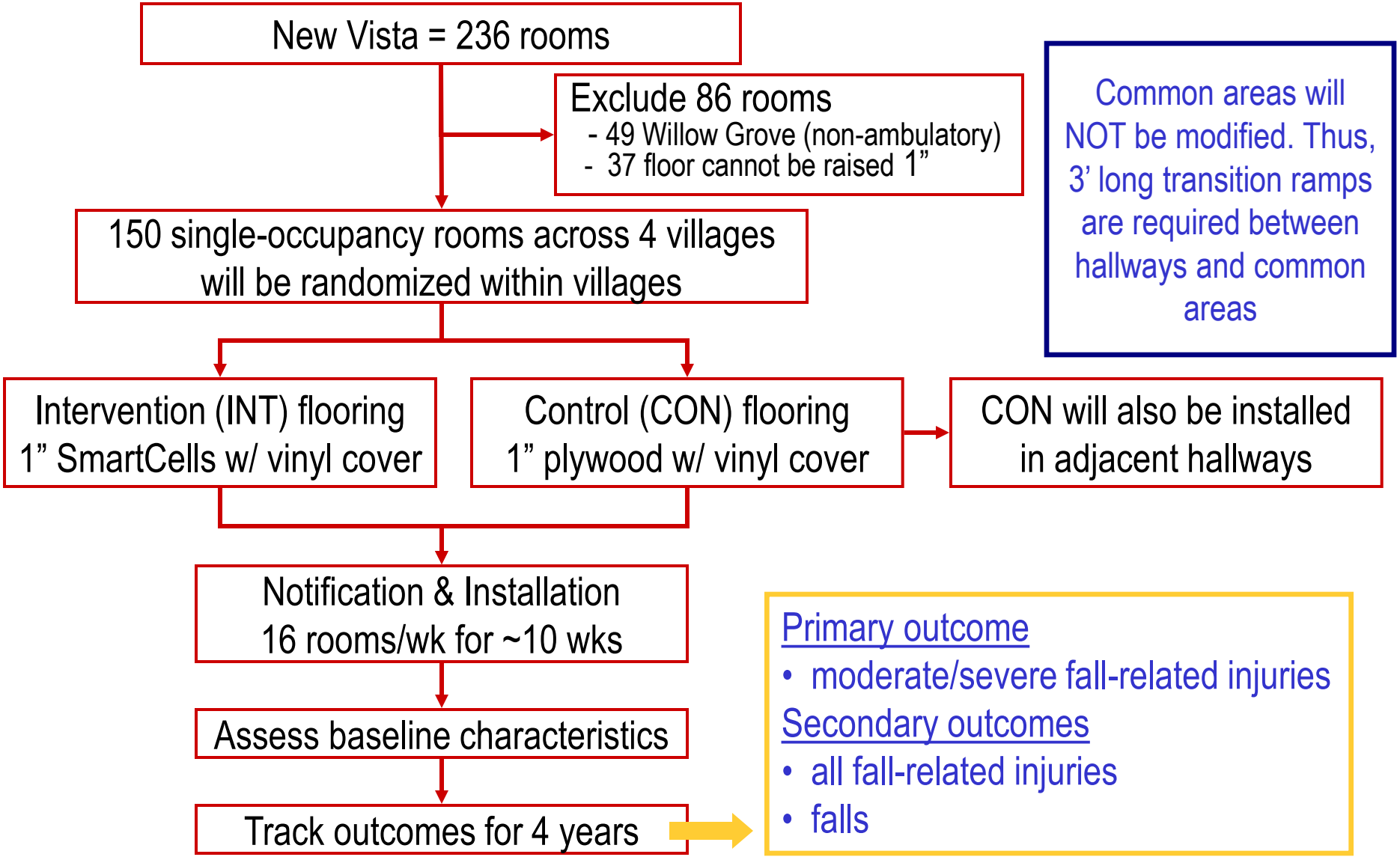
FLIP Trial will address 3 aims:

1. To determine the effect of compliant flooring on fall-related injuries in long-term care

2. To determine the effect of compliant flooring on healthcare utilization in long-term care

3. To assess perceptions about compliant flooring among key stakeholder groups

FLIP Trial Design



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Vitamin D Protocol for Residential Care

Fabio Feldman, PhD
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Fraser Health

Adjunct Professor, Biomedical Physiology and Kinesiology
Simon Fraser University

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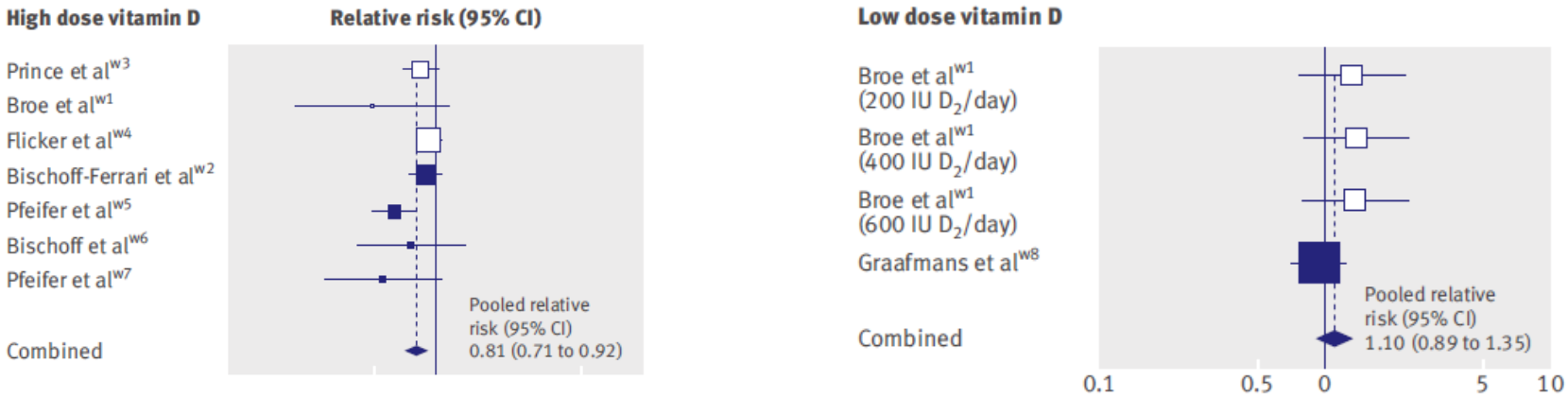
BMJ

RESEARCH

Fall prevention with supplemental and active forms of vitamin D: a meta-analysis of randomised controlled trials

H A Bischoff-Ferrari, director of centre on aging and mobility,[1,2] B Dawson-Hughes, director of bone metabolism laboratory,[3] H B Staehelin, professor emeritus ,[4] J E Orav, associate professor of biostatistics,[5] A E Stuck, professor of geriatrics,[6] R Theiler, head of rheumatology,[7] J B Wong, professor of medicine ,[8] A Egli, fellow,[1] D P Kiel, associate professor of medicine,[9] J Henschkowski, fellow[1,6]



WHAT THIS STUDY ADDS

A dose of 700-1000 IU supplemental vitamin D a day reduced falls by 19%, and by up to 26% with vitamin D_3, within 2-5 months of treatment initiation

Vitamin D may not reduce falls at doses of less than 700 IU a day

THE COCHRANE COLLABORATION®

Interventions for preventing falls in older people in nurs care facilities and hospitals (Review)

Cameron ID, Murray GR, Gillespie LD, Robertson MC, Hill KD, Cumming RG, Ke

Authors' conclusions

There is evidence that multifactorial interventions reduce falls and risk of falling in hospitals and may do so in nursing care facilities. **Vitamin D supplementation is effective in reducing the rate of falls in nursing care facilities.** Exercise in subacute hospital settings appears effective but its effectiveness in nursing care facilities remains uncertain.

Vitamin D & Muscle Function

- Mediated through highly specific receptor in muscle tissue
- ↑ function when Vitamin D levels >40 nmol/L
- Deficiency:
  - Muscle weakness & pain
  - ↓ mobility & ↓ walking distance, ↑ fall risk
  - Difficulty in mounting stairs/rising from chair
  - Increased body sway

Bischoff-Ferrari 2004

ARCHIVES OF
INTERNAL MEDICINE

Arch Intern Med. 2009;169(6):551-561

Prevention of Nonvertebral Fractures With Oral Vitamin D and Dose Dependency

A Meta-analysis of Randomized Controlled Trials

Heike A. Bischoff-Ferrari, DrPH; Walter C. Willett, DrPH; John B. Wong, MD; Andreas E. Stuck, MD; Hannes B. Staehelin, MD; E. John Orav, PhD; Anna Thoma, MD; Douglas P. Kiel, MD; Jana Henschkowski, MD

Conclusion: Nonvertebral fracture prevention with vitamin D is dose dependent, and a higher dose should reduce fractures by at least 20% for individuals aged 65 years or older.

Other Benefits

- Cancer Prevention
- Reduce risk of cardiovascular disease
- Positive effects on immune responses
- Reduce Mortality

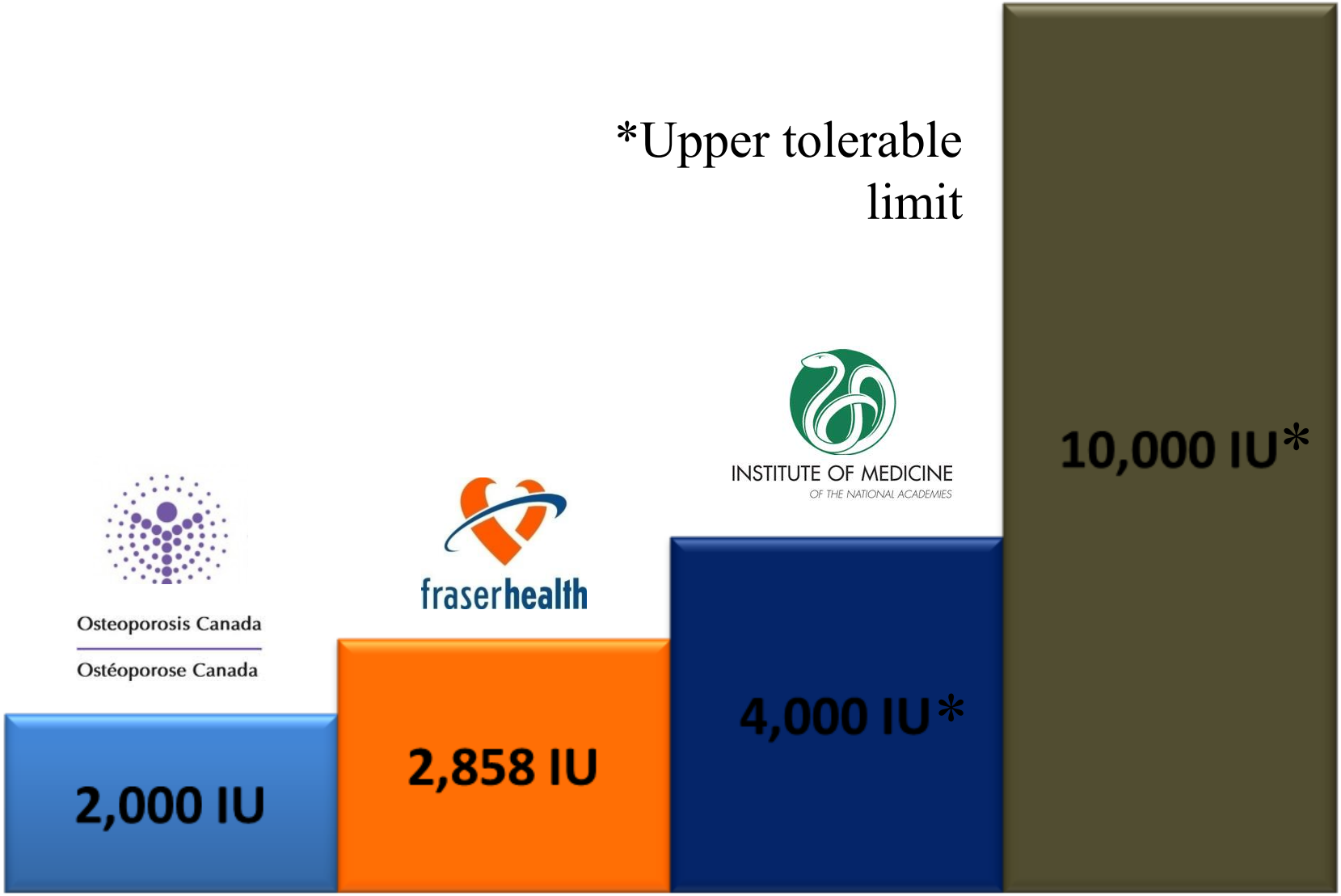
Vitamin D Protocol for Residential Care

Inclusion Criteria: All seniors 65 years and older living in residential care facility

Exclusion Criteria: Those with hypercalcaemia and/or severe renal failure (GFR<20ml/ min)

Dosage: 2x 10,000 IU/week, no loading dose

Risk of Harm



Vitamin D daily dosage

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Regional Pre-Printed Protocol for CHOLECALCIFEROL (VITAMIN D3)

DRDO104908A Rev: Nov 04/11 Page: 1 of 1

DRUG & FOOD ALLERGIES

• Mandatory ☐ Optional: Prescriber check (✓) to initiate, cross out and initial any orders not indicated.

INCLUSION (Target Population)

- All seniors 65 years and older living in a residential care facility who do not meet any of the exceptions to the criteria listed below.

Exceptions:

	EXCLUSION	DESCRIPTION
☐	***Severe Renal Failure***	Classification Stage 5: GFR less than 20 mL/min
☐	***Hypercalcaemia***	Documented high blood calcium levels resulting from malignancies, hyperthyroidism, sarcoidosis, thyrotoxicosis, medications, or other causes.

☐ Do not institute vitamin D protocol

THERAPY

☐ 20,000 units of **CHOLECALCIFEROL (VITAMIN D3)** PO once weekly

- Discontinue any form of vitamin D supplementation prior to initiation of protocol
- Continue multivitamins with low doses of vitamin D (if applicable)

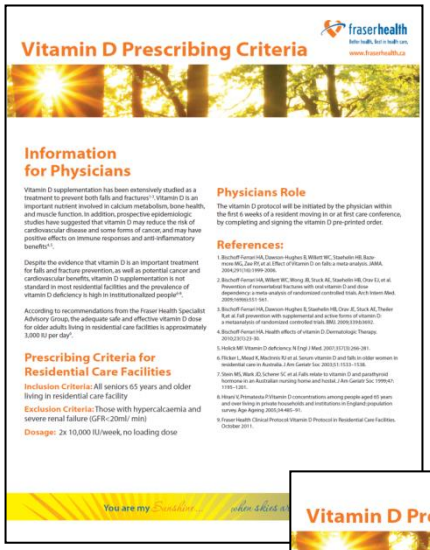
Date (dd/mm/yyyy)	Time	Prescriber Signature	Printed Name or College ID#

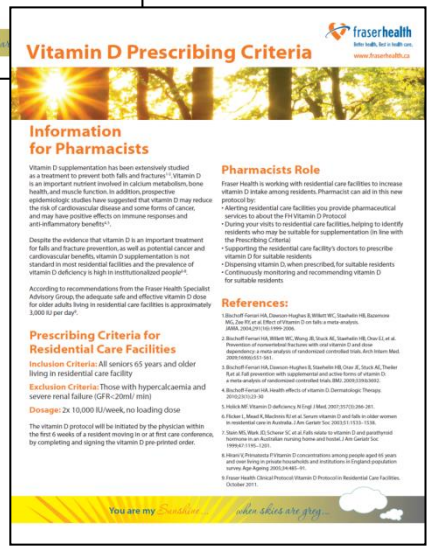
The vitamin D protocol will be initiated by the physician by completing and signing the vitamin D pre-printed order:

- within the first **6 weeks** of a resident moving in
- at **first** care conference

Vitamin D Protocol

Tool Kit





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Cost of Vitamin D

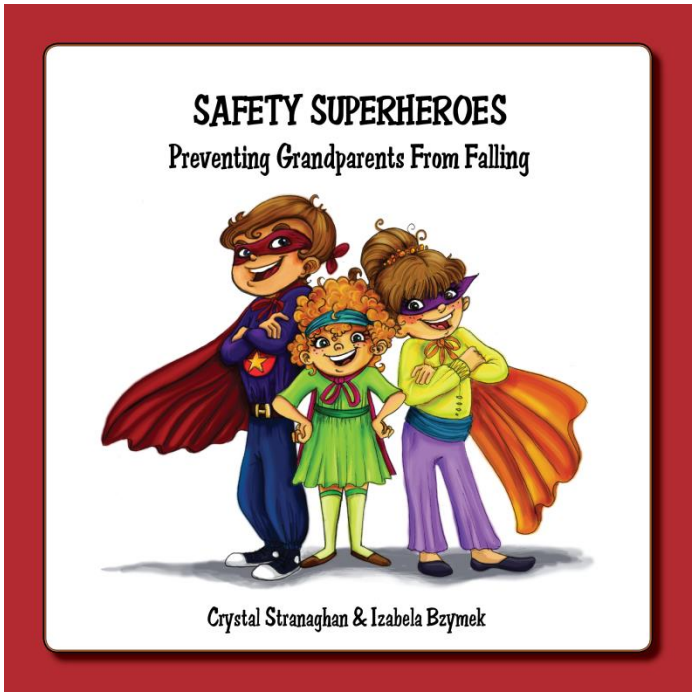
Fraser Health Operated Residential Care Facilities	weekly cost per resident is $0.42
Health Service Providers for Residential Care	weekly cost to the residents is $0.50

Effectiveness and Safety of A High Dose Weekly Vitamin D (20000 IU) Protocol in Older Adults Living in Residential Care

(n=236)	Mean (95% CI)	n (%)
Serum 25 hydroxyvitamin D, nmol/L	102 (98, 106)	-
< 40	-	7 (3)
< 50	-	15 (6)
< 75	-	45 (19)
≥100	-	100 (52)

Safety Superheroes Program

-an intergenerational approach to fall prevention-



Created to help kids and families learn how to keep their grandparents and loved ones safe from falls

a project brought to you by:

fraserhealth Better health. Best in health care.

Safety Superheroes Program

-an intergenerational approach to fall prevention-

Our school program features interactive workshops as well as a variety of different learning tools that can be used to check for understanding and challenge students to apply what they've learned at home and out in their local communities.

Safety Superhero Checklist

What can YOU do to keep your grandparents safe from falls?

- ☑ Make sure you pick up and put away all your toys, books and games so that there's nothing on the floor for people to trip over.
- ☑ Wear safe indoor shoes instead of floppy inside slippers, and encourage your grandparents to do the same thing!
- ☑ Remove any loose carpets, especially if they bunch up at the edges or won't lie flat.
- ☑ Make sure bathroom things are easy to reach so you don't have to bend down, or climb up to reach them.
- ☑ Rake up any leaves, rocks or loose gravel on porches and paths in the yard so that no one can trip over them or lose their balance.
- ☑ Wipe up any spills right away. You don't want anyone to slip and fall!
- ☑ Get your parents to help you place a cordless phone near the bed so it's easy to reach.

Are you ready to take the Safety Superhero Challenge

Name 15 things you cou the house below and to prevent poss

Need a hint? Flip the

Safety Superheroes Program

-an intergenerational approach to fall prevention-

BOARD OF EDUCATION BURNABY SCHOOL DISTRICT 41

New Horizons for Seniors Program

Burnaby Falls Prevention Society

fraserhealth

- 9 elementary schools
- 62 classes (grades K – 5)
- 1290 students participated

- 30 volunteers trained
- 13 delivered the program

Acknowledgments

SFU

Injury Prevention and Mobility Laboratory

technology for injury prevention in seniors
tips

CIHR IRSC

CENTRE for HIP Health and Mobility

Fabio.feldman@fraserhealth.ca

www.sfu/tips

www.agingisacontactsport.com

www.safetysuperheroes.ca