

# Fall Prevention: State of the Science

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# Overview

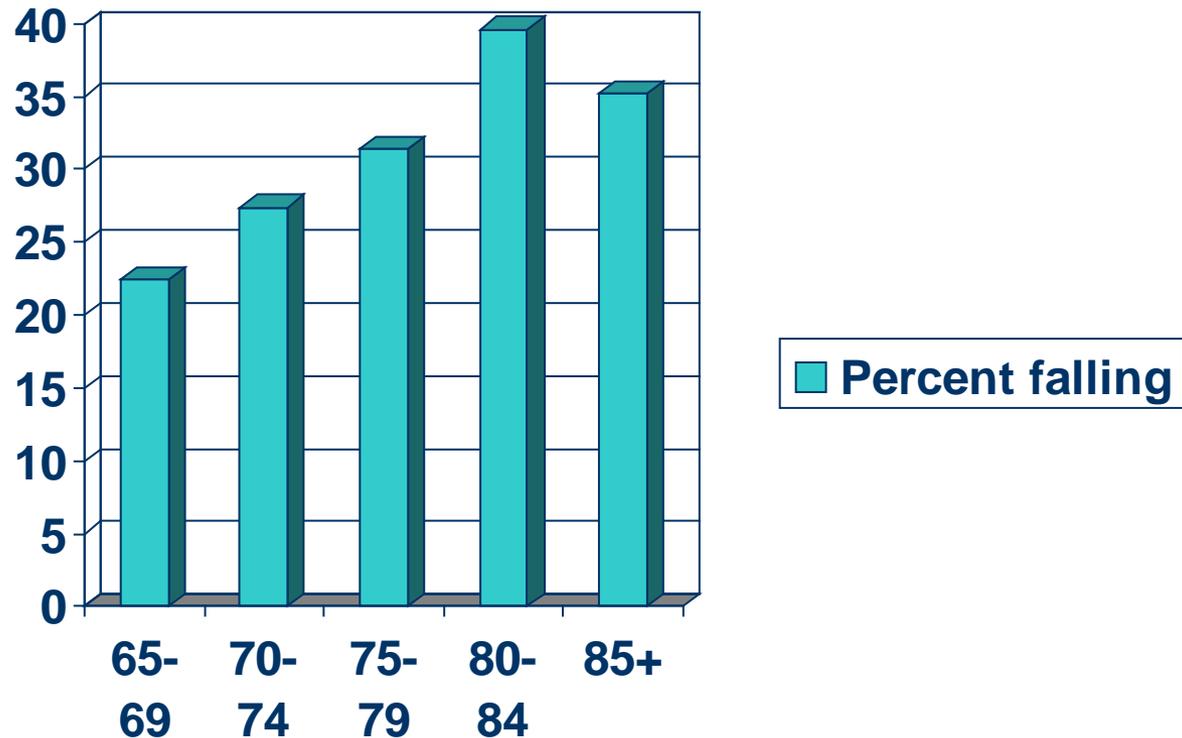
- The problem nationally and in Rhode Island
  - Who, where, when, and what
    - Consequences
- Etiology and risk factors - why
  - Intrinsic and extrinsic
  - Multifactorial
  - Acute care and nursing home settings
- Fall prevention is possible

# The Problem Nationally – Who Falls?

- 1 in 3 adults 65+ fall each year
  - Less than ½ of these talk to health provider about fall (CDC, 2011)
- Fall rates generally increase with age
- Women 1.5 – 2 x higher fall rates than men
  - but men have higher fall-related death rates
- Risk of falling is 33 – 60% higher in Caucasians than other races
- Low SES – higher rates of falls perhaps because of more chronic illness (WHO, 2009)

# Percent Falling by Age Group

(Tideksaar, 1996)



# The Problem –Where and When do Falls Occur?

- About  $\frac{3}{4}$  of falls occur in or in close proximity to the home
- 10% occur in nursing homes or other institutions
- About 50% occur outdoors in community-dwelling older adults (Kelsey et al., 2010)
  - Sidewalks (23%)
  - Yards or gardens (14%)
  - Streets or curbs (14%)
  - Outside stairs (13%)
  - Parking lots (6%)
- Most falls occur in daytime when people are most active, mid-day and 4 – 6 PM
- More fall injuries are caused by falls on same level (vs. stairs) and by falls from a standing position while walking (e.g. tripping while walking)

# The Problem – Consequences

- 20 - 30% of people who fall suffer moderate to severe injuries
- Unintentional injuries are 5<sup>th</sup> leading cause of death in older adults and falls constitute 2/3 of these deaths (Rubenstein, 2006)
- Falls most common cause of nonfatal injuries and hospital admissions for trauma among 65+ (CDC, 2005)

## Fatal and nonfatal fall injuries among people 65+

1.6 million



1% - Died

24% - Treated in ED and hospitalized

76% - Treated in ED and released

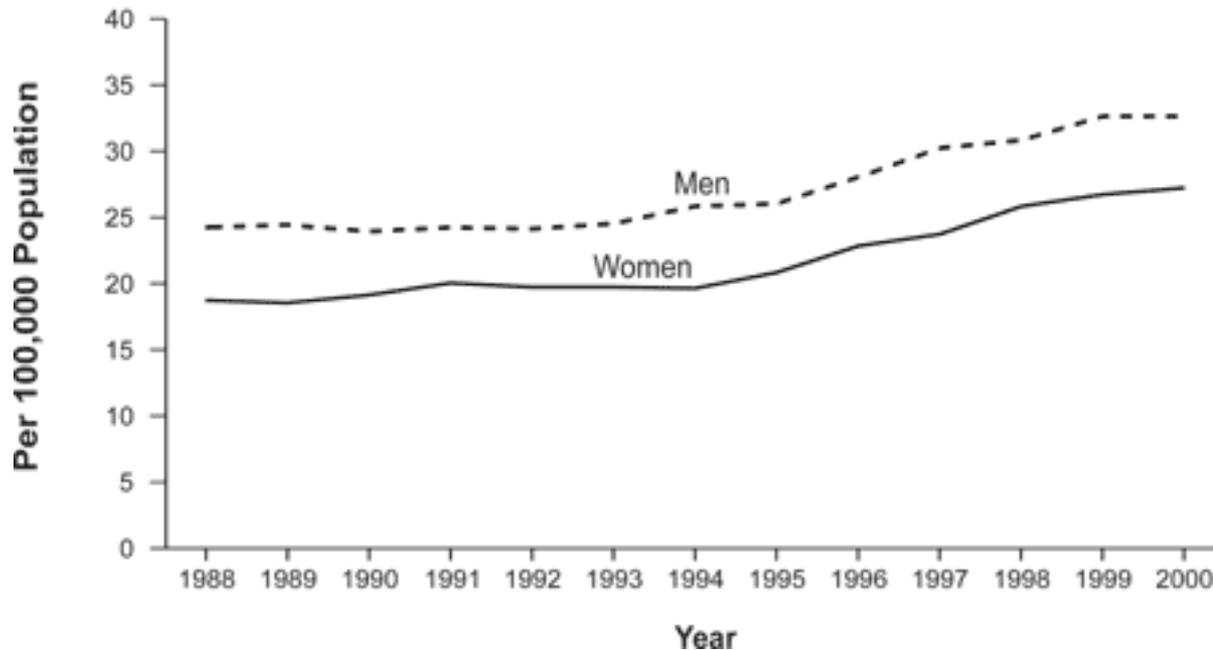
Fall-related injuries

# The Problem – Consequences (cont'd)

- Caucasians have highest fall hospitalization and injury rate - highest osteoporosis rates
- Fall injury rate increases with age
  - 85+ almost 4x higher than 65-74 year olds
- 12 month risk of mortality after hospitalization for a fall is 50%

# Fall Related Death Rates Increasing (Stevenson, 2006)

Unintentional Fall Death Rates for Men and Women Age 65+, United States, 1988-2000



# The Problem – Consequences (cont'd)

- 70% of fall-related injuries were to upper or lower limbs and consisted mainly of
  - fractures (60%)
  - superficial injuries (21%)
  - open wounds (8%) (Hartholt et al., 2010)
- Hip fractures cause greatest number of deaths and institutionalizations
- Women experience 80% of all hip fractures

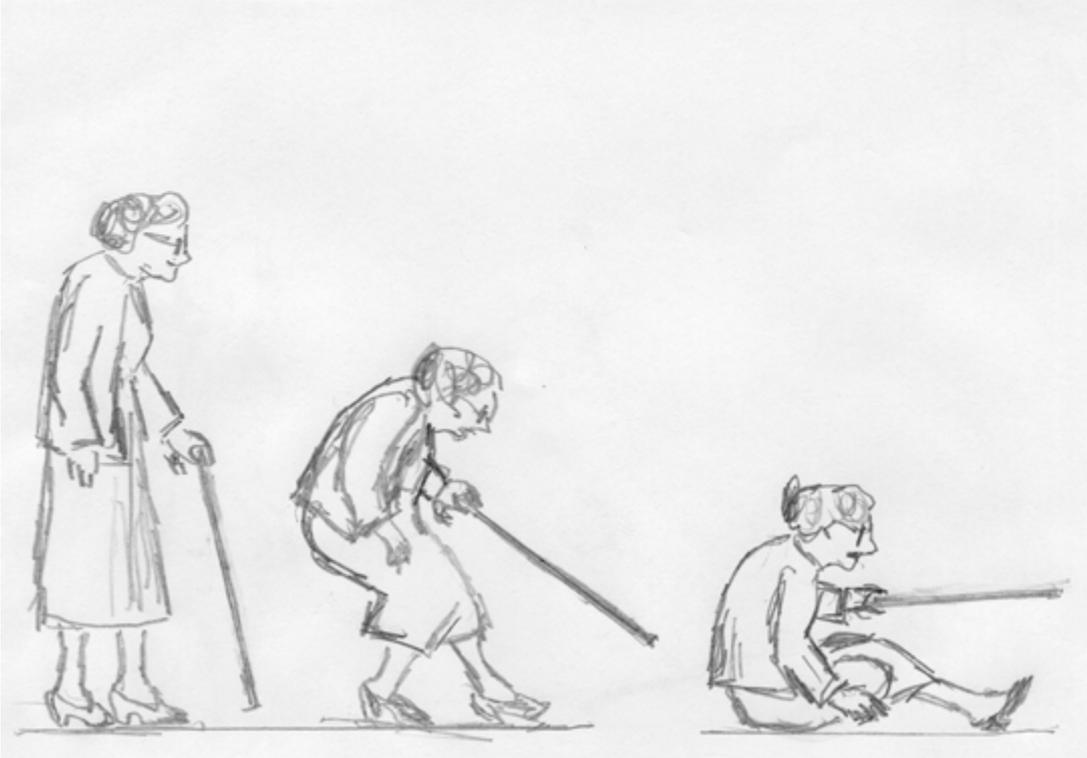
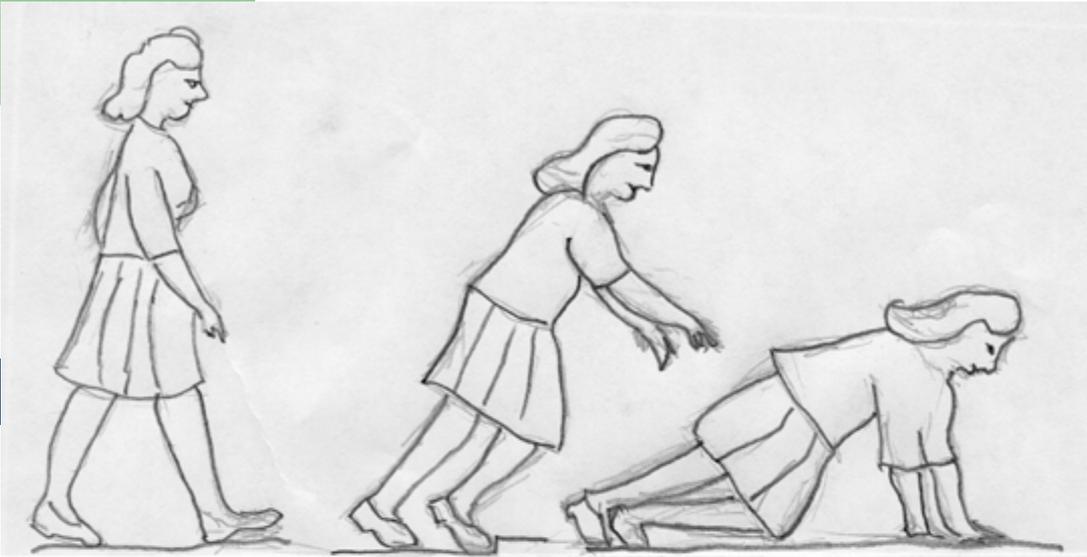
# For those with hip fractures...

- 20% die within a year
- 40% require nursing home care
- 50% lose ability to walk
- 25% make a full recovery

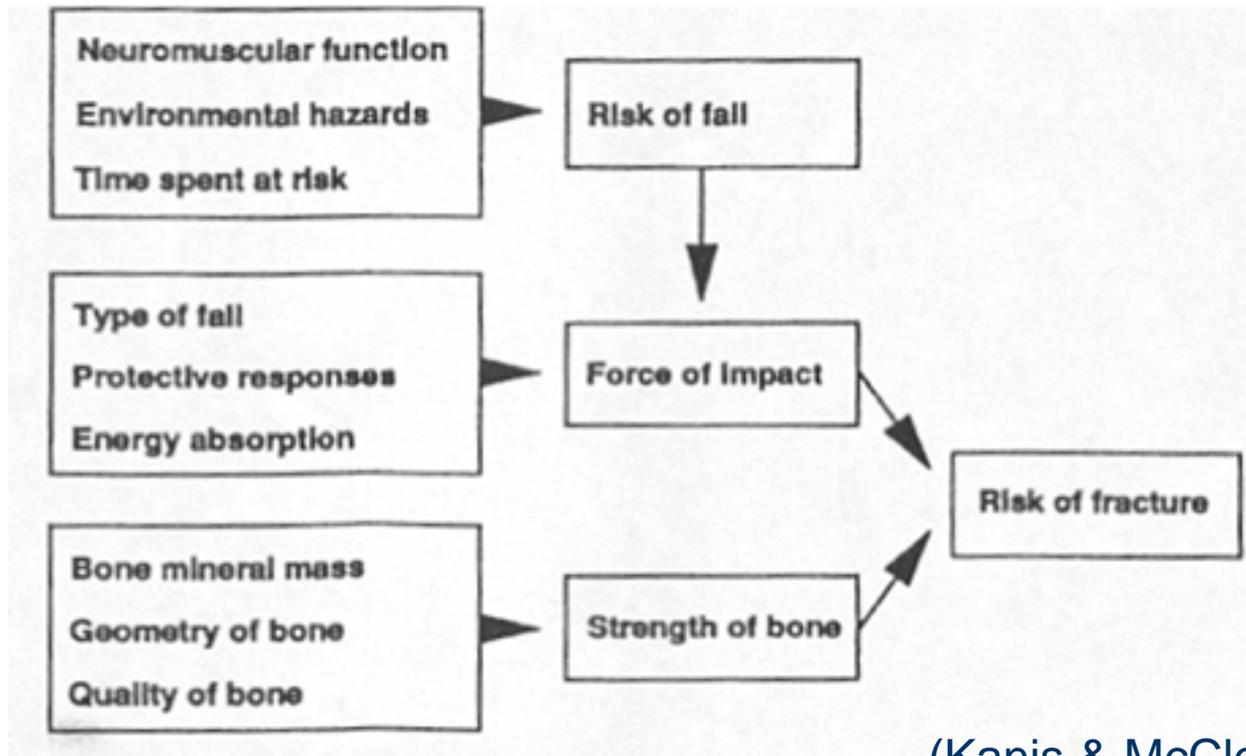
(AAOS, 2000)

# Falling and Fractures

- The way in which a person falls often determines type of injury
- Wrist fractures usually result from forward or backward falls onto outstretched hand
- Hip fractures typically result from falls to the side
- Backward falls directly onto buttocks have much lower rates of associated fractures
- More wrist fractures between ages 65 and 75
- Hip fractures predominate in ages over 75
  - Slower reflexes and loss of ability to protect the hip by ‘breaking the fall’ with one’s wrist



# Etiopathology of Fractures



(Kanis & McClosky, 1996)

# The Problem – Consequences (cont'd)

- Falls - most common cause of traumatic brain injuries accounting for 46% of fatal falls among 65+ (Stevens et al. 2006)
- Fear of falling common after a fall, even if not injured.





# The Problem - Costs

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- In 2000, direct medical costs totaled \$17.9 billion for fatal falls and \$19 billion for nonfatal fall injuries (Stevens et al., 2006)
- \$28.2 billion in 2010 dollars (CDC)
- Of the nonfatal injury costs
  - 63% (\$12 billion) were for hospitalizations
  - 21% (\$4 billion) were for ED visits
  - 16% (\$3 billion) were for outpatient treatment

## The Problem - Costs (cont'd)

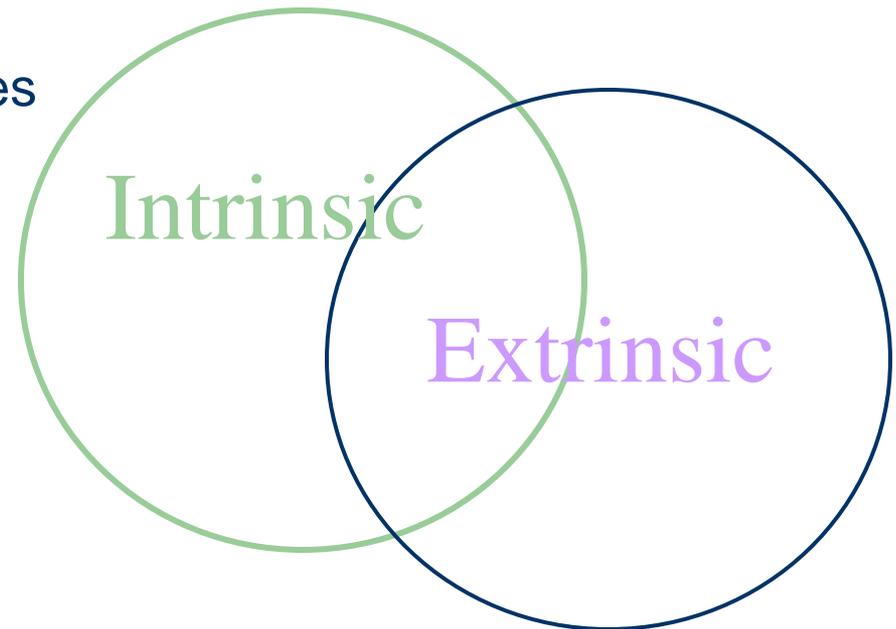
- Medical expenditures for women were 2 to 3x higher than men for all treatment settings
- Fractures accounted for just 35% of nonfatal injuries, but 61% of costs
- Costs to function and quality of life immeasurable

# The Problem in Rhode Island

- 66% of accidental deaths among Rhode Islanders 65+ are due to a fall injury
- Leading cause of injury death for RI females (suicide for males)
- Leading cause of injury-related hospitalizations for both sexes
- Age-adjusted fall death rate (6.9/100,000) is 20% higher than national rate and appears to be growing
- Death rate for >85 group is 168.3/100,000
- Estimates show 18.7% of RI females 50+ have osteoporosis

# Understanding Falls Etiology

- Multifaceted
  - Intrinsic
    - Age-related changes
    - Behavioral/psychological
    - Fear of falling
    - Medical conditions
    - Medications
  - Extrinsic





# Causes of Falls: Intrinsic Factors

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- Age-related changes
  - Sensory - vision and proprioception
  - Balance
  - Musculoskeletal and gait
- Behavioral/ psychological
- Fear of falling
- Medical Conditions
- Medications (covered later)

# Age-related Vision Changes

- Declines in
  - ability to detect differences in shapes
  - contrast sensitivity
  - acuity in low lighting
  - depth perception
  - visual field
- Greater sensitivity to glare

# Age-related Changes in Proprioception

- Proprioceptive input declines with age
- Loss of vibratory sensation and joint position greater in lower extremities
- Diminished proprioception leads to increases in postural sway and impaired balance



# Age-related Changes in Vestibular System

- Helps maintain eye stability and head orientation
- Vestibular- ocular reflex helps keep eyes on visual field - may decline with age
- Righting reflex - may diminish with age

**Balance relies on combination of vision, proprioception, and vestibular senses.**

**Deprivation in more than one system increases fall risk.**

# Balance

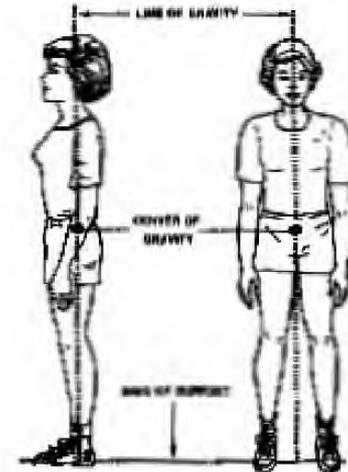
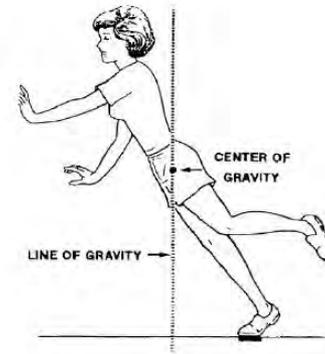
Position Center of Gravity (COG) over Base of Support (BOS) to maintain balance

Balance is maintained through coordinated efforts of sensory components, nervous system, and musculoskeletal responses.

When COG extends beyond BOS, loss of balance occurs.

- Imbalance is detected by sensory system
- Signals are sent to muscles and joints
- Set of coordinated motor responses are initiated

Postural sway and control attempts to realign COG and BOS.



# When balance is disrupted...

- Three primary postural control strategies
  - Ankle strategy
  - Hip strategy
  - Stepping or stumbling strategy
- Initiation and execution of these strategies is affected by age

# Postural Disturbances and Falls

- Fallers have greater postural sway both anteroposterior and lateral
- People with multiple falls have more than those with single falls
- Slowness detecting postural disturbances associated with increased postural sway - suggests that time to detect postural changes may be critical in controlling balance

# Musculoskeletal and Gait Changes

(Disagreement about whether age-related)

- Older people walk more slowly
  - Walking speed – the 6<sup>th</sup> vital sign (NIH, 2000)
- Increase in duration of double support
- Decline in stride length during fast walking
- Slight increase in step width and decrease in step height
- Decrease of normal arm swing, reduced pelvic rotations, reduced hip and knee rotation
- Changes may be compensatory – COG is outside BOS for 80% of walking time

# The Role of Sarcopenia

- Definition – age-related loss of muscle mass
- Often shown to be related to decreased functional status in cross-sectional studies
- Framingham Heart Study – not related to decreased functional status
- Only 2 studies on relationship between low muscle mass (assessed after the fall) and falls

# New Focus on Dynapenia

- Age-related loss of muscle strength – distinct process with different pathophysiology
- Relation with fall risk studied more extensively
- Lower and upper extremity (grip strength) weakness important predictors of future falls
- Exercise decreases risk of falling

# Faller's Gait and Dual Tasking

- Decreased walking speed
- Shorter stride lengths
- Increased variability of step length
- Dual-task performance
  - Gait parameters (cadence, speed, stride and step time, single-support time) significantly different between dual performance fallers and non-fallers (Toulotte et al., 2006)
  - Changes in performance while dual tasking associated with increased risk for falling among older adults and frail older adults in particular (Beauchet et al., 2009)

# Gait Risk Factors (Bridenbaugh & Kressig, 2011)

- Most falls occur when walking
- Several studies identified spatial and temporal gait parameters as independent fall predictors
  - Increased stride to stride variability in stride length, stride speed and double support time, and increased stride width
  - Quantitative measures of gait variability may be most predictive – variability of stride time and swing time

# Gait Impairments

(Bridenbaugh & Kressig, 2011)

- Important risk factor for falls
- Gait parameters often too subtle to be detected clinically but several different gait analysis systems available
- Dual task gait analysis most sensitive indicator of fall risk – new surrogate marker for fall risk, especially predictive for frail elders

# Behavioral Factors

- Reflect choices of how older people interact with their environments
- Not being careful, not looking where one is going, or being in a hurry cited in 63% of falls (Pynoos et al., 2010)
- Examples
  - Standing on unstable objects to reach something on a high shelf
  - Failing to turn on lights
  - Selecting unsafe footwear
  - Stepping over pets

# Psychological Factors

- Threat of loss of independence
  - May under-report falls
- Denial of frailty
- Anxiety & depression- lack of attention and awareness

# Fear of Falling (Reelick, et al., 2009)

- 21 – 85% of older adults
- Higher in women
- 1/3 of those without recent falls report fear of falling
- Fear increases with age
- Gait and balance is impaired, “cautious gait”
- Gait velocity lower, stride-length and stride time variability higher – may be useful adaptation

# Perceptions of Fall Risk and Falls

(Delbaere et al., 2010)

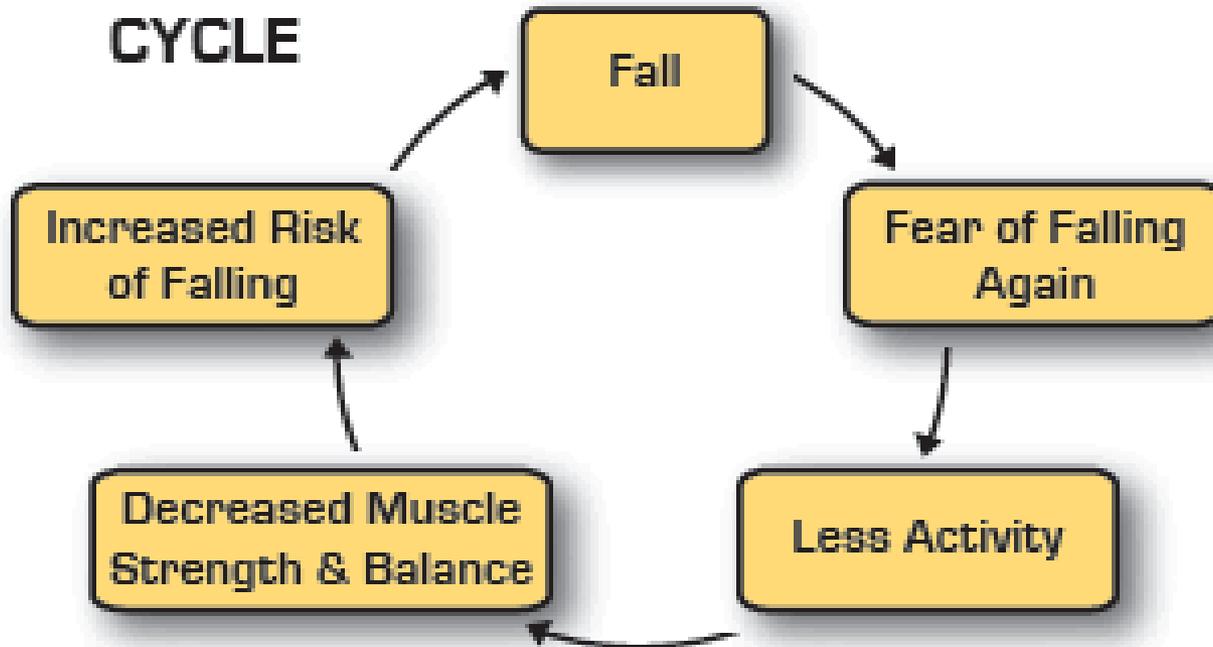
- Most (2/3) had accurate perception of their fall risk
- 1/3 had disparity between perceived and physiological fall risk
  - 11% had low physiological fall risk but high perceived risk (anxious)
  - 20% had high physiological risk but low perceived risk (stoic)
  - Both physiological and perceived fall risk – independent risk factors of future falls
  - In addition to physiological fall risk, depression and quadriceps strength independently contributed to explaining perceived fall risk

# Fear of Falling after Hip Fracture

(Visschedijk et al., 2010)

- Associated with negative rehabilitation outcomes
  - Loss of mobility
  - Institutionalization
  - Increased mortality
  - Less time spent on exercise
  - Increase in falls

## THE FALL CYCLE



**Fear of Falling - measured by falls efficacy scales  
May be modifiable**

# Medical Conditions

- Acute illnesses (about 10%; 90% chronic illnesses)
- Cardiovascular; syncope
- Neurological/ cognitive
  - Dizziness
- Dementia
  - 4 falls/person/year; Fracture rate - 3 times greater than non-cognitively impaired
- Delirium – increased risk among all types of delirium including subsyndromal (Decrane et al., 2011)

# Cardiovascular Causes

(Cronin and Kenny, 2010)

- Up to 77% presenting to EDs
- Those with cardiac causes for falls have higher mortality rates
- 3 categories of cardiovascular causes
  - Neurally mediated
    - Most likely carotid sinus syndrome or post-prandial hypotension
  - Orthostatic hypotension
    - Primary or secondary, drug-induced, volume depletion
  - Cardiac abnormalities of structure or rhythm

# Medical Conditions (cont'd)

- **Musculoskeletal**
  - Muscle weakness from immobility
    - Quadriceps weakness increases risk
  - Diseases associated with muscle weakness
    - Arthritis, foot pain
- **Genitourinary**
  - Incontinence – especially urge
- **Gastrointestinal**
  - Diarrhea, vomiting
- **Multisystem decline, frailty, dynapenia**



# Causes of Falls: Extrinsic Factors

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- Environmental hazards contributing to falls are greatest in those with poor ambulation and transfer abilities
- A mismatch between individual's mobility capabilities and surrounding environment
  - Person - environment fit theory (French et al., 1982)
  - Theory of environmental press (Lawton & Nahemow, 1973)
- Physical environment - about 25% of all falls result from hazards
  - e.g. slippery or wet surfaces, poor lighting, inadequate footwear, pets, and cluttered pathways in a home
- About 80% of homes contain at least 1 identifiable hazard; 39% contain 5 + hazards

# Important Environmental Hazards

- Low or elevated bed heights
- Low-seated chairs
- Low-seated toilets lacking sufficient grab bar support
- Poor lighting
- Stairways (lack of hand supports/rails)
- Slippery floor surfaces (wet or polished floors; rugs)
- Slippery tub/shower surfaces
- Obstacles e.g. room and hallway clutter, pets
- Improper walking devices and wheelchairs (inappropriate size and/or use; poorly maintained)
- Faulty footwear (slippery soles, improper fit)
- Lack of safety equipment, such as grab bars
- Bed side rails interfering with safe bed exits

# Multifactorial Approach to Understanding Fall Risk (Delbaere et al., 2010)

- Absolute fall risk – 11% in those with no risk factors to 54% in those in highest risk group
- Fall risk factors
  - Disability
  - Poor performance on physical tests
  - Depressive symptoms
  - Poor executive function
  - Concern about falling
  - Previous falls

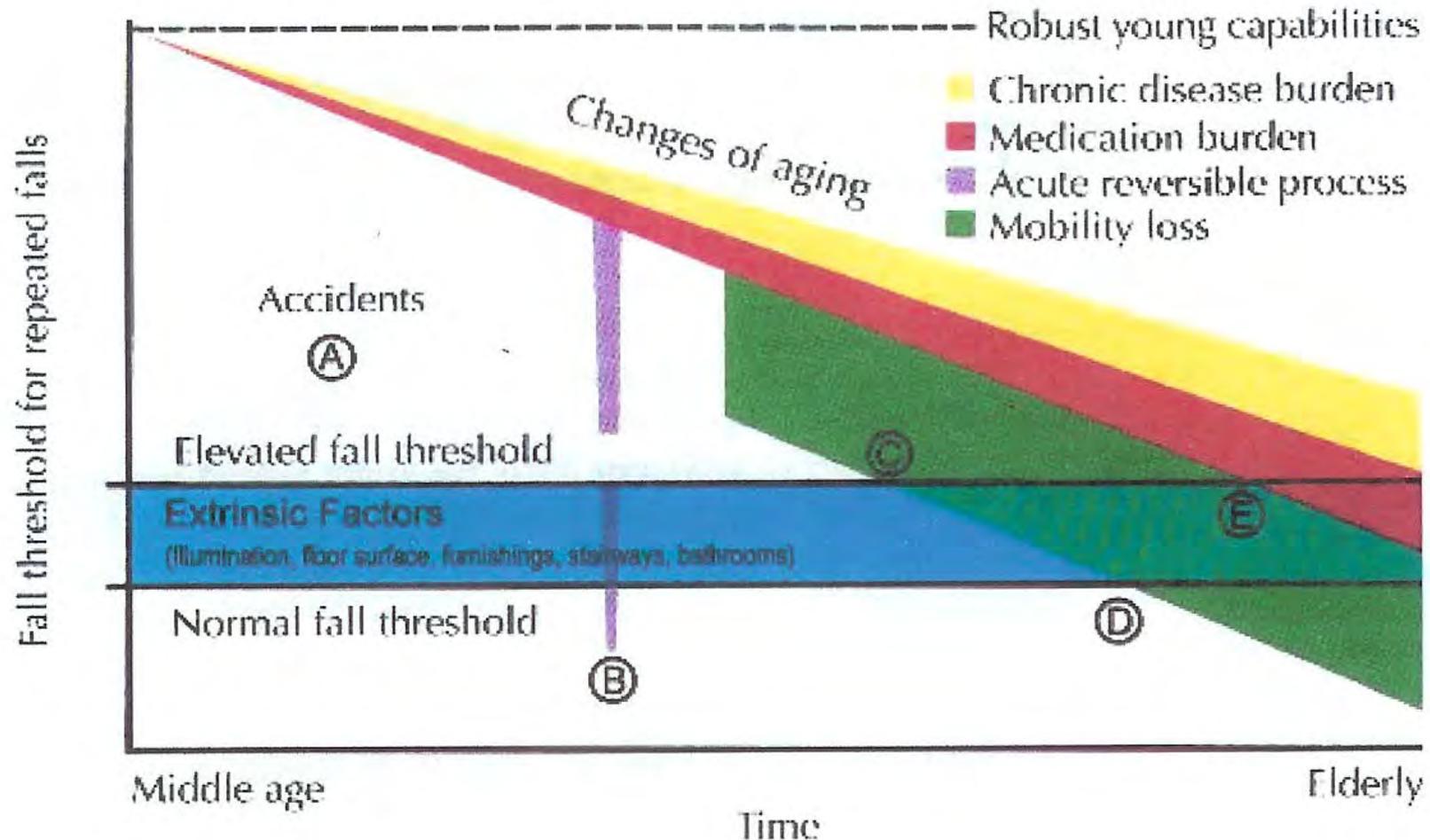
# Critical Predictors of Falls - cont'd

(Delbaere et al., 2010)

- Balance related - In those with good balance
  - Disability and exercise levels influenced fall risk
  - People in lowest and highest exercise tertiles were at greatest risk
- In those with impaired balance – different risk factors
  - Poor executive function
  - Poor dynamic balance
  - Low exercise levels

# Factors Contributing to Risk of Falls

(Steinweg, 1997)



# Falls in Acute Care Settings

- Patient falls consistently compose the largest single category of reported incidents in hospitals
- Primary root causes of fatal falls as reported by health care organizations involved (all extrinsic factors) (The Joint Commission, 2005):
  - inadequate staff communication
  - incomplete orientation and training
  - incomplete patient assessment and reassessment
  - environmental issues
  - incomplete care planning
  - unavailable or delayed care provision
  - inadequate organizational culture of safety.

# Falls in Acute Care Settings

- Over 80% are non-witnessed
- 56 – 60% occur from bed, bedside chair, or transferring between the two
- ½ of falls occur in people who fall only once; ½ in repeated fallers
- Suggests 2 groups of fallers
  - Those falling during period of confusion, postural instability, or hypotension
  - Those falling with postural instability, restlessness, wandering, or high risk behavior

# Falls in Acute Care Settings

- Timing factors
  - Difficult to separate patient specific factors (activity, diurnal rhythms) from unit-specific factors (staffing, drug rounds, nursing handover times)
  - Differences in fall rates between units needs careful exploration

# Falls in Nursing Homes

- Approximately 75% of nursing home residents fall each year
- LTC facilities have a mean fall rate of 1.7 falls per person per year (Becker & Rapp, 2010)
- In LTC facility with 100 beds, a fall can be expected every other day
- >3/4 occur in bedrooms or bathrooms
- Higher fall rates (42%) with sit-to-stand or stand-to-sit transfers than walking (35%)
- More serious complications – 10 – 25% resulting in fractures or lacerations

# Risk Factors for Falls in Nursing Homes

(Becker & Rapp, 2010)

- Muscle weakness
- Balance and gait deficits
- Poor vision
- Delirium
- Cognitive and functional impairment
- Orthostatic hypotension
- Urge incontinence
- Nocturia
- Comorbidities

# Summary - Important Individual Risk Factors (16 controlled studies)

- Weakness 11/11
- Balance deficit 9/9
- Gait deficit 8/9
- Visual deficit 5/9
- Mobility limitation 9/9
- Cognitive impairment 4/8
- Impaired functional status 5/6
- Orthostatic hypotension 2/7

Note: Numbers indicate number of studies with significant association/ total number of studies looking at each factor.

# Summary - Factors independently associated with a recurrent fall

(van Nieuwenhuizen et al., 2010)

Age and risk factors:

- orthostatic hypotension (OR 2.4)
  - fear of falling (OR 2.2)
  - high risk of osteoporosis (OR 2.0)
  - mobility disorder (OR 1.9)
  - incontinence (OR 1.7)
- 
- Age and high risk of osteoporosis were only risk factors predicting serious consequence of a fall (OR, 4.6)

# Determining Fall Risk from Important Health Problems/ Risk Factors (Tinetti, 2005)

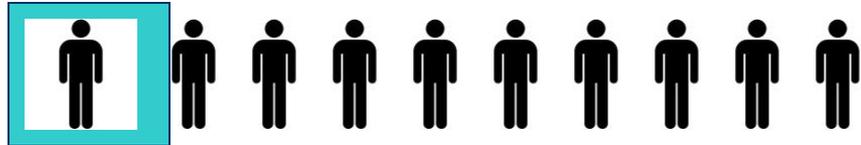
- Problems walking or moving around
- 4 or more medications
- Foot problems, unsafe footwear
- Orthostatic hypotension
- Vision problems
- Tripping hazards in home

If your number of health problems is:

Your chance of falling is: :

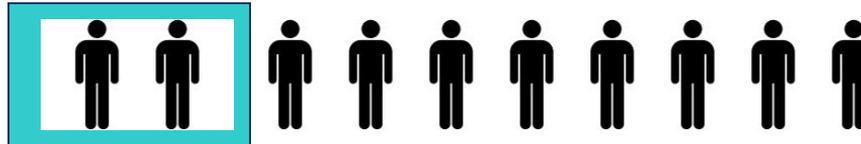
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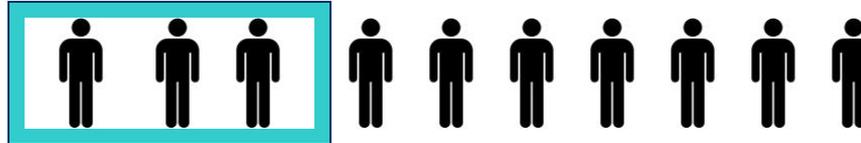
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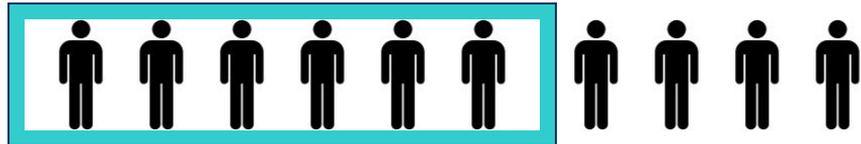
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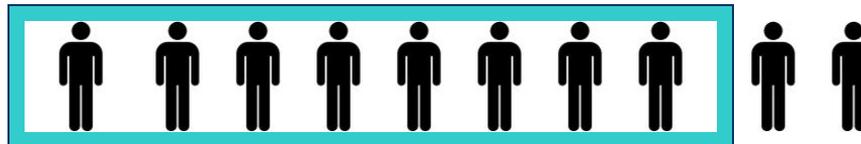
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6/10



4

8/10



or more

(Tinetti, 2005)

# Reducing Fall Risk (Using Same 6 Problems)

<b>If senior has</b>	<b>The chance she will suffer a serious fall in the next year is...</b>	<b>Treating risk factors reduces risk about 1/3 to...</b>
Fallen in past year	50%	30%
No falls in past year but even minor problems with walking or movement	30%	20%
Any 1 of 6 risk factors listed	20%	10%
Any 2 of 6 risk factors listed	30%	20%
Any 3 of 6 risk factors listed	60%	40%
Any 4 or more of 6 risk factors	80%	50%

# Fall Prevention in the Elderly: Analysis and Comprehensive Review of Methods Used in the Hospital and in the Home (Clyburn & Heydemann, 2011)

- Concluded that fall risk is only slightly greater in hospital than at home, “that there is no medical evidence that evidence-based guidelines are effective in fall prevention” and “not appropriate to make hospitals financially responsible for falls in facility”
- Nothing on method for their literature review, only 36 references, chose 2 studies to discuss for each risk factor
- “Although studies have shown that the HELP program may reduce fall risk, the authors believe that the literature is not adequate to support its consideration as a medical evidence-based guideline.” – however 95% of medical staff in 20 hospitals reported fall reduction with HELP.

# Many Falls are Preventable

- The U.S. Public Health Service has estimated that two-thirds of deaths due to falls are potentially preventable, based on a retrospective analysis of causes and circumstances of serious falls
- Interventions work – 2 reviews in 2011 ( Bula et al, Leung et al.)
- Fall prevention is cost effective

# Summary

- Who, where, when, what
- Why – Etiologies
  - Intrinsic
  - Extrinsic
- Falls in hospitals and nursing homes
- Summaries of risk factors
- **Fall prevention works to decrease falls and fall injuries!**