

---

# Fall Prevention: The State of the Art

**Laurence Rubenstein, MD, MPH**

*Director, Sepulveda VA GRECC*

*Professor of Medicine, UCLA*

**ASA/NCOA Conference -- San Francisco April 2004**

# **FALLS IN OLD PEOPLE**

---

- **Common**
- **High morbidity, mortality, service use**
- **Many causes & risk factors**
- **Largely preventable**
- **Systematic approach needed**

# Fall Incidence in Older Adults

[rate/person/yr]

	<u>Home</u>	<u>Hospital</u>	<u>Nsg Home</u>
<u>Any fall</u>	.3	1.5	1.7
<u>Severe fall</u>	.03(10%)	.3	.35(20%)
<u>Fracture</u>	.01	.05	.07
<u>Hip fx</u>	.003		.02

# Falls Mortality

---

- **Accidents: the 5th leading cause of death in older adults**
- **Deaths from falls: 2/3 of accidental deaths**
- **72% of U.S. fall-related deaths occur in the 13% of population age 65+**

# Costs of Falls

---

- 8% of pop  $\geq 70$  visit ERs for falls yearly
- 1/3 of these are hospitalized
- 5.3% of hosp patients  $\geq 65$  are due to falls
- U.S. cost est. 1995  $\rightarrow$  \$20 B. (2020  $\rightarrow$  \$32.4 B)
- 42% of fallers reduce activity after fall
- 18% restricted activity initiated by falls
- Precipitate NH entry

# **Causes of Falls: Imprecise at best**

---

- **Multiple causes usually involved**
- **Frequently not observed**
- **Poor recall of event**
- **Different ways to categorize cause:**
  - **Primary or precipitating cause**
  - **All contributing causes**
  - **Other risk factors**

# Causes of Falls: Summary of 12 Studies

---

■ Accident/environment	31%
■ Gait/balance disorder	17
■ Dizziness/vertigo	13
■ Drop attack	10
■ Confusion	4
■ Postural hypotension	3
■ Vision problem	3
■ Other specified	15
■ Unknown	5

# **Aging Changes:**

## **Contributors to “Accidental” Falls**

---

### **■ Gait changes**

- feet not picked up as high**
- slowing (~1%/yr) (shorter steps, ↓strength)**
- broader based, more cautious gait**

### **■ Postural instability**

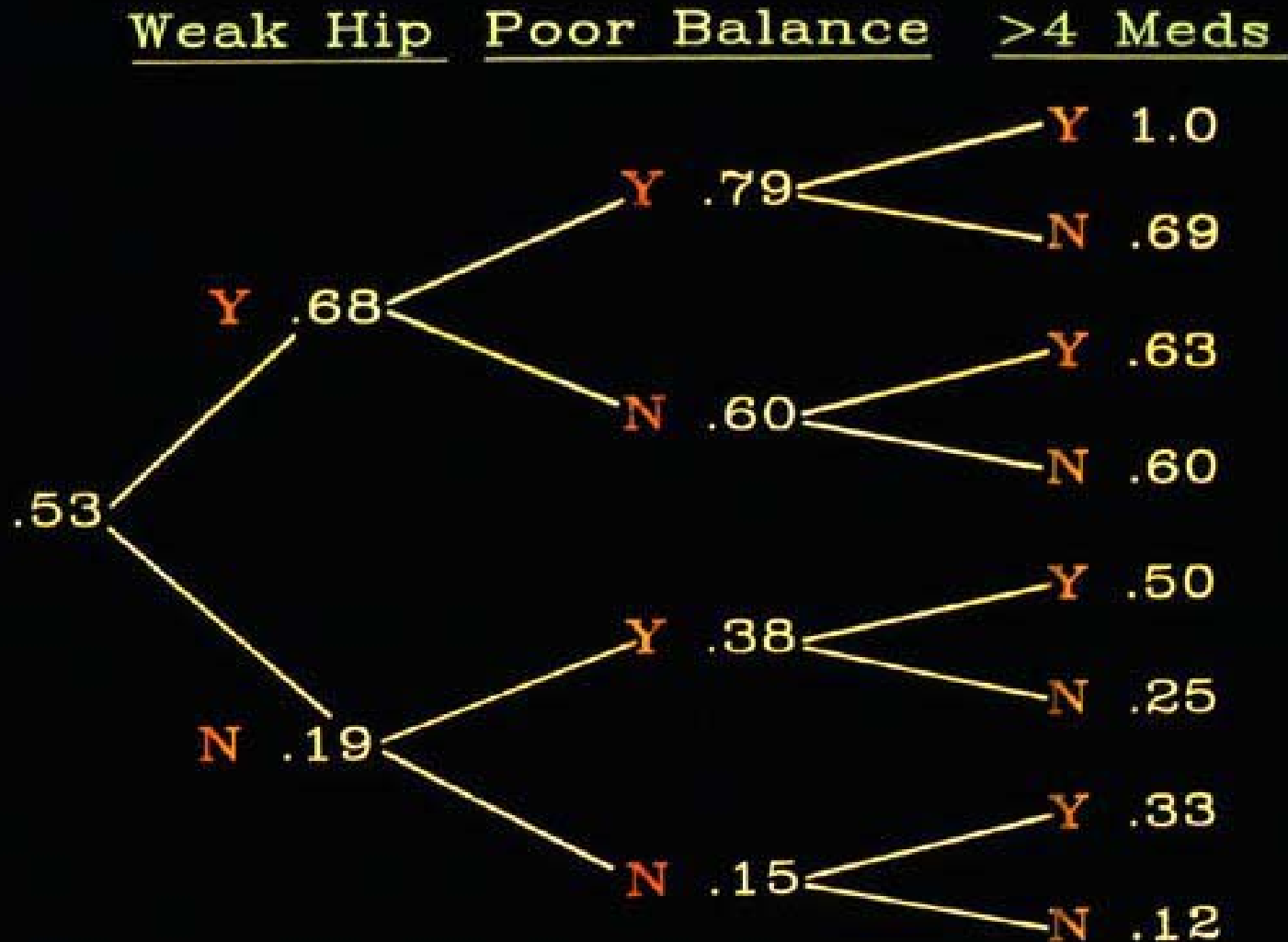
- slowed processing & propriocep: ↑sway**
- altered balance response “strategies”**

### **■ Impaired vision, hearing, memory**

# Risk Factors for Falls: 16 Multivariate Studies

<u>Factor</u>	<u>Signif/All</u>	<u>Mean RR</u>	<u>Range</u>
Weakness	10/11	4.4	1.5 - 10.3
Prior fall	12/13	3.0	1.7 - 7.0
Balance deficit	8/11	2.9	1.6 - 5.4
Gait deficit	10/12	2.9	1.3 - 5.6
Assistive device	8/8	2.6	1.2 - 4.6
Vision deficit	6/12	2.5	1.6 - 3.5
Arthritis	3/7	2.4	1.9 - 2.9
ADL deficit	8/9	2.3	1.5 - 3.1
Depression	3/6	2.2	1.7 - 2.3
Cognitive deficit	4/11	1.8	1.0 - 2.3
Age >80	5/8	1.7	1.1 - 2.5

# 12-Month Fall Rate in NH: Interacting Risk Factors



# Drugs & Falls: Meta-analysis

Leipzig, Cumming, Tinetti, JAGS, 1999

---

- **Psychotropics, any: 1.73** (1.52-1.97)
  - Neuroleptics: **1.50** (1.25-1.79)
  - Sedative/hypnotics: **1.54** (1.40-1.70)
  - Antidepressants: **1.66** (1.40-1.95)
  - Benzodiazepines: **1.48** (1.23-1.77)
- **Diuretics: 1.08** (1.02-1.16)
- **Anti-arrhythmics (Ia) : 1.59** (1.02-2.48)
- **Digoxin: 1.22** (1.05-1.42)

# Fall Injury Risk Factors

---

<u>Risk Factors</u>	<u>Signif/All</u>
Gait/balance deficit	3/6
Cognitive deficit	3/6
Female sex	3/6
Vision deficit	2/6
Medications	2/6
Weakness	2/5
ADL deficit	2/6
Low body mass	2/6
Higher activity	1/6

# Fall Risk Assessment Measures

Perell K, et al *J Gerontol Med Sci* 2001.

---

## ■ Review of 20 fall risk measures

- 14 nursing tools, 6 functional tools

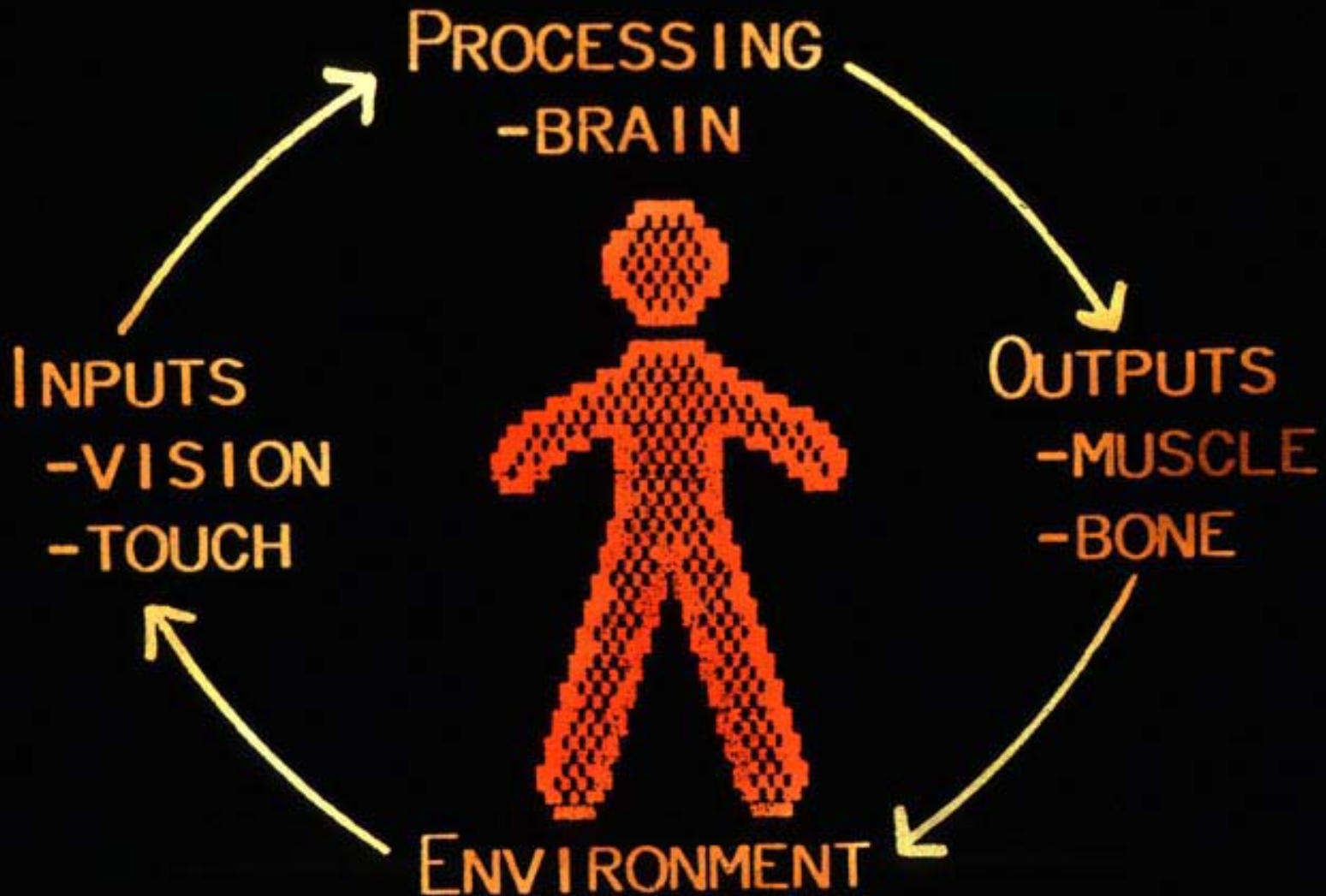
## ■ Common items for nursing tools:

- mental status (13), fall hx (10), mobility (10), other dx (8), incontinence (8), drugs (7), sensory deficits (7), balance (5), age (4), ADLs (4), assistive device (4), weakness (4), gender (3), acuity (3), restraint use (1)

## ■ Best measures overall

- Hospital: Oliver '97, Schmid '90, Morse '89, Hendrick '95, Rapport '93
- Outpatient: Shumway-Cook '00, Cwikel '98, Tinetti '86, Berg '89
- NH: “universal precautions” (or Morse '89, Shumway-Cook '00)

# Control of Balance & Gait: An Interactive Feedback Loop



# Tinetti Balance & Gait Scale:

---

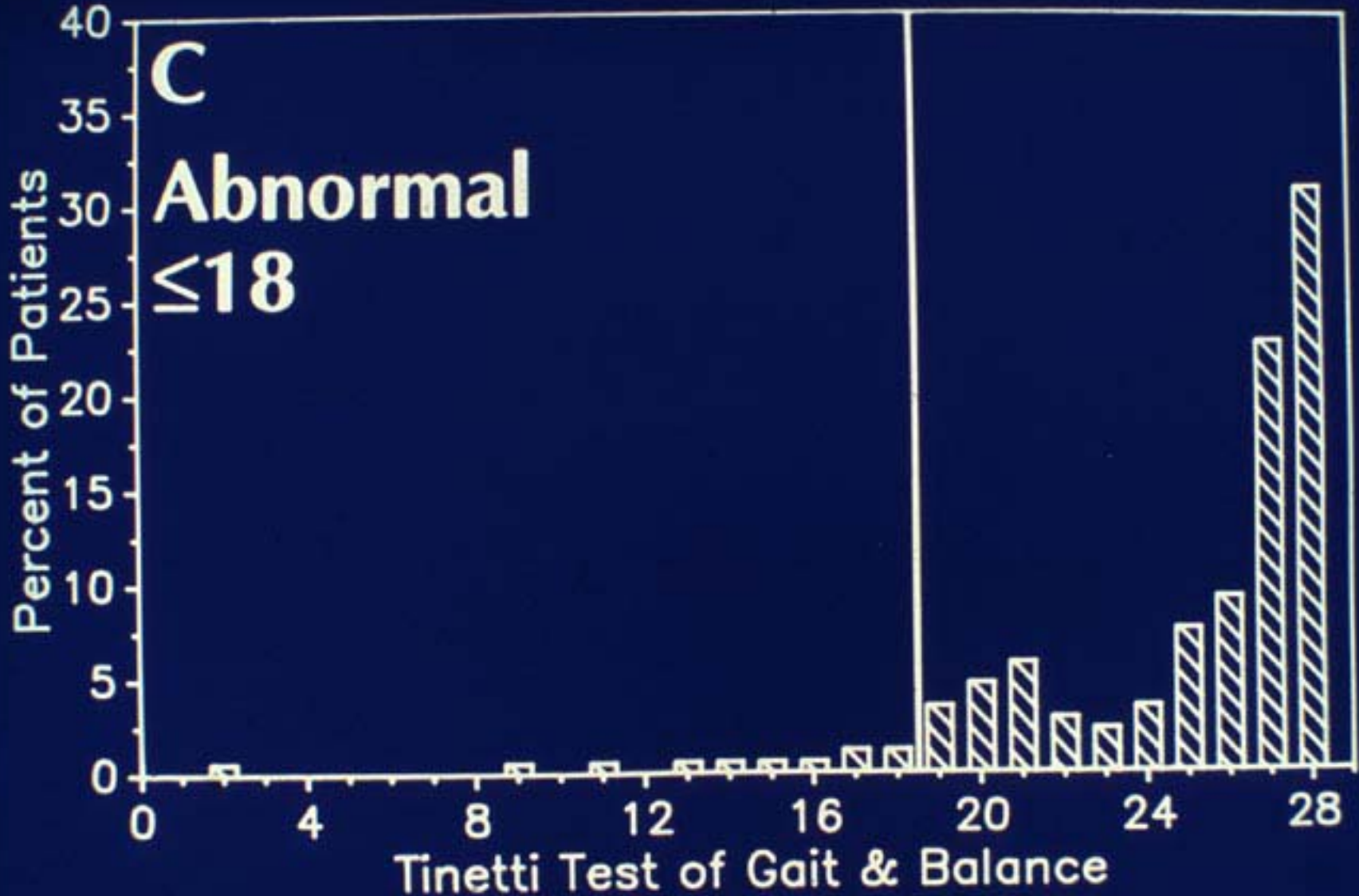
## Balance (16 pts)

- Sitting balance (1)
- Rising from chair (4)
- Standing balance (4)
- Nudge (2)
- Eyes closed (1)
- Turning 360° (2)
- Sitting down (2)

## Gait (12 pts)

- Initiation (1)
- Step length (2)
- Step height (2)
- Continuity (1)
- Symmetry (1)
- Stance/sway (3)
- Path deviation (2)

# Gait/Balance Scores in Medical Pts Age 65+



# Gait Disorders: *Classic Patterns*

---

- **ataxic** (*sens, cerebellar*)
- **spastic** (*pyram. dysfct*)
- **steppage** (*foot drop*)
- **waddling** (*weak glut's*)
- **frontal lobe** (*DAT, NPH*)
- **hemiplegic/paretic**
- **short-leg**
- **age-related** (*"senile"*)
- **Vestibular**
- **Parkinsonian**
- **Dystonic**
- **Drunken**
- **Toppling**
- **Antalgic**
- **Trendelenberg**
- **Weakness**

# Pathologic Gait: Causes

---

- **Decreased ROM** (*eg, arthritis, contractures*)
- **Weakness** (*eg, deconditioning, neuropathy*)
- **Sensory/balance deficit** (*eg, stroke, neuropathy*)
- **Spasticity** (*eg, stroke, cord lesion*)
- **Pain** (*eg, arthritis, injury*)
- **Impaired central processing** (*eg, dementia, delirium, stroke, drugs*)

# Environmental Fall Risk Factors

---

## *Home*

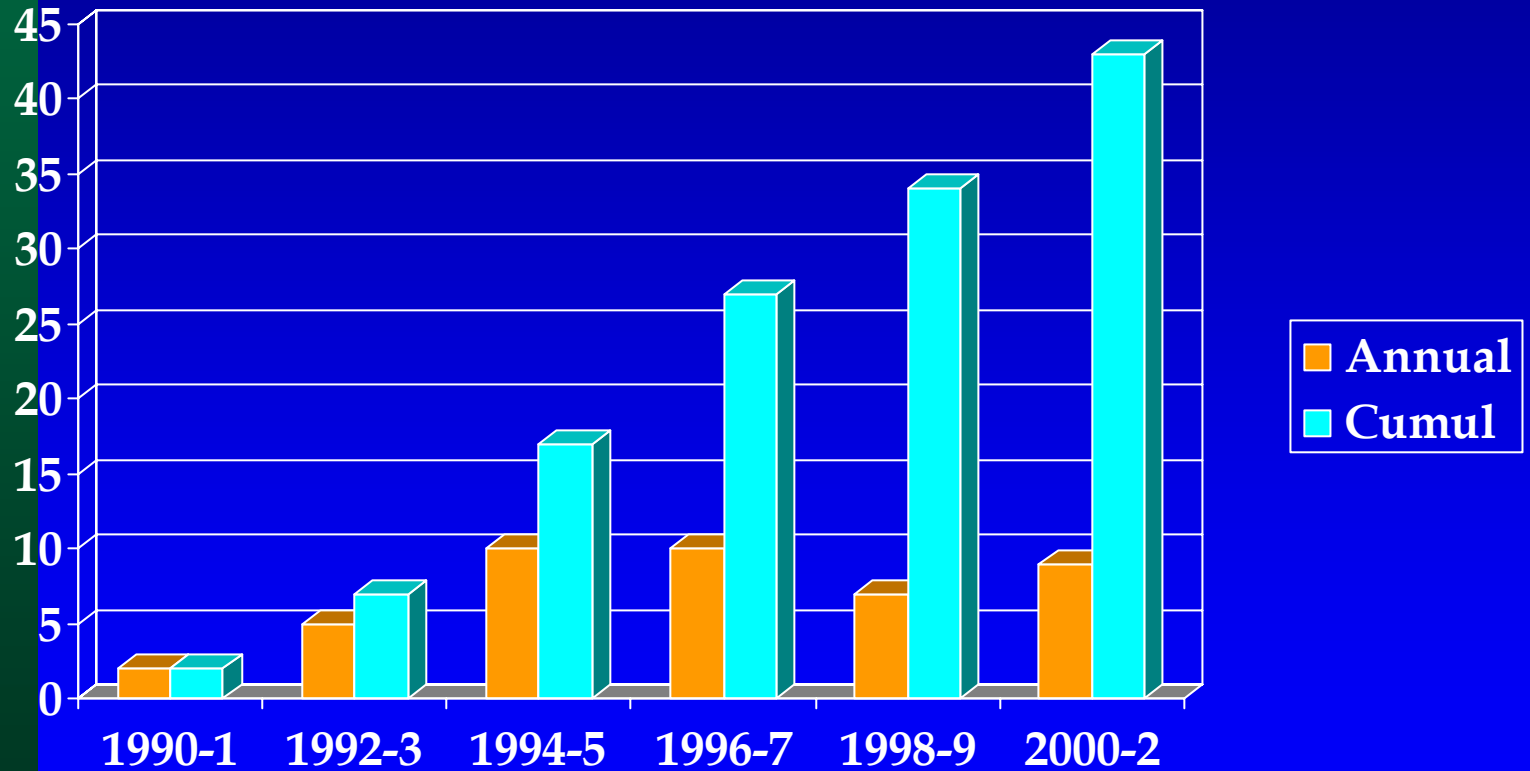
- unstable furniture
- poor stairs & railing
- hazardous rugs/carpets
- poor lighting
- low beds & toilets
- objects on floor
- pets
- medication excess

## *Institution*

- recent admission
- hazardous furniture
- slick hard floors
- unsupervised activities
- reduced # of nurses
- meal times
- absent hand rails
- poor lighting

# Fall Prevention: Growth of RCTs

---



# Fall Prevention Trials

---

- **Assessment (preventive & post-fall)**
- **Exercise & rehabilitation programs**
- **Environmental modifications**
- **Devices**
- **Nursing interventions**
- **Combined interventions**

# Benefits of a Post-Fall Assessment

Results of a Randomized Controlled Trial in NH

---

- **Intervention:** 1-2 hr post-fall assessment protocol by GNP (H&P, gait/bal, envir, lab); Feedback to PCP (dx, risk factors, recs)
- **Setting/sample:** 700-bed LTC facility, 2/3 F, age  $x=88$ , 160 fallers randomized, 2 yr f/u.
- **Results:** ↓9% falls in assessed group (n.s.)
  - ↓17% mortality (n.s.)
  - ↓52% hosp days ( $p<.01$ )

Rubenstein et al, *Ann Intern Med*, 113: 308, 1990

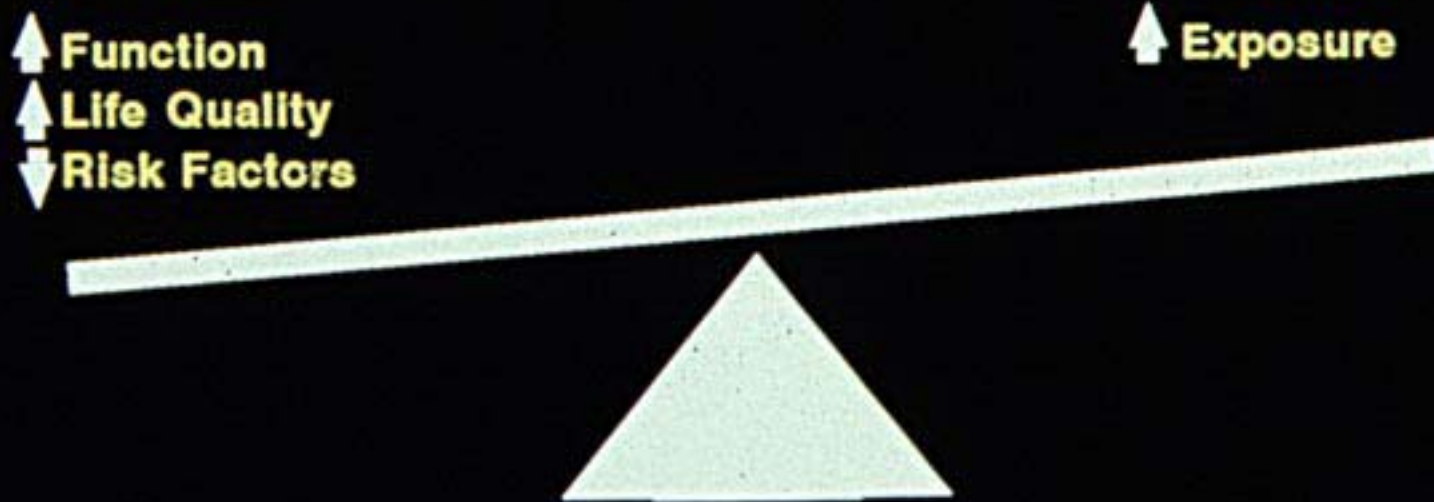
# Prevention of Falls in the Elderly Trial (PROFET)

---

- Randomized trial of post-fall assessment of fallers seen in ED & assessed by 7 days.
  - N=397,  $\geq 65$  (mean age 78); London
- Assessment revealed many causes and risk factors and generated many referrals.
- 12-month follow-up: Intervention group had reduced risk of falls (OR=.39) & hospital admissions (OR=.61). Controls had greater decline in function.

# Exercise & Falls

a dynamic balance



# The FICSIT Trials:

## Frailty & Injuries: Coop Studies of Intervention Techniques

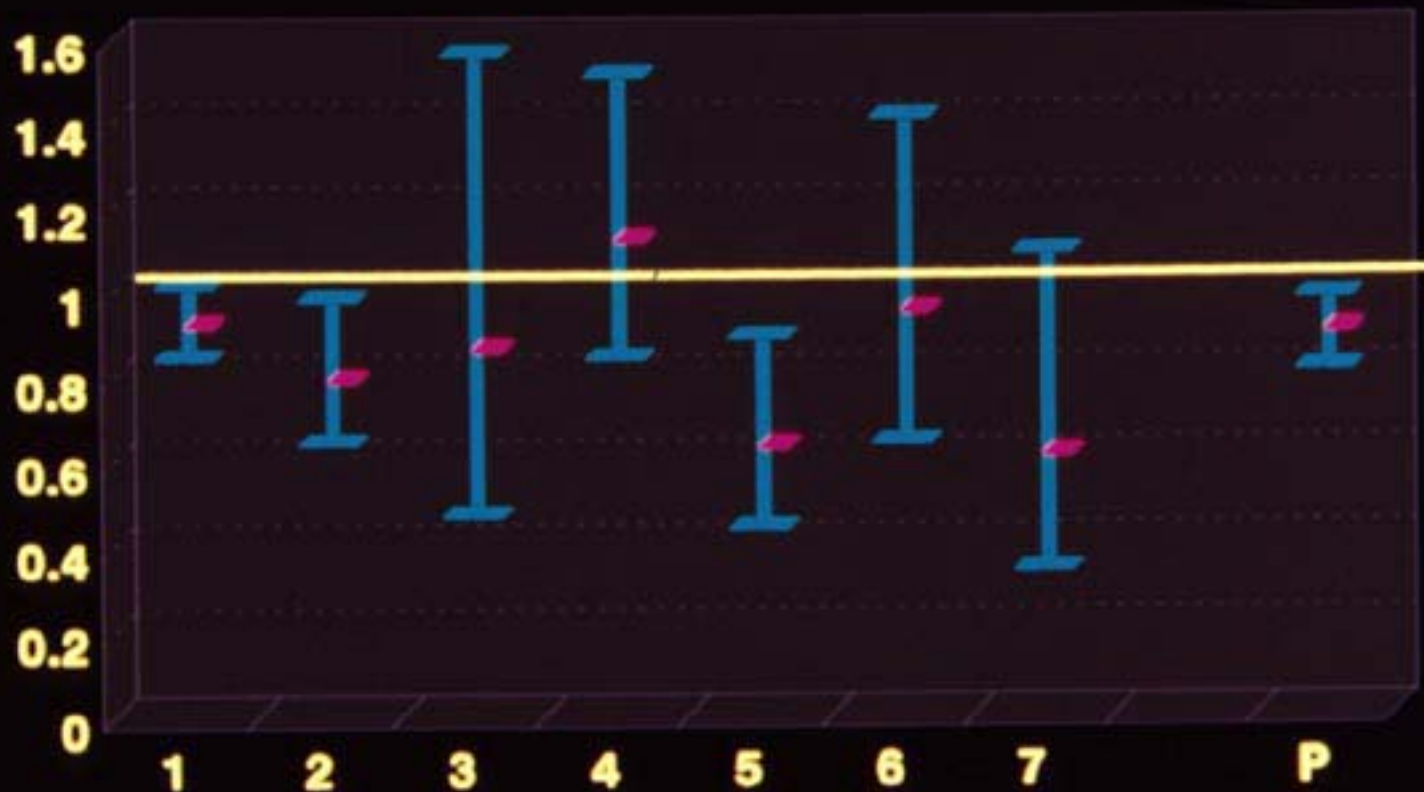
---

- **7 independent randomized controlled trials**
  - N: Total = 2328, Mean = 333, Range = 100-1323
  - Sites: Atlanta, Boston, Farmington, New Haven, Portland, San Antonio, Seattle
- **Variety of interventions to reduce falls & frailty, all included exercise**
- **Exercise lasted 10-36 weeks,  $\geq 2$  year follow-up**
- **Pooled effects on falls: .90 (95% CI, .81-.99)**
  - **Effect for balance exercises: .83 (.70-.98)**

Province, MA, Hadley EC, Hornbrook MC, et al.  
*JAMA*. 1995; 273(17):1341-1347

# FICSIT Studies Meta-analysis

## Effect of Exercise Intervention on Fall Risk



Province MA, Hadley EC, Hornbrook MC, et al.  
*JAMA*. 1995; 273(17):1341-1347.

# Nursing Interventions

---

---

- Risk assessments (Morse, Hendrich, MDS)
- Treat identified risks
- Universal fall precautions:
  - call light & assist devices close
  - bed wheels & w/c brakes locked
  - adequate lighting
  - clean spills immediately
  - patient orientation & staff educ
  - low beds
  - non-skid slippers
  - rails & grab bars
  - clutter-free rooms
  - clear signage
- For high-risk patients:
  - move closer to nursing station
  - increased observation / sitter
  - bed-chair alarms
  - floor mats
  - special careplans
  - hip protectors

# Do Bedrails Prevent Falls? Pre-Post Study

AHC Hanger et al, *J Am Geriatr Soc*, 47:529, 1999

---

- Study of falls in New Zealand hospital
  - 6-mo before & 6-mo after bedrail restriction program.
- After policy, fewer beds w/ rails (29.6% → 13.7%).
- Total falls/10,000 bed-days:    before-165    after-192
  - Falls around bed/10,000 b-d:    before-89    after-106
  - Serious fall injuries:    before-33    after-18
  - Minor fall injuries:    before-43    after-60

# Effect of Hip Protectors on Fractures

Lauritzen JB, *Lancet* 341:11-13, 1993

---

- Randomized trial in 10 NH wards (Denmark)
  - n=247 subjects, 418 controls; 11-month f/u
- ↓Hip fx at f/u: 8 subj, 31 cont (RR=.41, 0.18-0.82)
  - No subject w/ hip fx was wearing pad.
  - No effect on non-hip fx (RR=.94, 5.51-1.7)



**Hip protector.**

# Finnish Hip Protector Trial

Kannus P, *N Engl J Med* 343: 1506-13, 2000

---

- Randomized trial in 22 Finnish geriatric care programs
  - $n=653$  subjects, 1148 controls; age 70+;  
2/3 NH, 1/3 home care;  $\geq 1$  hip fx risk factor
  - 2-yr f/u
- ↓ Hip fx at f/u: 21/1000 vs. 46/1000 pers-yr (RR=.4, 0.2-0.8)
  - ↓84% hip fx among fallers wearing protectors
  - Trend toward lower pelvic fx, no effect other fx
  - NNT to prevent one hip fx / yr = 41 (25-115)

# Swedish NH/ALF Fall Prevention Study

Jensen, Nyberg et al. *JAGS* 51:627-35, 2003

---

- RCT (cluster) of 9 NHs/ALFs
- N=362, stratified by MMSE  $\geq 19$  &  $< 19$
- Intervention: Staff ed, environ mod, exercise 3d/w, medication evals, hip protectors, post-fall confs.
- 34-wk f/u (Int vs Cont):

	<u>Hi Cog</u>	<u>Lo Cog</u>
– Faller %	38 vs 54*	54 vs 61
– Fall rate (f/p/y)	1.8 vs 2.9*	3.5 vs 3.3
– Hip fracture	3 vs 2	0 vs 8*

# German NH Fall Prevention Study

Becker, Kron et al. *JAGS* 51:306-13, 2003

- RCT (cluster) of 6 NHs in Ulm Germany
- N=981 (Intervention=509, Control=472)
- Intervention: Staff & pt ed, environ mod, exercise 2d/w, hip protectors (28% adherence).

■ 52-wk f/u:	Interv'n	Cont	RR
Fall rate (f/p/y)	<b>1.4</b>	<b>2.6</b>	<b>0.55*</b>
Fallers %	<b>37</b>	<b>52</b>	<b>0.75*</b>
Fractures %	<b>6.4</b>	<b>7.4</b>	n.s.

(No hip fx while wearing pads)

# **Hospital Falls Prevention Program: Australian RCT – Haines et al *BMJ*: 328,2004.**

---

- **1042 consecutive adms to sub-acute hosp, 626 (60%) consented to randomization**
- **Mean age 80, 33% men; mean LOS 32 d**
- **Intervention: Fall risk alert card, Hip pads, Exercise prog TIW, Education prog BIW,**
- **30% fewer falls in intervention group**
- **Most effect after day 45**
- **2 hip fx in each group**

# Ca+VitD *May* Reduce Fall Risk

Larsen ER, et al. *J Bone Miner Res* 2004

---

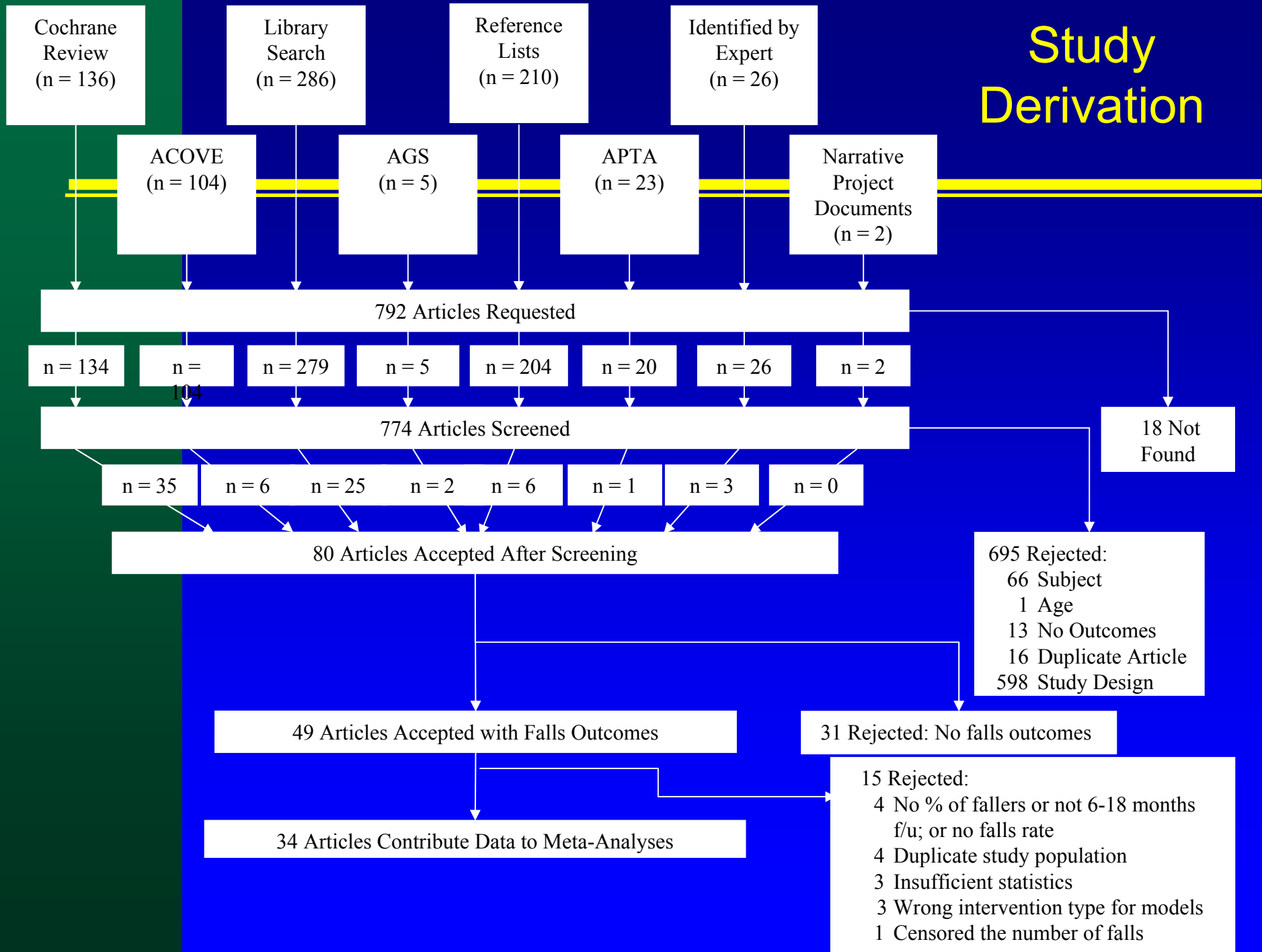
- 4-group cluster RCT in Danish city
- n=9605 (half given Ca+VitD -- 1gm+400iu, 60% F, mean 3 yr f/u, 80% low serum VitD)
- Reduction in osteoporotic fx
- Females had small reduction in falls leading to hosp (78 vs 72 per 1000 pt yrs), RR = .88, p<.05. No effect for males or overall.
- Authors postulate positive effect of VitD on neuromuscular function.

---

# **Evidence Report : RAND-CMS Healthy Aging Project**

Falls Prevention Interventions in  
the Medicare Population, 2002

# Study Derivation



# Meta-regression Estimates of the Effect of Individual Intervention Components

Treatment Component	Subjects who fell at least once		Mean number of falls	
	Number of Studies (Arms)	Adjusted Risk Ratio (95% CI)	Number of Studies (Arms)	Adjusted Incident Rate Ratio (95% CI)
Focused Falls Risk Assessment with Follow-up	8 (8)	<u>0.83</u> (0.71, 0.98)	5 (5)	<u>0.54</u> (0.41, 0.71)
Exercise	11 (12)	0.88 (0.74, 1.04)	17(18)	<u>0.80</u> (0.70, 0.92)
Environmental Modifications	2 (2)	0.92 (0.73, 1.16)	3 (3)	<u>0.71</u> (0.52, 0.93)
Education	2 (3)	1.31 (0.95, 1.79)	1 (1)	0.33 (.09, 1.26)

# Exercise Components

Exercise Type	Subjects who fell at least once		Mean number of falls	
	Number of Studies (Arms)	Adjusted Risk Ratio (95% CI)	Number of Studies (Arms)	Adjusted Incident Rate Ratio (95% CI)
Balance	7 (8)	0.94 (0.74, 1.19)	13 (14)	<b><u>0.73</u></b> (0.61, 0.86)
Endurance	7 (7)	<b><u>0.80</u></b> (0.66, 0.98)	4 (4)	1.19 (0.77, 1.84)
Flexibility	4 (4)	0.72 (0.41, 1.25)	5 (5)	0.90 (0.60, 1.34)
Strength	8 (9)	0.80 (0.54, 1.20)	13 (13)	0.91 (0.67, 1.23)

# Fall Prevention Trials: RAND-CMS Meta-analysis

---

- Lit review (1980-2002): 830 pubs, 41 RCTs

	<u>Fall risk</u>	<u>Monthly fall rate</u>
<u>All RCTs:</u>	.88 [.82 - .95]	.80 [.72 - .88]

## Meta-regression of intervention components:

• <u>Fall eval + f/u</u>	.82 [.72 - .94]	.63 [.49 - .83]
• <u>Exercise</u>	.86 [.75 - .99]	.86 [.73 - 1.0]
• <u>Environ mod</u>	.90 [n.s.]	.85 [n.s.]
• <u>Education</u>	[n.s.]	[n.s.]

# **AGS/BGS Guideline for Prevention of Falls in Older Persons**

---

## **Aim of Guideline:**

- **To assist health care professionals in assessing fall risk and in management of older people at risk of falls and who have fallen**

# The Panel

---

## **Co-Chairs:**

Laurence Rubenstein, MD (AGS)  
Rose Anne Kenny, MD (BGS)

## **Associate Co-Chair:**

Kenneth Koval, MD (AAOS)

## **Guideline Specialist:**

Martin Eccles, MD

## **Workgroup Co-Chairs:**

Finbarr Martin, MD (assessment)  
Mary Tinetti, MD (intervention)

## **Working Panelists:**

David Apple, MD  
Judith Cantrill, PharmD  
John Chang, MD  
Pamela Duncan, PhD, PT  
Margaret Ellis, PhD, OT  
Teresita Hogan, MD  
Lewis Lipsitz, MD  
Michael Rich, MD  
Neville Strumpf, RN, PhD  
W. Angus Wallace, MD  
Archie Young, MD

# Evidence Based Guideline for Fall Prevention (AGS-BGS-AAOS Task Force, 2001) SUMMARY

---

## ■ Assessment

- **Inquire** about falls, gait, balance at routine visits (at least annually).
- **Screen** persons reporting a problem (e.g., “get up & go” test).
- **Assess** persons failing screen, or w/ >1 fall:
  - Hx of fall circumstances, meds, chronic illness, mobility level
  - Examine gait, balance, orthostasis, vision, neuro, cardiovascular

## ■ Management of Fallers

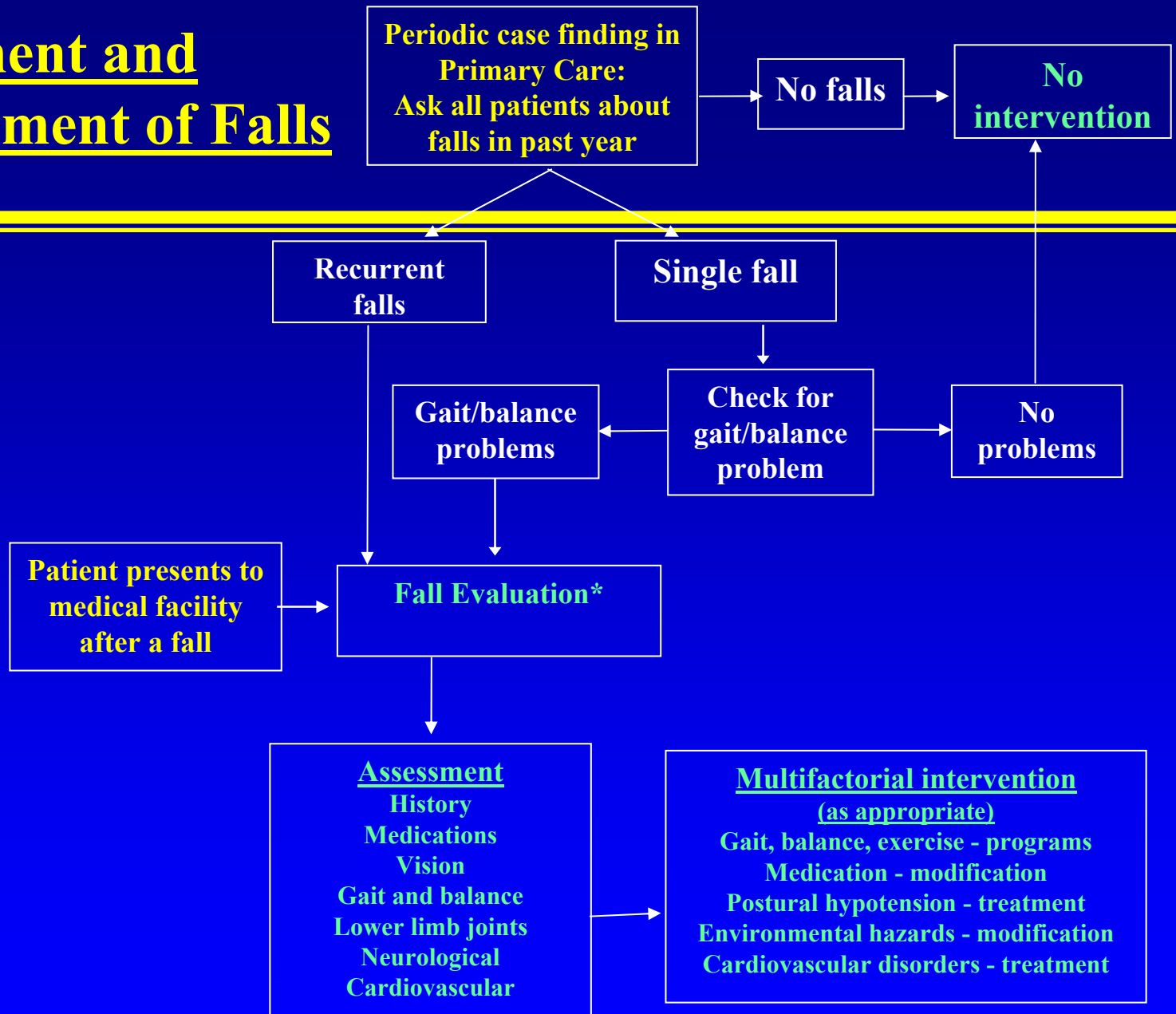
- **Multi-component interventions:** assessment & f/u, exercise, gait training, med review, treatment (e.g., visual, cardiac, orthostasis)
- **LTC setting interventions:** assessment & f/u, staff education, gait training & assistive devices, medication review & adjustment
- **Single interventions:** assessment & f/u, exercise (esp balance), environmental assm't/mod, medication review & adjustment

# Other Evidence-based Observations

---

- **Some interventions can clearly benefit fallers, while not reducing falls *per se***
  - **Hip protectors**--prevent hip fx in high risk persons
  - **Bone-strengthening agents** (e.g., HRT, calcium, vit D, anti-resorptives)--prevent fractures
- **Insufficient evidence on some interventions**
  - Hosp fall-prevention programs, specific footwear mods, cardiac pacing, vision interv alone, asst devices alone
- **Negative evidence on some interventions**
  - Restraints, education/behavioral interventions alone

# Assessment and Management of Falls



# Quality of Care Indicators for Falls & Mobility Disorders (ACOVE Project) (Part 1)

---

1. All vulnerable elders should be ***asked about recent falls*** at least annually
2. All vulnerable elders should be ***asked about or examined for balance &/or gait problems***
3. If pt reports >1 fall in past yr (or 1 w/ Rx), then ***basic falls evaluation*** should be done:
  - a) History: fall circumstances, meds, medical probs, mobility/ambulatory status
  - b) Exam: orthostatics, vision, gait, balance, neuro

# Quality of Care Indicators for Falls & Mobility Disorders (ACOVE Project) (Part 2)

---

4. If pt has problem w/ balance or gait, then a ***basic gait/balance eval*** should be done
5. If pt has problems w/ balance or proprioception, then ***exercise program & assistive device evaluation*** should be offered
6. If pt has problem w/ gait, strength, or endurance, then an ***exercise program*** should be offered

# Fall Prevention Strategies

---

## ■ COMMUNITY

- Risk-factor screen & intervention
- Post-fall assessment
- Exercise program (strength, balance)
- Environmental inspection & modification

## ■ INSTITUTION

- Organized program
- Risk-factor screen
- Post-fall assessment
- Nurse awareness
- Targeted interventions (e.g., hip pads, low bed, bed/ chair alarms, monitors)

# **What do we still need to know?**

## **Quite a bit!**

---

- **Fine tuning of effective interventions**
- **Matching the right persons to do-able interventions**
- **Recruiting populations & maintaining adherence**
- **Creating overall system(s) that work, both institutional and community**

# Setting a Research Agenda for Fall Prevention: Expert Recs

---

- **Mary Tinetti, 1994**
- **Medicare, 1998**
- **AGS/BGS Task Force, 2001**
- **Stephen Lord, 2001**
- **British Columbia, 2002**
- **VA VISN 8 Patient Safety Center, 2002**
- **California Blueprint, 2003**

# Fall Prevention Research Agenda:

**Tinetti ME, *Preventive Medicine*, 1994; 23:756-62.**

---

- Do falls cause functional decline & increase utilization, or are they markers?
- What are the risk factors for falls & injuries?
- Which fall outcomes to target (fall vs injury)?
- What is role of physical activity & exercise? What types of exercise are most beneficial?
- Which subgroups to target (eg, healthy vs frail)?
- Ideal components of fall prevention programs (eg, risk modification, multidimensional, intensity)?
- Ideal delivery method (eg, PH recs, direct delivery)?

# Fall Prevention Research Agenda:

AGS/BGS Fall Guideline Task Force: *JAGS* 2001; 49:664-72

---

- Cost-effectiveness of recommended strategies?
- Who will benefit most?
- Effective hospital program elements?
- Preventing falls in demented patients?
- Effective elements of exercise (type, freq., dur.)?
- When is home assessment effective?
- Assistive device (eg, cane, walker) effectiveness?
- Effect of restraint removal?
- Effect of treating visual problems?
- Safest footwear?
- Hip protectors: Best designs? Compliance?

# **Fall Prevention Research Agenda:**

## **California Blueprint for Fall Prevention, 2003**

---

- **Crucial parts of multi-component programs**
- **Optimal recruitment & retention strategies**
- **Exercise: Optimal type, duration & frequency**
- **Optimal reassessment interval**
- **Program efficiency, effectiveness/safety tradeoffs**
- **High-risk targeting vs. community-wide programs**
- **Group vs. individual exercise programs**
- **How to provide comprehensive assessments:  
manpower, scheduling & financing issues**

# Fall Prevention Research Agenda: Common Elements

---

- Optimal intervention components
- Optimal exercise characteristics
- Recruitment: who, where, how often
- Best assistive devices & footwear
- Environmental mod: strategies, elements
- Enhancing compliance: exercise, devices, assessment recs
- Innovative technology
- Program cost-effectiveness

# Conclusions

---

- Falls: Common, debilitating, expensive
- Preventable w/ existing technology
  - Assessment+f/u, exercise, environment mod
- System needed to mobilize evidence-based preventive approaches
- Prevention probably cost-effective

