



February 26, 2020
ALMA Santa Marta

VI CURSO DE EGRESADOS DE ALMA
"ACTIVIDAD FÍSICA, CAÍDAS Y FRACTURAS"
SANTA MARTA, COLOMBIA
Del 25 al 28 de febrero de 2020

Falls in Older Adults

Epidemiology, Prevalence, Assessment, Challenges, and Proposed approach

Manuel Montero-Odasso MD, PhD, AGSF, FRCPC

Professor, Departments of Medicine (Geriatrics), and Epidemiology and Biostatistics
Division of Geriatric Medicine, The University of Western Ontario
Director, Gait and Brain Lab, Parkwood Institute
Scientist, Lawson Health Research Institute, London ON







Sometimes it is easy to understand why we fall,



...but other times not

**World Health Organisation
defines a fall as:**



**World Health
Organization**

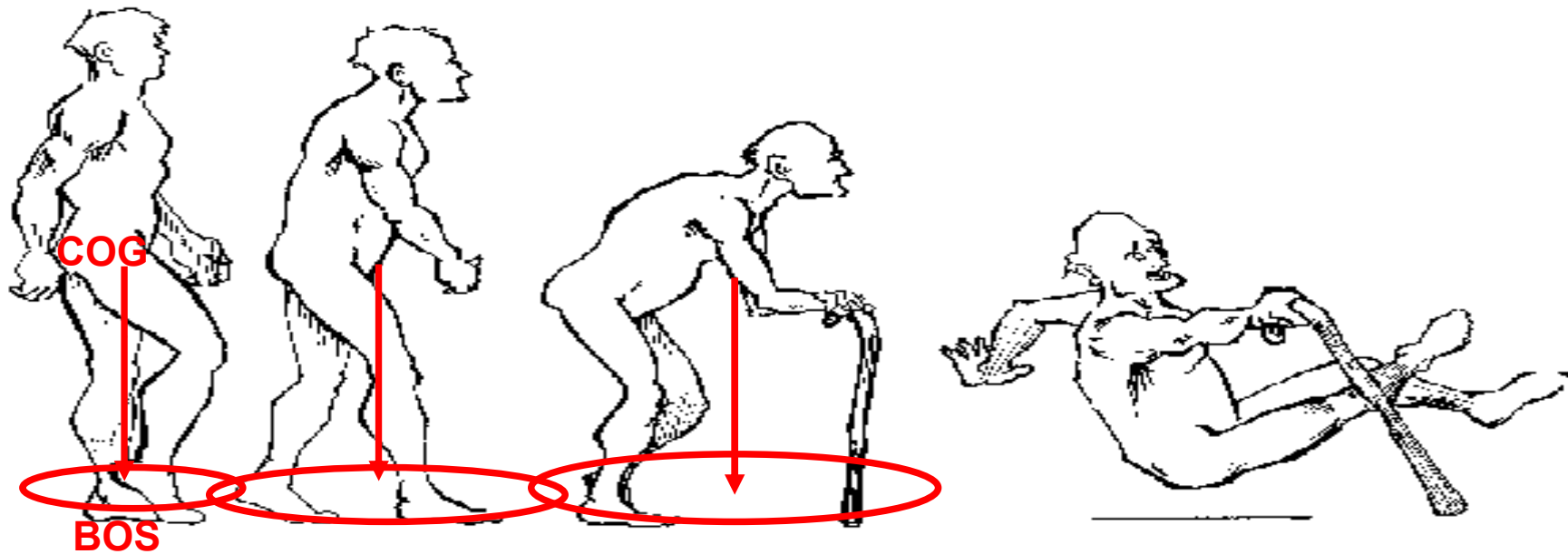
“An event which results in a person coming to rest inadvertently on the ground or floor or other lower level”.

Excluded:

- major internal event e.g. stroke
- being hit by an external force e.g. knocked over

Why are we prone to fall?

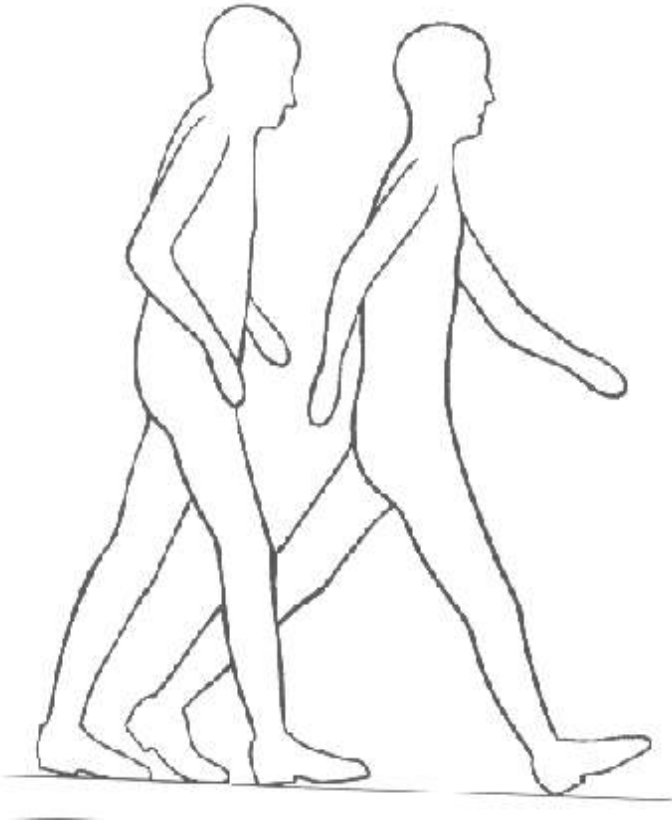
- Most of the falls happen while walking
- The upright human body position is unstable



COG: center of gravity
BOS: base of support



Age-associated changes of posture and gait



- Forward flexion, head and torso
- Increased flexion, shoulders and knees
- Decreased stride length and arm swing
- Slower gait
- Increased lateral sway



Falls are prevalent

25% of elderly people have at least 1 fall per year

75% of fallers will fall again in the same year

Community Non-disabled	Community Disabled	In Hospital	Nursing Home
15%	30%	40%	60%



Falls are prevalent

25% of elderly people have at least 1 fall per year

75% of fallers will fall again in the same year

Community Non-disabled	Community Disabled	In Hospital	Nursing Home
15%	30%	40%	60%



Falls cause morbidity and mortality

Mortality

- FALLS accounts 70 percent of accidental deaths in older persons (they are the 5th cause of death in elderly persons)

Morbidity

- **20%** Develop fear of falling
- **15%** Have enough injury to visit Emergency Department due to pain, bruises, or dizziness
- **10%** Have a severe injury non-fracture. e.g.: head injury, brain hemorrhages, chest trauma
- **5%** Have a fracture (1% hip fracture)



Table 1. Frequent consequences of the fall syndrome in older people

Cause:	Consequence:
Medical	Head Trauma Cutaneous Haematoma Fracture Chronic Pain Death
Psychological	Fear of falling Anxiety Loss of confidence Depression
Social	Dependency Isolation Placement in long term care
Functional	Immobility Deconditioning Disability and dependence



Consequences of falls

Not all falls lead to injuries

- 54% of community dwelling elderly experience fear of falling
- 38% associated avoidance of activity
- underreported because
 - most fearful elderly not included
 - and fear of stigmatization

Fear of falling results in debilitating spiral of loss of confidence

- restricted activities & reduced physical fitness
- increased risk for future falls
- reduced functioning
- premature nursing home admissions



Falls are often multifactorial

Intrinsic Factors

Medical conditions

Impaired vision
and hearing

Muscle/bone
changes

Medications

FALLS

Extrinsic Factors

In-hospital hazards:
iv, catheters,

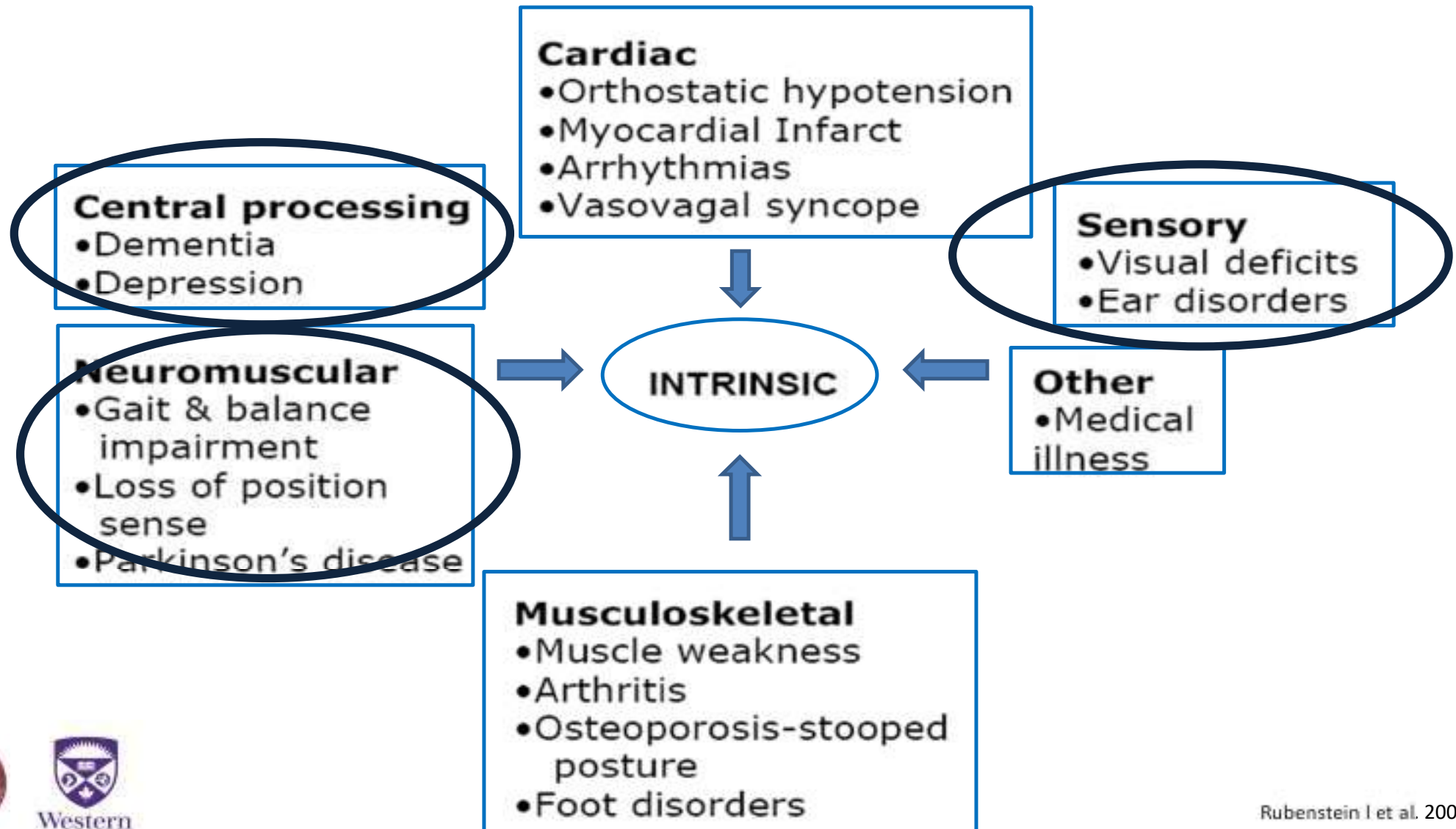
Improper use of
assistive devices

Environment

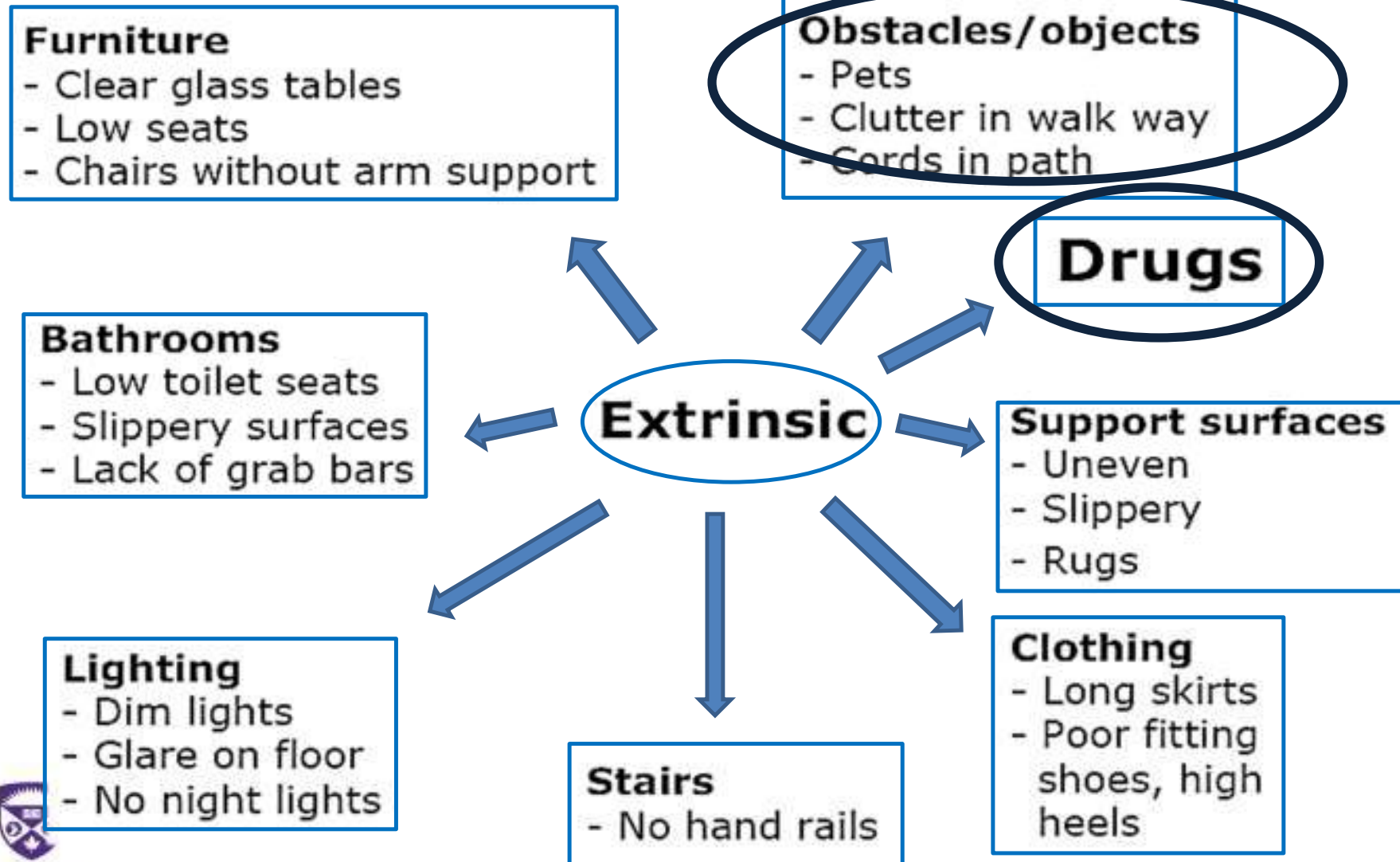
Co-morbidity & Frailty increase the risk of falls



Intrinsic (Personal) Factors Causing Falls



Extrinsic (Environmental) Factors



Interaction of risk factors

- The remainder of falls result from multiple interacting factors
- Falls result from “interactive” etiological factors, not simply from the additive effects of multiple pathologies



Interaction of risk factors

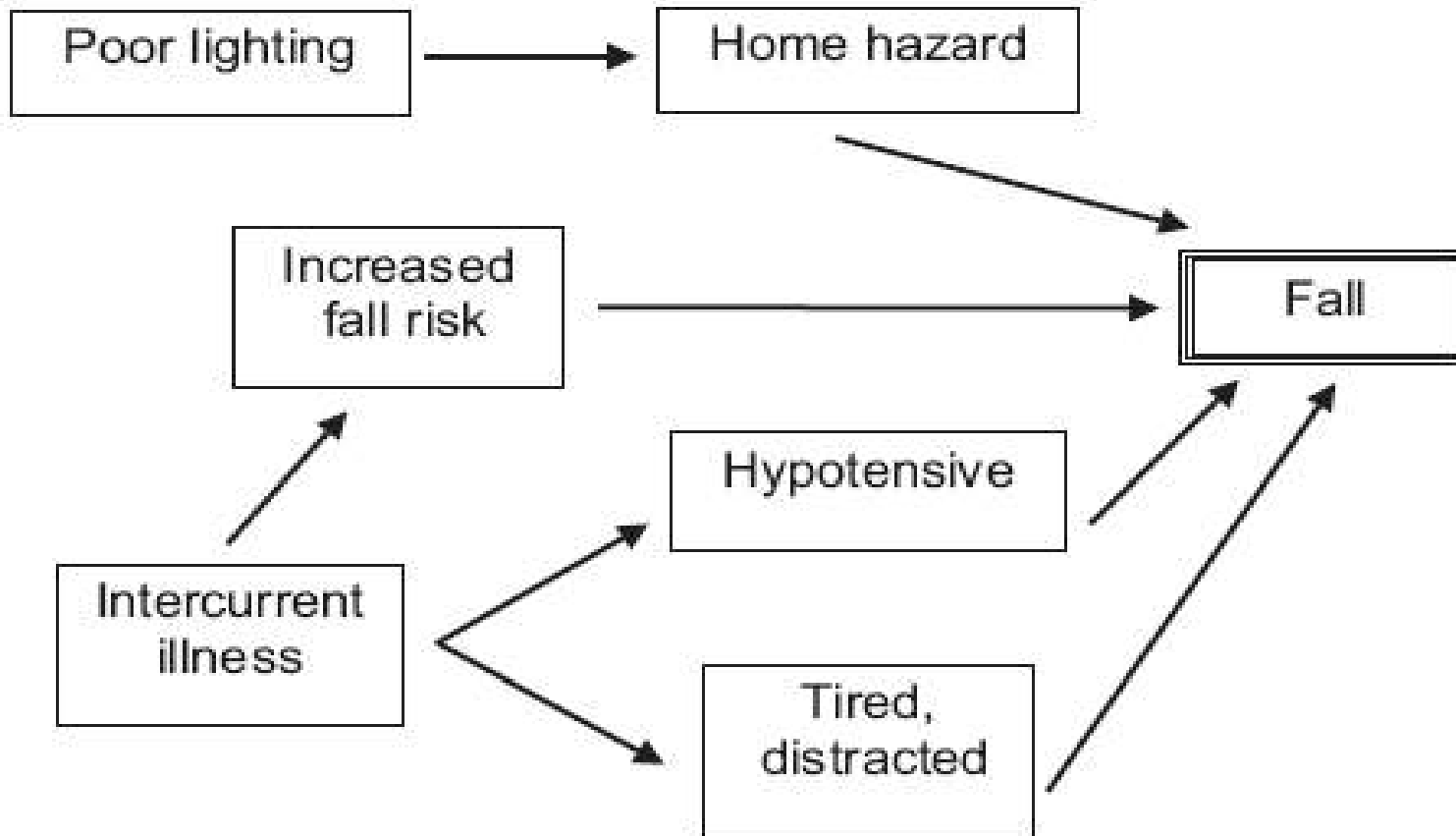


Figure 2. Interaction of risk factors precipitating falls.

Interaction of risk factors

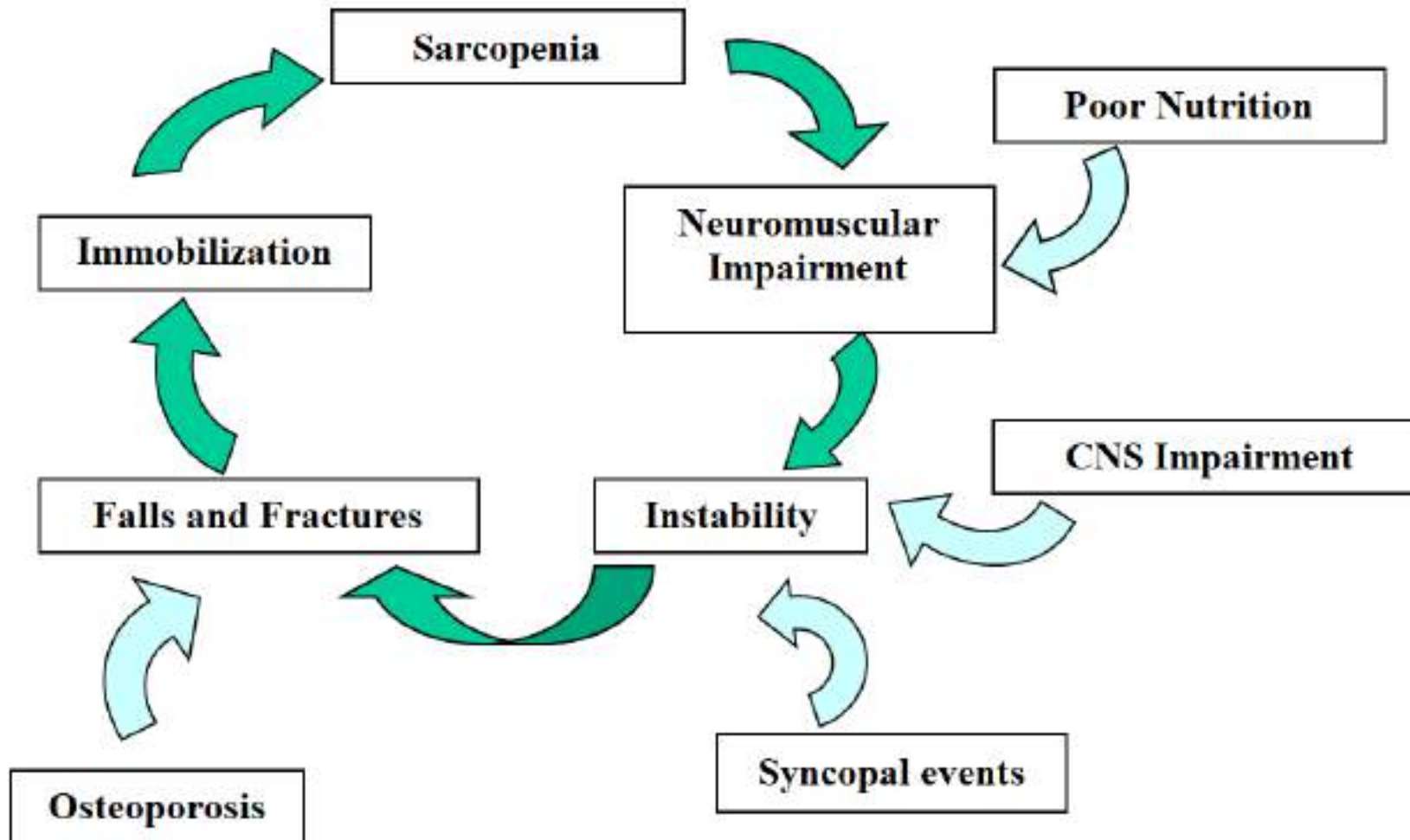


Figure 1. Vicious cycle in falls and fractures and principal contributors.

Montero-Odasso et al. Preventing Falls & Injuries, & Healthy Aging. In Healthy Aging. 2019 Springer-Verlag Publisher.



**Why is important the risk factor
assessment?**

Table 2. Cause of falls according risk factor identification and grouped regarding potential management based on observational and clinical trials evidence.

Domain Assessed:	Risk Factor / Disease:	Level of evidence^a	Screen/Assessment:	Management:
Neuromuscular	Parkinsonism syndrome Balance and gait problems Lower extremity weakness	Ia Ia Ia	Gait velocity test Get Up and Go POMA	1-Supervised programmes (structural gait retraining, balance, transfer and mobility interventions, progressive limb strengthening and flexibility exercises) 2-Provision of appropriate walking aids when needed 3-Vitamin D and calcium supplementation
Medical	Dizziness or vertigo Visual impairment Peripheral neuropathy Psychoactive medication/alcohol Hip problems or deformity Cognitive problems or depression	II Ib for cataracts, III for visual acuity n/a Ia n/a III	History and examination, incl. review of drugs, visual acuity assessment, echocardiograph, short Geriatric Depression Scale CAGE questionnaire	1-Appropriate investigation and management of untreated medical problems 2-Review and modification of psychotropic drugs, other culprit drugs, and polypharmacy. Alcohol counselling if indicated 3-Optical correction by an optician or referral to an ophthalmologist 4-Formal psychogeriatric assessment
Environmental	Environmental fall hazards Footwear Multifocal eyeglasses	Ia III II	Occupational therapy: assessment of environmental fall hazards using a standard checklist Check footwear	1-Home hazard modification using standard protocol 2-Advise to wear well-fitting shoes of low heel height and high surface contact 3-Avoid multifocal eyeglasses while walking
Cardiovascular	Orthostatic hypotension Postprandial hypotension Vasovagal syndrome Carotid sinus hypersensitivity	Ia Ib Ia Ib	Cardiac evaluation including heart rate, morning orthostatic blood pressure, and carotid sinus massage supine and tilted upright, prolonged head-up tilt, if indicated	1-Advice on avoiding precipitants and modification of drugs 2-Postural hypotension: compression hosiery, fludrocortisone, or midodrine 3-Cardioinhibitory carotid sinus hypersensitivity: permanent pacemaker 4-Symptomatic vasodepressor carotid sinus hypersensitivity or vasovagal syncope: fludrocortisone or midodrine

a) Level of evidence based on reference(81) as following : class Ia, evidence from at least 2 randomized controlled trials; Ib, evidence from 1 randomized controlled trial or meta-analysis of randomized controlled trials; II, evidence from at least 1 nonrandomized controlled trial or quasi-experimental study; III, evidence from prospective cohort study ; IV, based on expert committee opinion or clinical experience in absence of other evidence

Who is at high risk of falling? Classic view



Tinetti et al, JAMA 2010; AGS/BGS guidelines 2010

Who is at high risk of falling? Classic view

Community-dwelling older persons who...

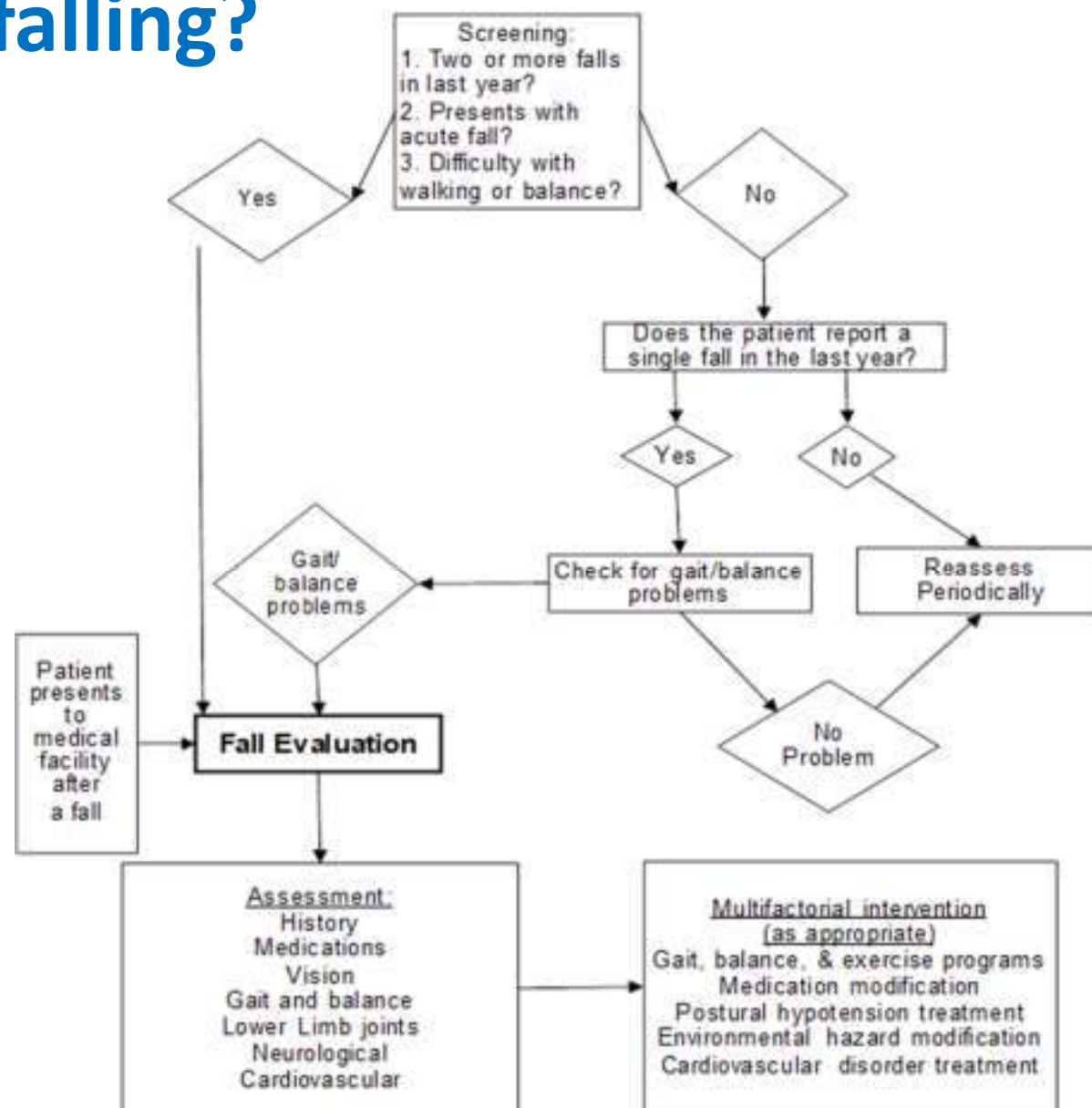
- report at least 1 injurious fall
- report recurrent (two or more) non-injurious falls
- seek medical attention or present to the ED because of a fall
- report/display difficulties with gait or balance

... should have a multifactorial fall risk assessment

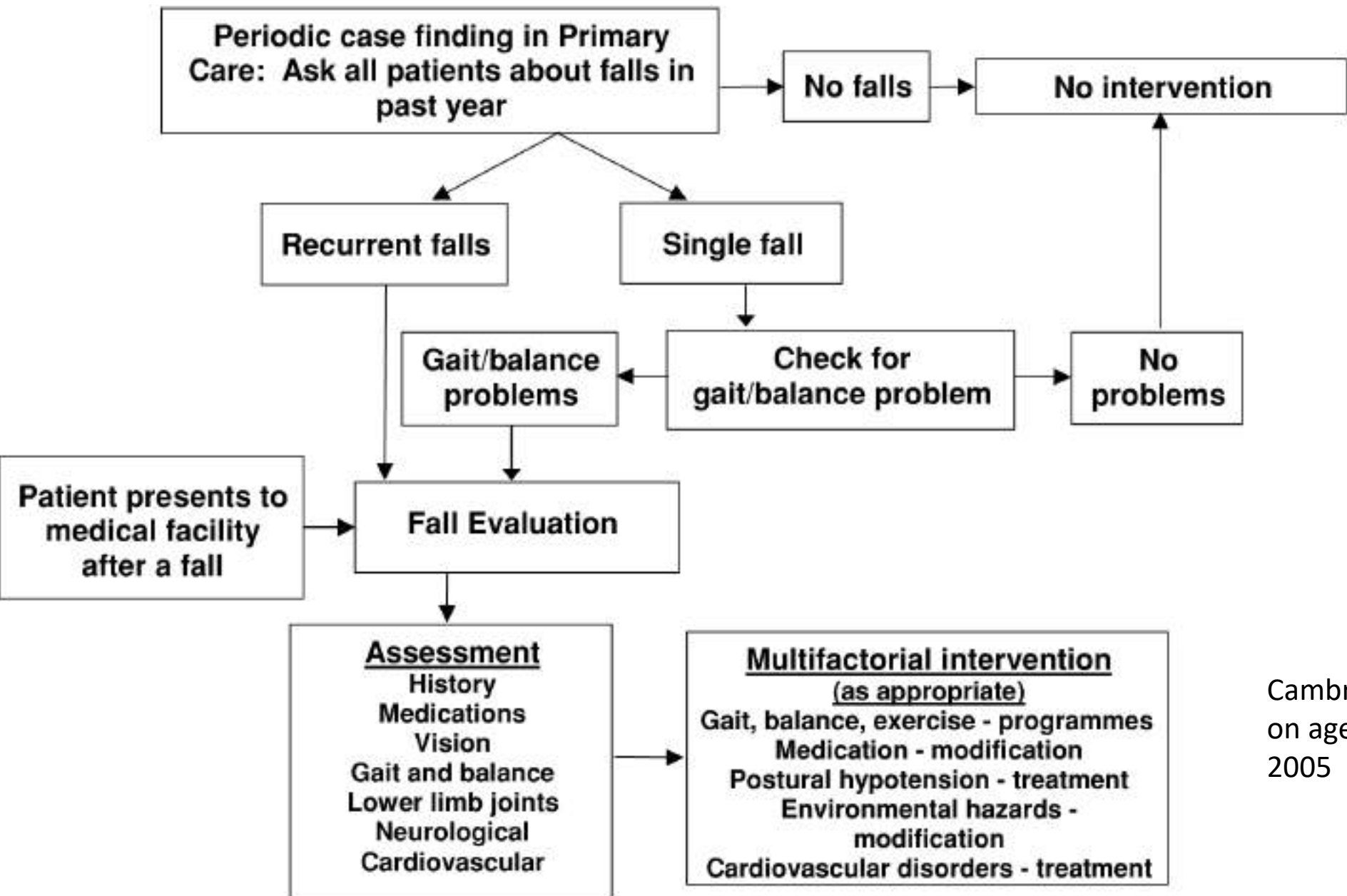


Who is at high risk of falling?

Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention(17). Used with permission of Blackwell Publishers.



Western



Cambridge handbook on age and ageing , 2005

Application of a Fall Screening Algorithm Stratified Fall Risk But Missed Preventive Opportunities in Community-Dwelling Older Adults: A Prospective Study

Susan W. Muir, PT, PhD¹; Katherine Berg, PT, PhD²; Bert Chesworth, PT, PhD³; Neil Klar, PhD¹; Mark Speechley PhD¹

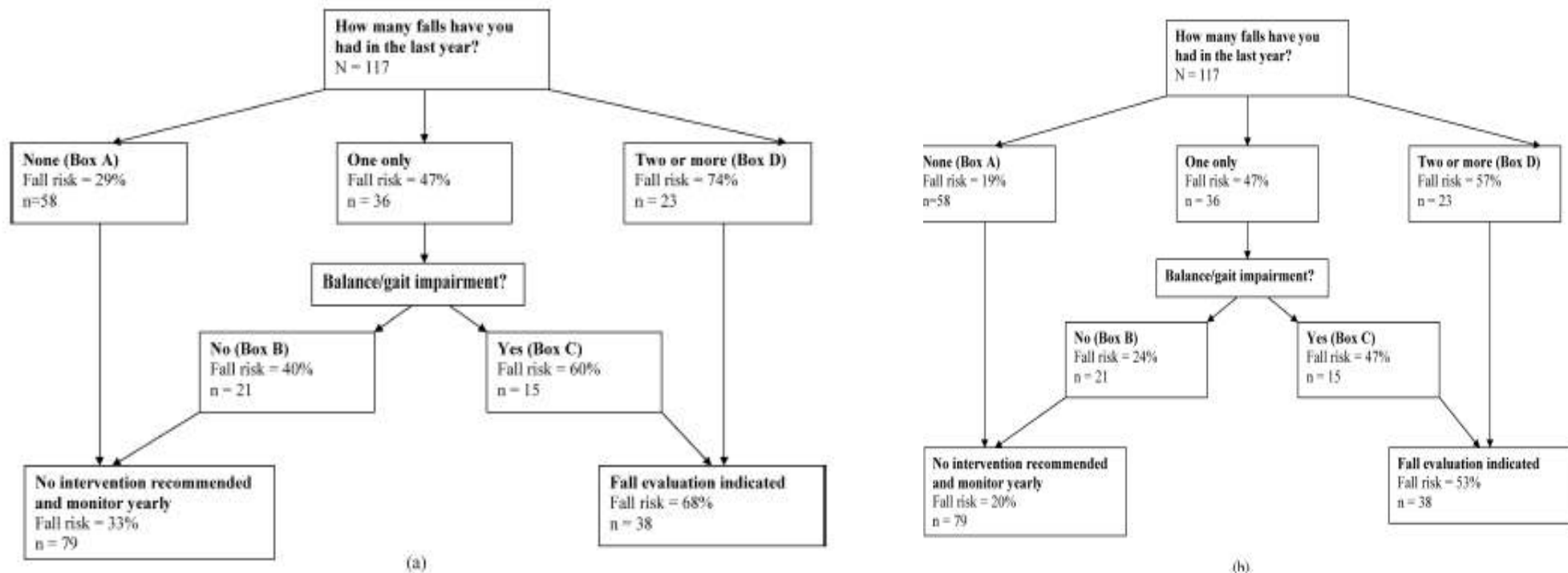


Figure 2. Flow chart showing fall risk values after the application of the AGS/BGS/AAOS fall risk screening algorithm in a sample of community-dwelling older adults for the outcomes of (a) any fall and (b) any injurious fall.

Our research on falls (n= 250, mean age 75.27±7.24, female: 62%, 7 years follow up)

THOSE WHO DO NOT HAVE A FALLS HISTORY

1- They also fall (33% of them)

	No fall history (12 months)	Fall history (12 months)
No Fall during follow-up	114 (67%)	23 (33%)
Fall during follow-up	55 (33%)	47 (67%)
	169 (100%)	70 (100%)

2- These falls are not benign. 70% of falls provoke injury, regardless of NO presence of history of falls.

From the ones that fall...	No fall history (12 months)	Fall history (12 months)
Fall with NO injury during follow-up	15 (32%)	12 (30%)
Fall with injury during follow-up	32 (68%)	28 (70%)
	47 (100%)	40 (100%)



Our research on falls (n= 250)

THOSE WHO DO NOT HAVE A FALLS HISTORY

3- 29% have normal gait speed, no fall history, and they still fall!

Proportion Slow Gait	No Fall history (12 months)			Fall history (12 months)		
	Gait \geq 1m/s	Gait < 1m/s	p value	Gait \geq 1m/s	Gait < 1m/s	
No Fall during follow-up	91 (71%)	23 (56%)	<0.001	17 (38%)	6 (24%)	0.022
Fall during follow-up	37 (29%)	18 (44%)*	0.010	28 (62%)	19 (76%)	0.189
	128 (100%)	41 (100%)		45 (100%)	25 (100%)	

*those who fell during follow up and did not have previous history of falls

Mean Gait Speed	No Fall history (12 months)				Fall history (12 months)			
	Total gait speed	Gait \geq 1m/s	Gait < 1m/s	p value	Total gait speed	Gait \geq 1m/s	Gait < 1m/s	p value
No Fall during follow-up	115.0 (21.57)	122.63 (15.65)	84.79 (13.86)	p<0.001	112.57 (19.31)	121.50 (12.85)	87.24 (8.45)	p<0.001
Fall during follow-up	109.8 (24.05)	122.59 (16.04)	83.53 (14.33)	p<0.001	105.75 (21.03)	119.84 (13.22)	85.0 (10.23)	p<0.001
	p= 0.160				p= 0.196			



Western

Who is at high risk of falling? Emerging view

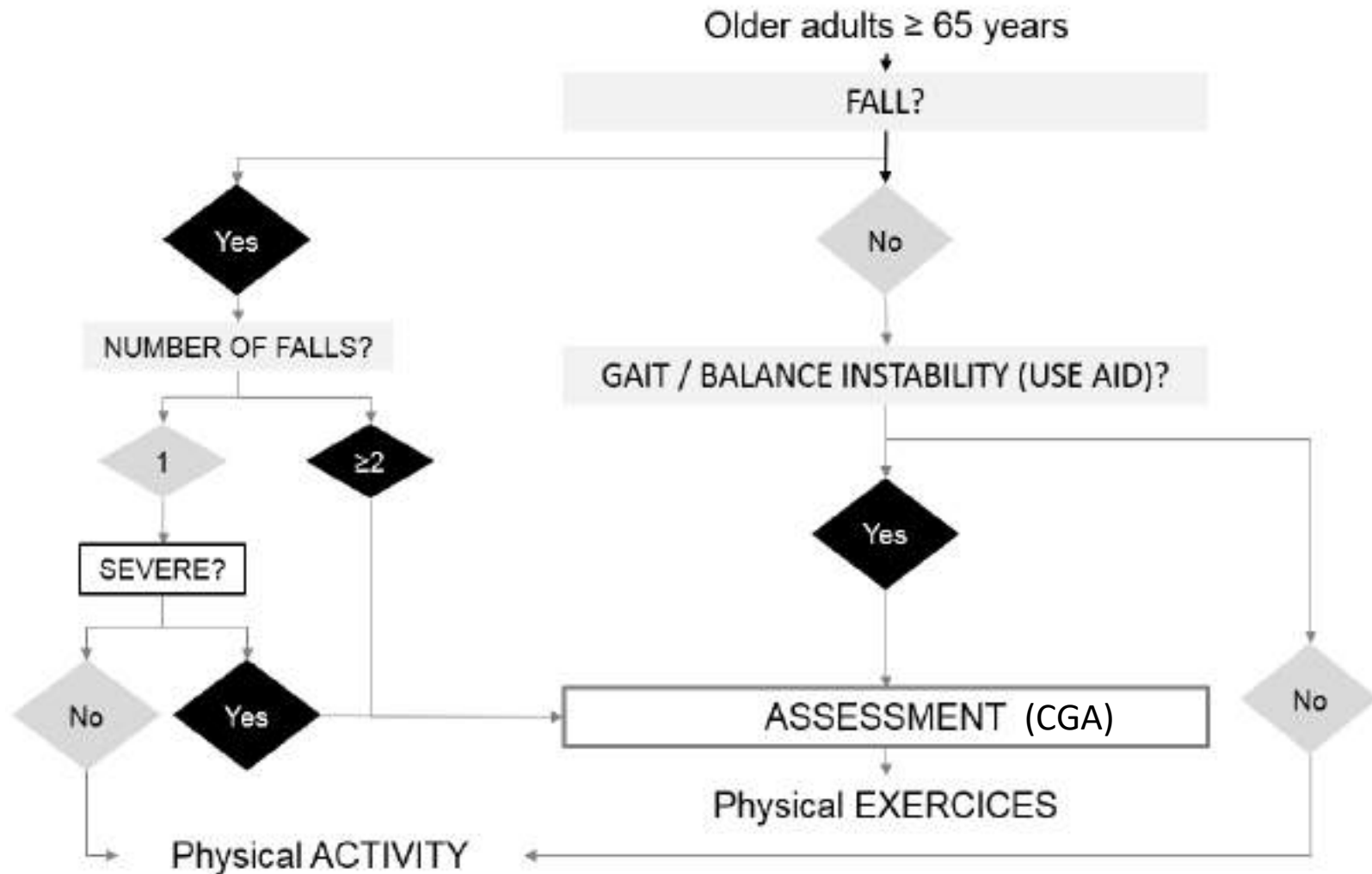
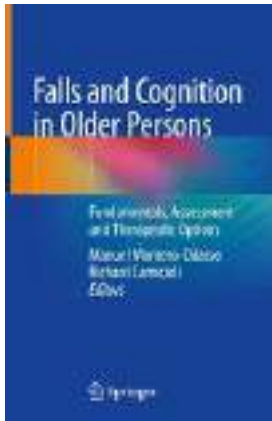


Figure 3. Proposed Algorithm for assessing falls risk

Montero-Odasso M. Preventing Falls & Injuries. Chapter In "Falls and Cognition". 2019 Springer-Nature.



How are falls described?

- “Simple fall”
 - easily understood or done; presenting no difficulty
- “Accidental fall”
 - happening by chance, unintentionally, or unexpectedly.
- “Mechanical fall”
 - caused by, resulting from, or relating to a process that involves a purely physical as opposed to a chemical or biological change or process

What do we understand about what happens when someone falls

Most are unwitnessed, they occur quickly, patient report can be vague, and are related to an external perturbation or foot misplacement

What do we understand about what happens when someone falls

Falls in the Cognitively Impaired - Facts

- Falls are two-fold in people with Dementia¹⁻³
- Fallers with cognitive problems have
 - ↑ risk of injuries, falls & fractures
 - ↓ functional outcomes
 - ↓ access to rehabilitation
 - ↑ institutionalization
 - ↑ mortality
- Fall prevention is not successful in those with MMSE <20⁴



1. Tinetti et al. *N Engl J Med* 1988
2. Shaw. *J Neural Transm* 2007
3. Petersen RC et al. *Neurology* 2001
4. Oliver et al. *BMJ* 2007

Evidence and Assumptions in Fall prevention

- **Evidence**

Cognitive impairment is a risk factor for falls

- **Assumption**

Falls are not related to cognition when a “normal” global cognition (MMSE/MoCA) is present



Western

SYSTEMATIC REVIEW

The role of cognitive impairment in fall risk among older adults: a systematic review and meta-analysis

SUSAN W. MUIR^{1,2}, KAREN GOPAUL², MANUEL M. MONTERO ODASSO^{1,2,3,4}



Key points

Fall Outcome	Odds Ratio(95% CI)	I ² (%)
Any fall	1.32 (1.18,1.49)	74.3%
Serious injury	2.33 (1.61,3.36)	5.9%
Fractures	1.78 (1.34,2.37)	0%
Any fall-low executive function	1.44 (1.20,1.83)	70.9%

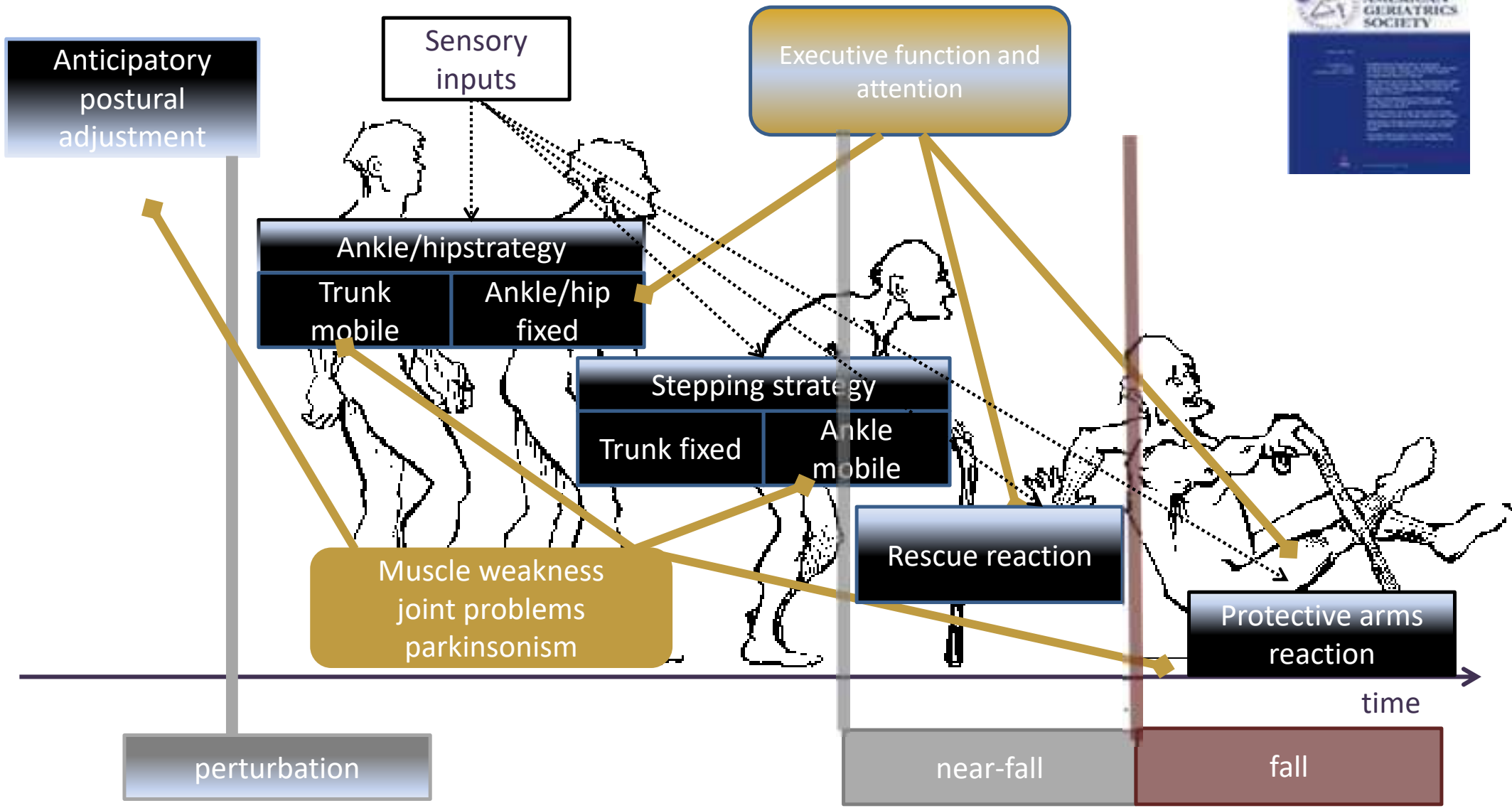
1-Cognitive impairment (MMSE<26) confers high risk of serious injury from a fall **OR=2.33**

2- Executive dysfunction increases fall risk **OR=1.44**

3- Executive dysfunction can be present despite normality in “global cognition”

4- EF assessment should be part of a falls risk evaluation





Working memory



Attention

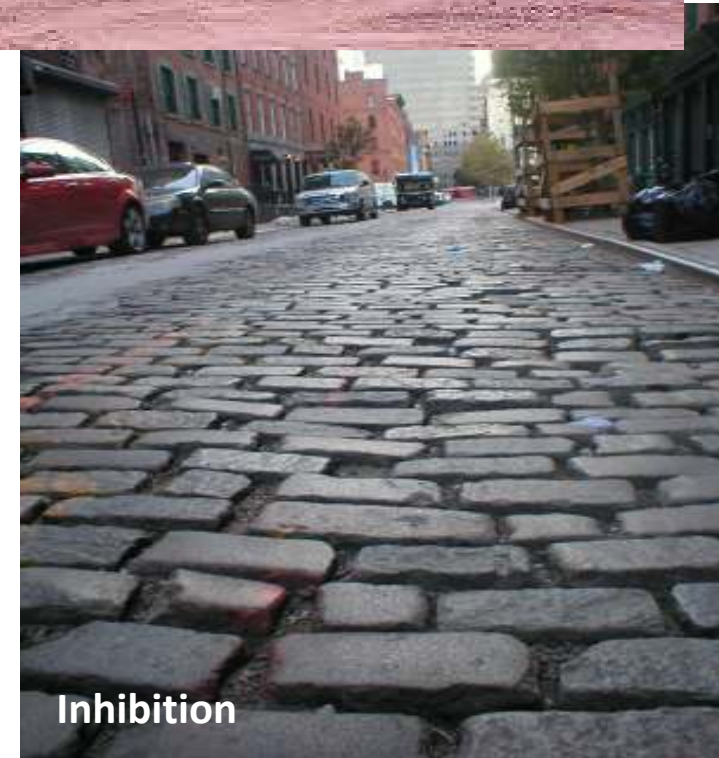


**Walking is
cognitively
demanding!**

Dual-Tasking



Inhibition



Western

**Proposed approach
for falls assessment and prevention**

Two scenarios

- **No previous falls**

- Screening (pretest probability:19-36%)
- Ask/asses for falls or gait/balance problems
- Gait domain offers the highest yield for screening
- If gait is normal → **dual-task gait test?**
Other?
- Not screening of other domains (vision, orthostatic changes, cognition, medication) if only purpose is to determine risk of falls

- **Previous falls**

- Higher risk of falling (pretest probability 25-65%)
- Gait and balance is also important
- If gait is normal, cardiovascular risk factors become important to rule out syncopal falls
- Stepped Fall assessment

Who is at high risk of falling? Emerging view

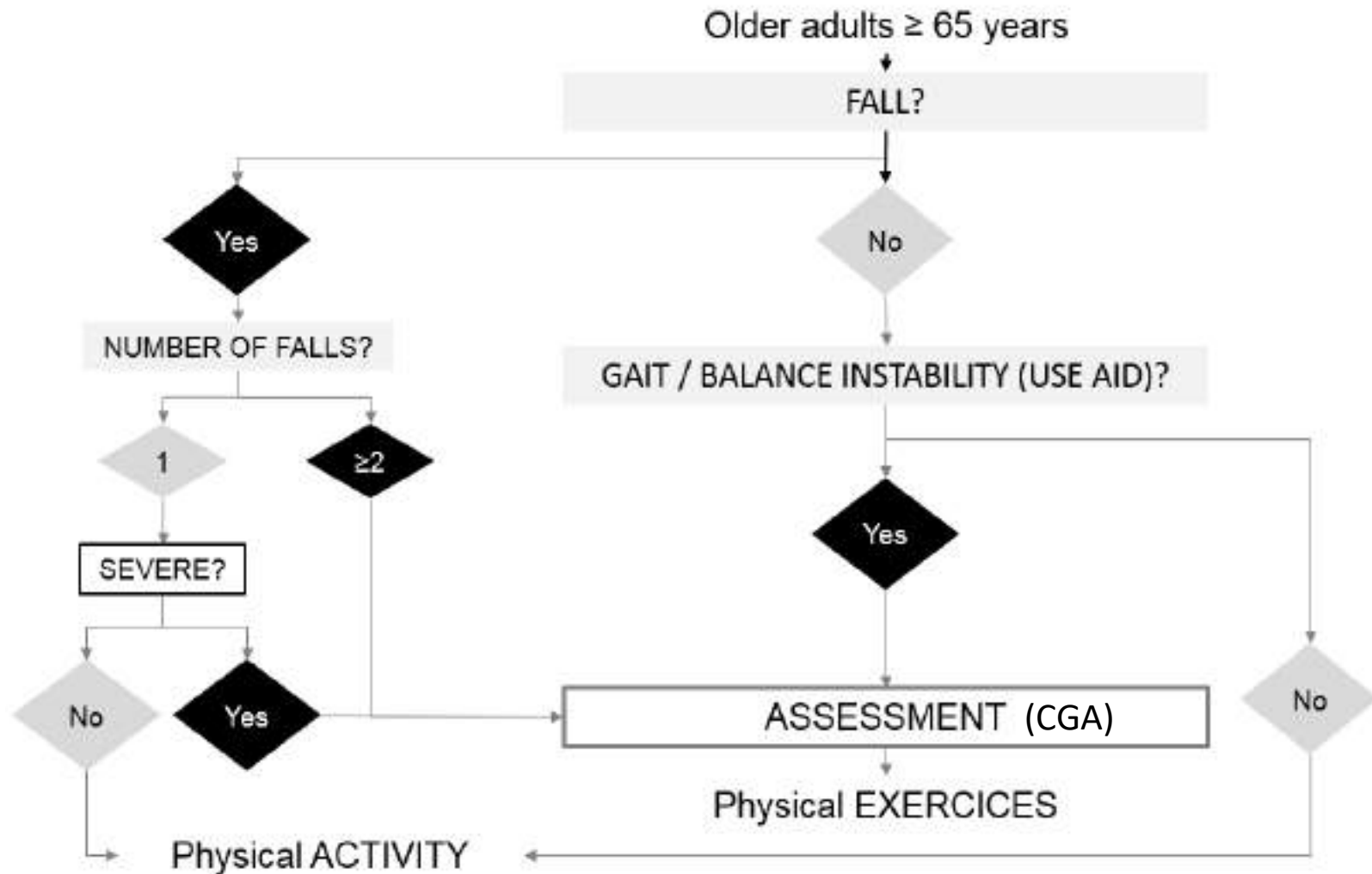


Figure 3. Proposed Algorithm for assessing falls risk

Montero-Odasso M. Preventing Falls & Injuries. Chapter In "Falls and Cognition". 2019 Springer-Nature.



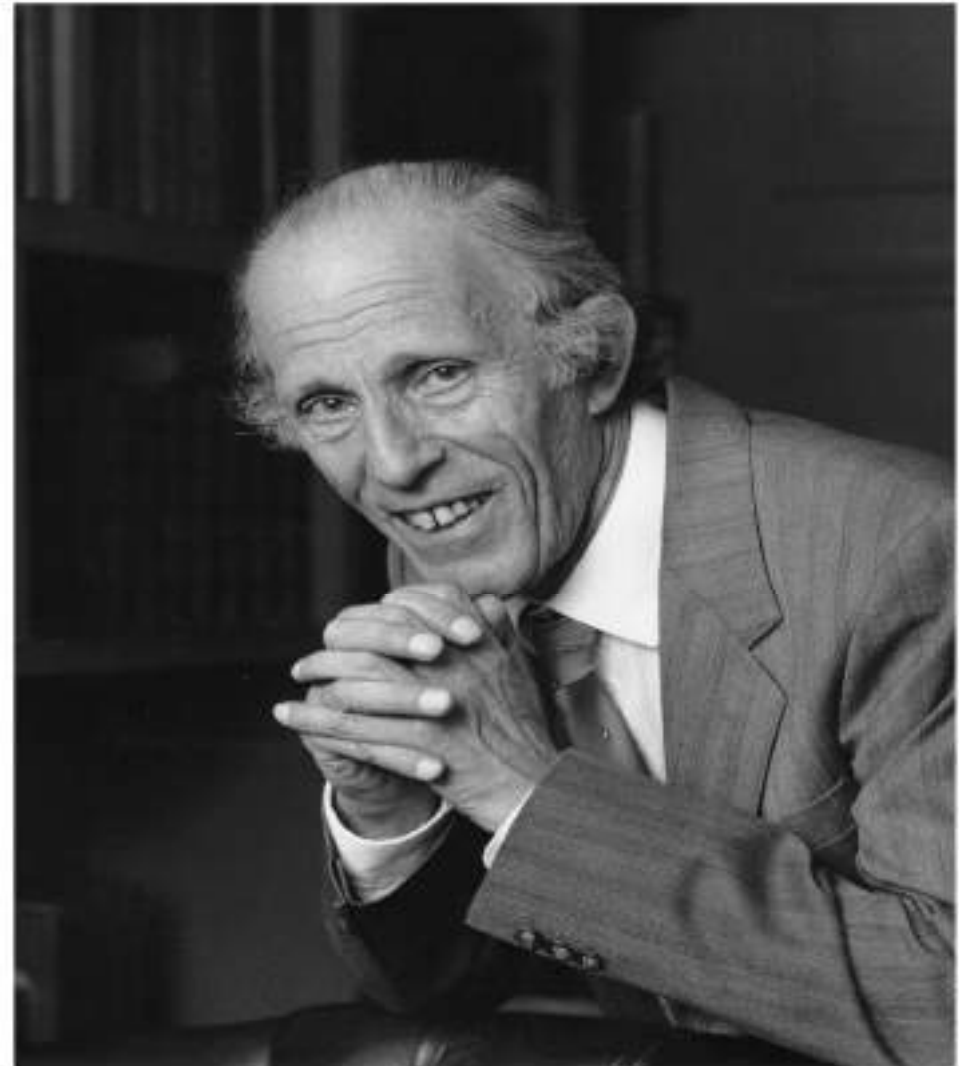
Conclusions

- Falls are multifactorial, and risk factors tend to aggregate and interact
- Current fall risk stratification misses up to 30% who will fall (Not being falls = 70% have injuries)
- Screening needs to find way to detect this group
- Gait/balance is the domain that yield the highest probability to detect risk
- Cognition is key to regulate walking. Particularly, selective attention, conflict resolution, and dual-tasking

**“It takes a child one year to acquire independent movement and ten years to acquire independent mobility.
An old person can lose both in a day”**

Bernard Isaacs

“The Challenge of the Geriatric Medicine”



Professor Bernard Isaacs, MD; F.R.C.P. (Glas.)
1922-1995



Gait & Brain Team

Parkwood Institute, London ON

Alanna Black	Shay Nejim
Frederico Faria	Yanina Sarquis-Adamson
Stephanie Cullen	Nick Bray
Josh Titus	Korbin Blue
Ryota Sakurai	Susan Muir-Hunter



Web: gaitandbrain.com
 Email: mmontero@uwo.ca



**ONTARIO
BRAIN
INSTITUTE** **INSTITUT
ONTARIEN
DU CERVEAU**

**Canadian Consortium
on Neurodegeneration in Aging.**
 The Canadian Component of CIHR's International
 Collaborative Research Strategy for Alzheimer's Disease.

Collaborations

Western University

*Dr Vladimir Hachinski Dr Mark Speechley
 Dr Tim Doherty Dr Michael Borrie
 Dr Jennie Wells Dr Kevin Shoemaker
 Dr Rob Bartha Dr Susan Hunter
 Dr Amer Burhan Dr Akshya Vasudev*

Montreal

*Dr Howard Chertkow- McGill University
 Dr Louis Bherer- U de Montreal
 Dr K. Li - Concordia University*

UBC

Dr Liu-Ambrose

Alberta

Dr Richard Camicioli Dr David Hogan

Harvard University, Cambridge

Dr Lewis Lipsitz Dr Brad Manor

University of Pittsburgh, PA

*Dr Caterina Rosano Dr Stephanie Studenski
 Dr Ervin Sejdic Dr Andrea Rosso*

Einstein College of Medicine, NYC

Joe Verghese Roe Holzter

WALK, France

*Dr Olivier Beauchet – Univ of Angers, France
 Dr Cedric Anweiler - Univ of Anger*

Japan

Dr Ryota Sakurai

Australia

Dr Gustavo Duque- Dr Michelle Calisaya

Spain

Dr Alavaro Casas - Dr Nicolas Martinez



Table 3. Common causes of falls and abnormal mobility and gait in older adults in relation to performance based evaluation.

Symptom:

Potential cause:

Difficulty rising from a chair

Lower Limb Weakness
Osteoarthritis

Instability on first standing

Postural Hypotension
Muscle Weakness

Instability with eyes closed

Proprioception deficits

Decreased step height/length

Parkinsonism
Frontal lobe disease
Fear of falling



Consequences of falling for community-dwelling old

CONSEQUENCE

% OF FALLS

Hip fracture

1-2

Other fracture

3-5

Other injury (lacs, head, internal)

2-10

Minor inj (bruise, abrasion, sprain)

30-55

% of FALLERS

Inability to get up after fall

39-50

Fear of falling

40-73

Decreased activity

41-43

(From: King 1995)

Independent Risk Factors for Falling Among Community-Living Older Adults

Risk Factor	# signif studies	RR	OR
Previous falls	16	1.9-6.6	1.5-6.7
Impaired balance	15	1.2-2.4	1.8-3.5
↓ UE or LE strength	9	2.2-2.6	1.2-1.9
Impaired vision	8	1.5-2.3	1.7-2.3
>4 or psych meds	8	1.1-2.4	1.7-2.7
Impaired gait	7	1.2-2.2	2.7
Depression	6	1.5-2.8	1.4-2.2
Dizzy/Orthostatic	5	2.0	1.6-2.6

Independent Risk Factors for Falling Among Community-Living Older Adults

Risk Factor	# signif studies	RR	OR
Functional/ADL prob	5	1.6-6.2	1.3
Age > 80 y	4	1.1-1.3	1.1
Female	3	2.1-3.9	2.3
Low BMI	3	1.5-1.8	3.1
Urinary incontinence	3		1.3-1.8
Impaired cognition	3	2.8	1.9-2.1
Arthritis/Pain	2/2	1.2-1.9	1.7
Diabetes	2	3.8	2.8

Intrinsic factors: falls and gait disorders

AGE

- Central processing
- Vision
- Vestibular
- Systemic
- Musculoskeletal
- Neurological

AGE-ASSOCIATED DISEASES

- Central processing
Dementia
- Vision
Cataracts, ARMD, Glaucoma
- Vestibular
Previous labyrinthitis, BPPV
- Systemic
Disease
- Musculoskeletal
Arthritis
- Neurological
Parkinson's, myelopathy, stroke, PN

Determine Fall Risk

- Hx falls
- Meds
- Gait, Balance, Mobility
- Visual Acuity
- Rest neuro (incl cog)
- Muscle Strength
- Heart Rate, Rhythm
- Postural hypotension
- Feet and footwear
- ADL/Fear of falling
- Environment hazard

Why Gait assessment and Falls?

Source	Risk Factor Domain*					
	Orthostatic Hypotension	Visual Impairment	Gait/Balance Impairment	Medications	Limitations in ADL	Cognitive Impairment
Bergland et al, ²⁴ 2003		+	+	-	-	-
Campbell et al, ²⁵ 1989	-	-	+	+	+	-
Chu et al, ²⁵ 2005	-	-	+	-	-	+
Duncan et al, ²⁷ 1992			+			?
O'Loughlin et al, ²⁸ 1993			+	-	-	
Stalenhoef et al, ²⁹ 2002		-	+		-	-
Tinetti et al, ²² 1988		-	+	+	-	+
Tinetti et al, ³⁰ 1995		-	-	-		-
Tromp et al, ³¹ 2001	-	+	-	+	+	-
Zhang et al, ³² 2004			-			
Coleman et al, ³³ 2004		+	+	-		
Luukinen et al, ³⁴ 1995			+	+		
Luukinen et al, ³⁵ 1996	-	-	-		-	-
Teno et al, ³⁶ 1990		-	-		-	
van Bommel et al, ³⁷ 2005					+	?
Weiner et al, ³⁸ 1998			?	+		?
Arden et al, ³⁹ 1999	?		?	?		
Gerdhem et al, ⁴⁰ 2005		-	+	+		
Summary†	0/4	3/11	10/15	6/11	3/10	2/8

Classification system for gait disorders

1. High Sensorimotor Level

- a) **Frontal Lobe Related**: Cerebro vascular/Normal Pressure Hydrocephalus / Gait ignition failure
- b) **“Cautious Gait”** (fear of falling)

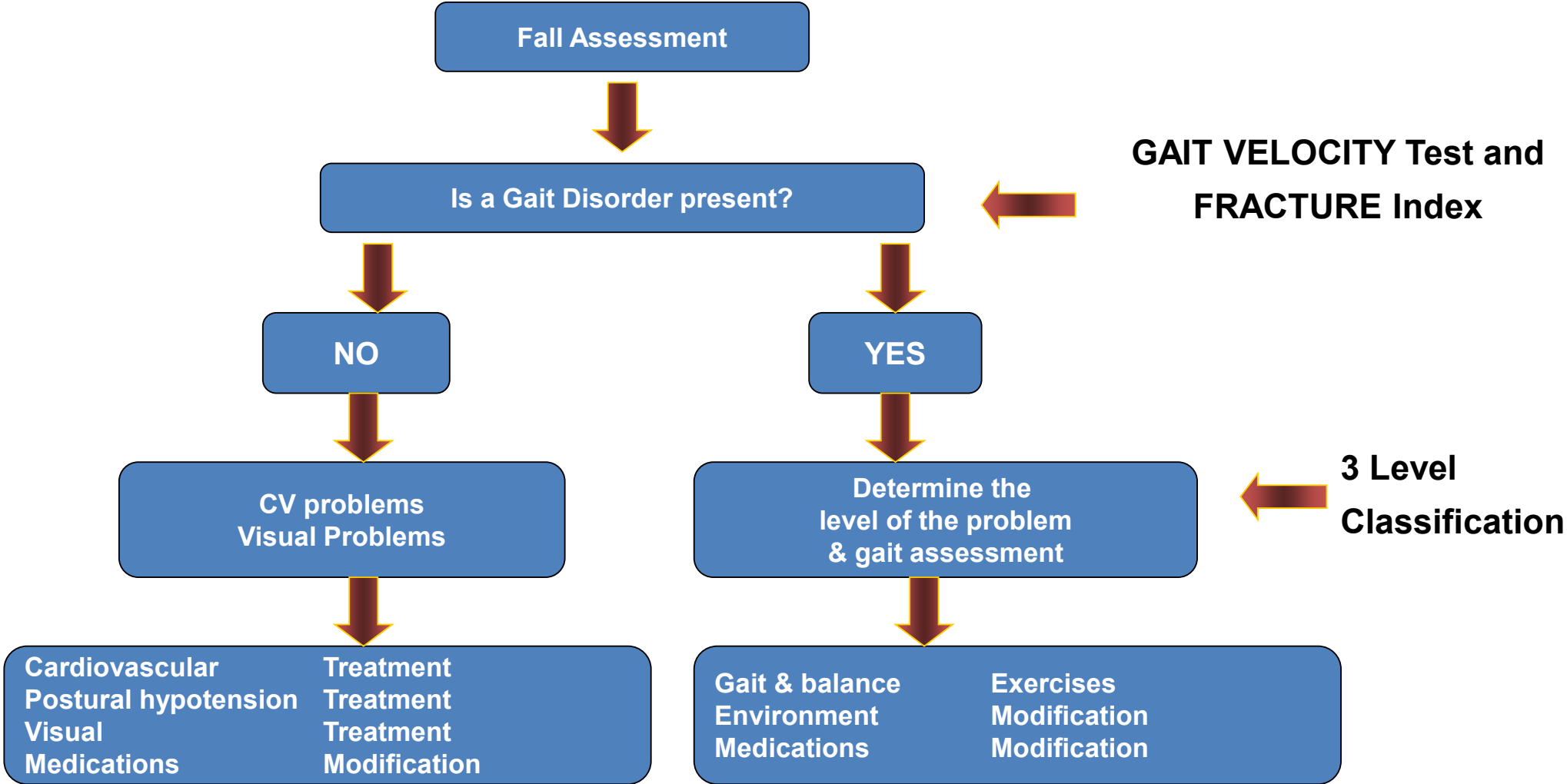
2. Middle Sensorimotor level

- a) **Spasticity**: hemiplegia (paresis)
- b) **Cerebellar ataxia**
- c) **Parkinsonism**

3. Low Sensorimotor Level

- a) **Peripheral Motor**:
Arthritic (antalgic or joint deformity). Myopathic. Neuropathic
- b) **Peripheral sensory**:
Sensory ataxia (posterior column disease, peripheral nerves)
Vestibular Ataxia/ Visual ataxia

Proposed approach to assess falls older subjects

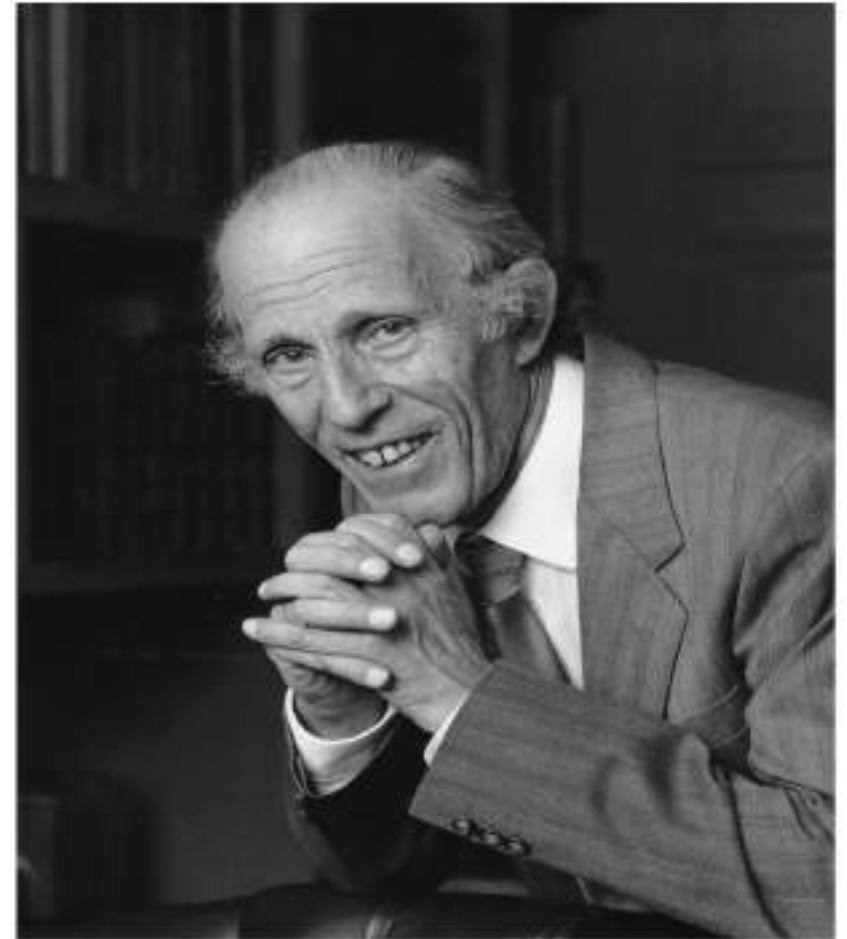


Adapted from: Montero Odasso M, Schapira M, Duque G et al. BMC Geriatrics, 2005. 5:15

**“It takes a child one year to
acquire independent movement
and ten years to acquire
independent mobility.
An old person can lose both in
a day”**

Bernard Isaacs

“The Challenge of the Geriatric Medicine”



Professor Bernard Isaacs, MD; F.R.C.P. (Glas.)
1922-1995