



Critical Illness, Disability, and Vulnerability

Lauren Ferrante, M.D., M.H.S.

Assistant Professor of Medicine
Section of Pulmonary, Critical Care, and Sleep Medicine
Yale School of Medicine



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Objectives

1. Understand why pre-existing vulnerability factors are especially relevant for our older ICU patients
2. Evaluate the effect of these factors on post-ICU outcomes
3. Review what changes we can make NOW to improve outcomes for this demographic and areas for future research

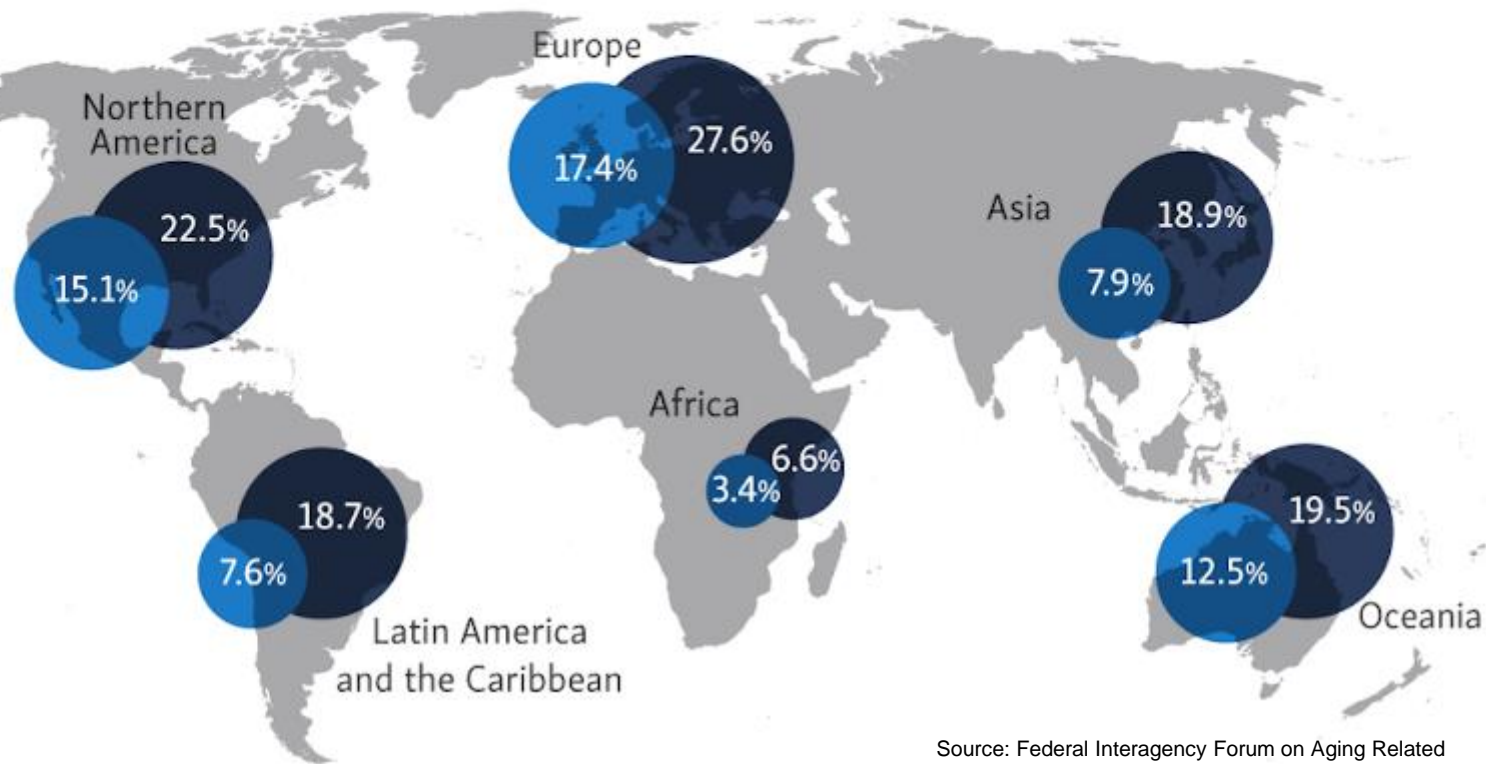
Percentage of people age 65+

● 2015 ● 2050

World

8.5%

16.7%



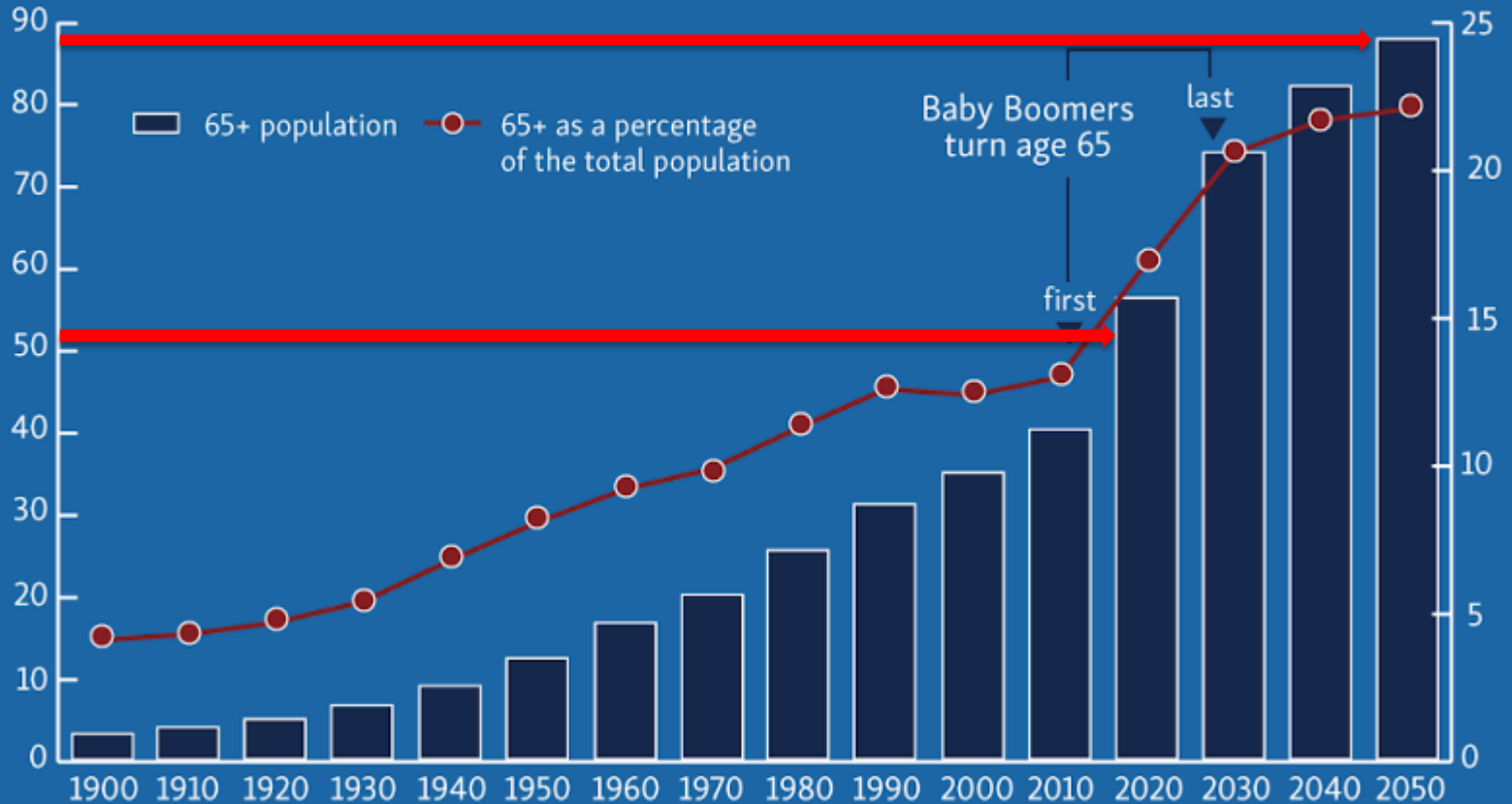


As an example: the U.S. now and in 2050



Population (in millions)

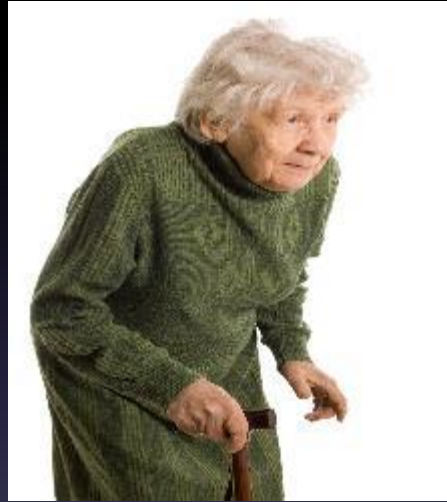
Percent



Are these 3 patients at equal risk of poor ICU/post-ICU outcomes?



Age 83



Age 83



Age 83

Chronological age does not tell the whole story

“She Was Probably Able to Ambulate, but I’m Not Sure”

-Covinsky et al, JAMA 2011



ICU

Post-
ICU

Severity of illness
Mechanical ventilation
Shock
Length of stay
Delirium

Disability
Cognitive impairment
Poor quality of life
PTSD
Depression
Frailty



Activities of daily living (ADLs)

- Bathing
- Dressing
- Walking across a room
- Transferring from a chair

Disability = dependence in activities essential to independent living

Instrumental activities of daily living (IADLs)

- Shopping
- Housework
- Meal preparation
- Taking medications
- Managing finances

Mobility activity

- Walk ¼ mile
- Climb 1 flight of stairs
- Lift/carry 10 lbs
- (Driving)

Predisposing vulnerability + precipitating event = disability

ICU = high severity

Severity of Intervening Event

Illnesses or injuries leading to:
Hospitalization
Restricted activity

High

Disability

No Disability

Mild

Low

High

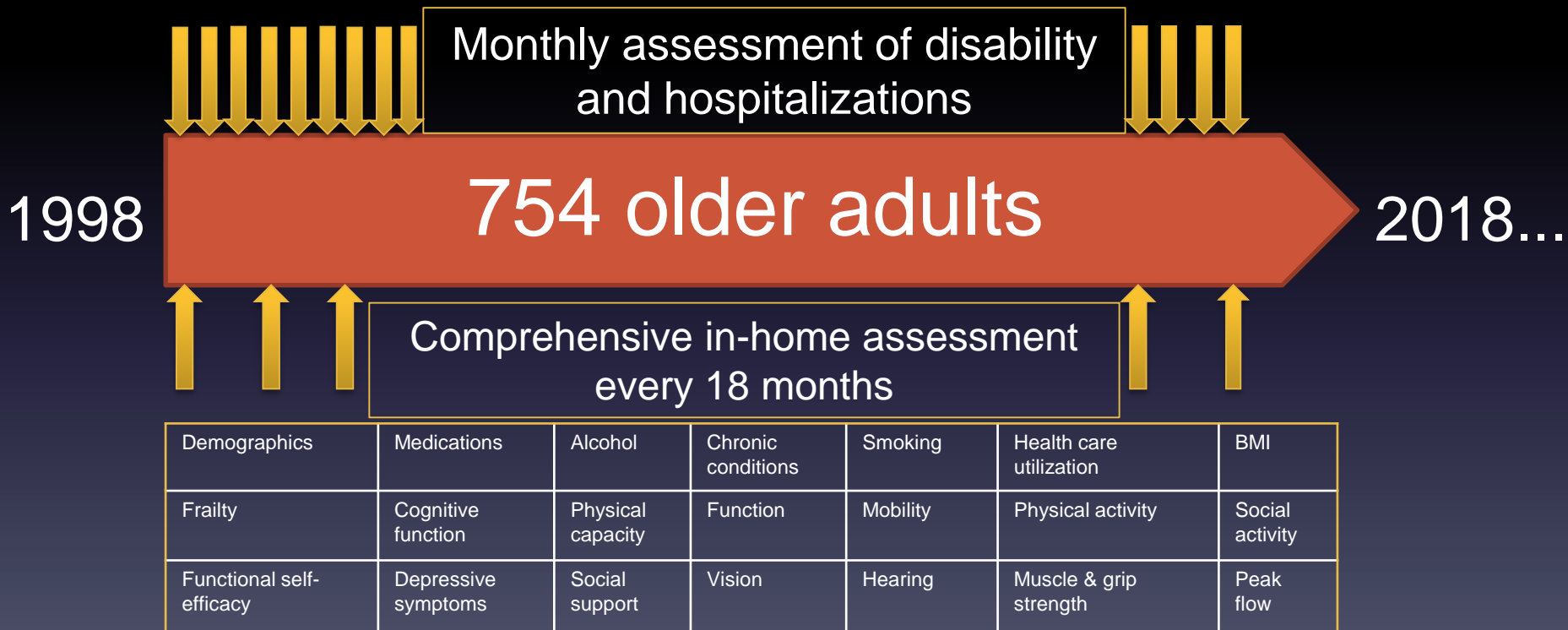
Vulnerability

- Frailty
- Cognitive impairment
- Multimorbidity

Disability doesn't just "happen" in normal aging! Insidious disability = extremely rare

Precipitating Events Project (PEP)

Yale Program on Aging

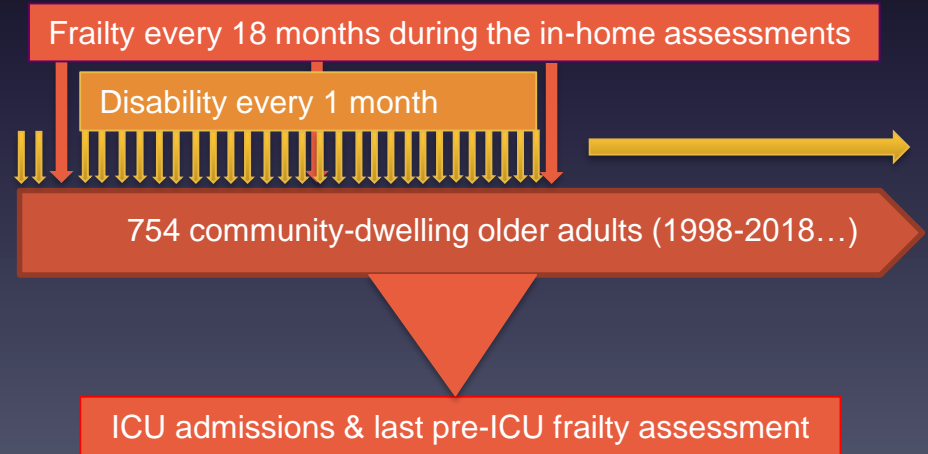


PEP Study: Disability count (0-13) is assessed monthly

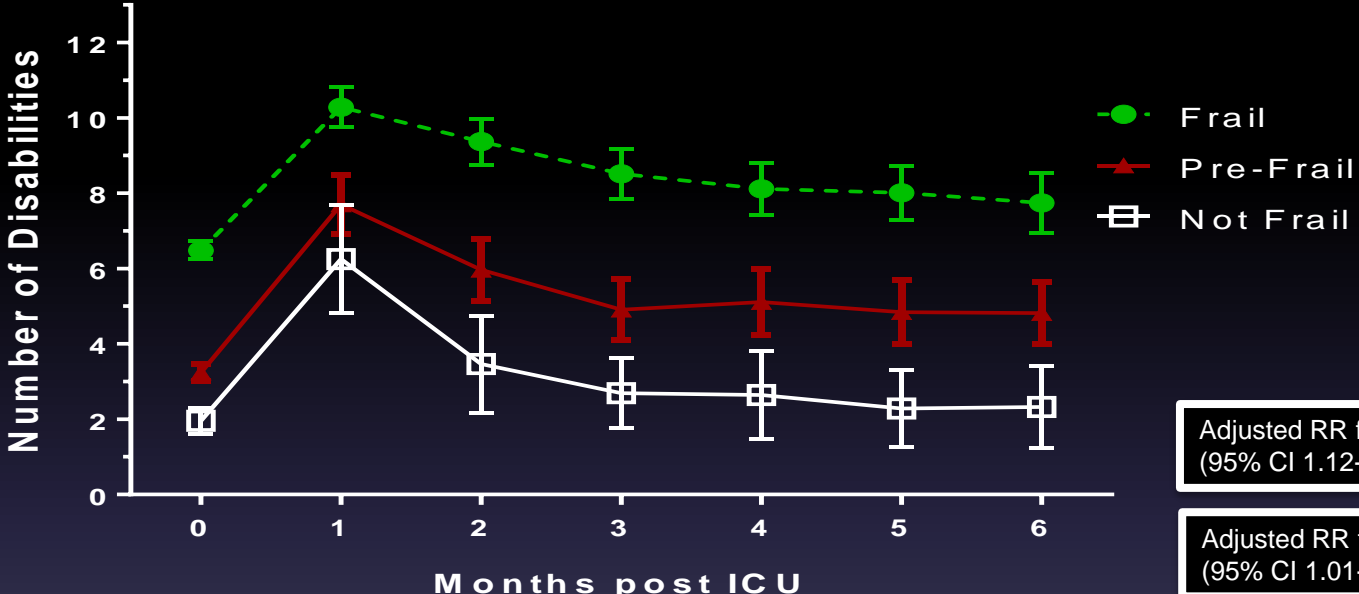
Activity type	Activity	Need for personal assistance = 1 point
Activity of daily living (ADL)	Bathing	1
ADL	Dressing	1
ADL	Walking across a room	1
ADL	Transferring from a chair	1
Instrumental activity of daily living (IADL)	Shopping	1
IADL	Housework	1
IADL	Meal preparation	1
IADL	Taking medications	1
IADL	Managing finances	1
Mobility	Walking a quarter mile	1
Mobility	Climbing a flight of stairs	1
Mobility	Lifting & carrying 10 lbs	1
Mobility	Driving in the past month	1
Total possible disabilities		13

The Fried Frailty Index

1. Slow gait
 - Frail: 3-5 criteria
 - Pre-frail: 1-2 criteria
 - Not frail: 0 criteria
2. Low physical activity
3. Shrinking
4. Exhaustion
5. Muscle weakness



Disability Count (0-13) by Pre-ICU Frailty Status (N=266)

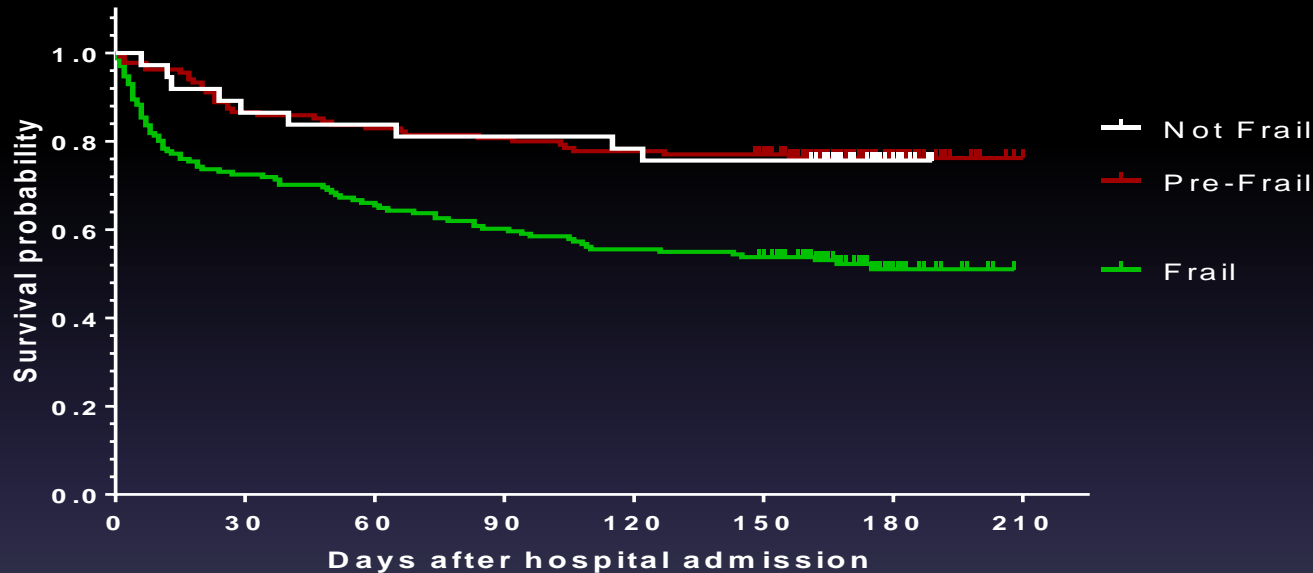


	Pre-ICU	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Frail	120	120	114	105	95	91	89
Pre-frail	114	114	111	107	105	104	103
Non-frail	32	32	30	29	28	28	28

Ferrante et al, CHEST 2018

Adjusted for age, sex, race, education, # of chronic conditions, disability count (month prior to ICU), depression (excluding exhaustion), cognitive impairment, mechanical ventilation, shock, ICU LOS

Survival by Frailty Subgroup from Admission through Six Months of Follow-Up (N=391)



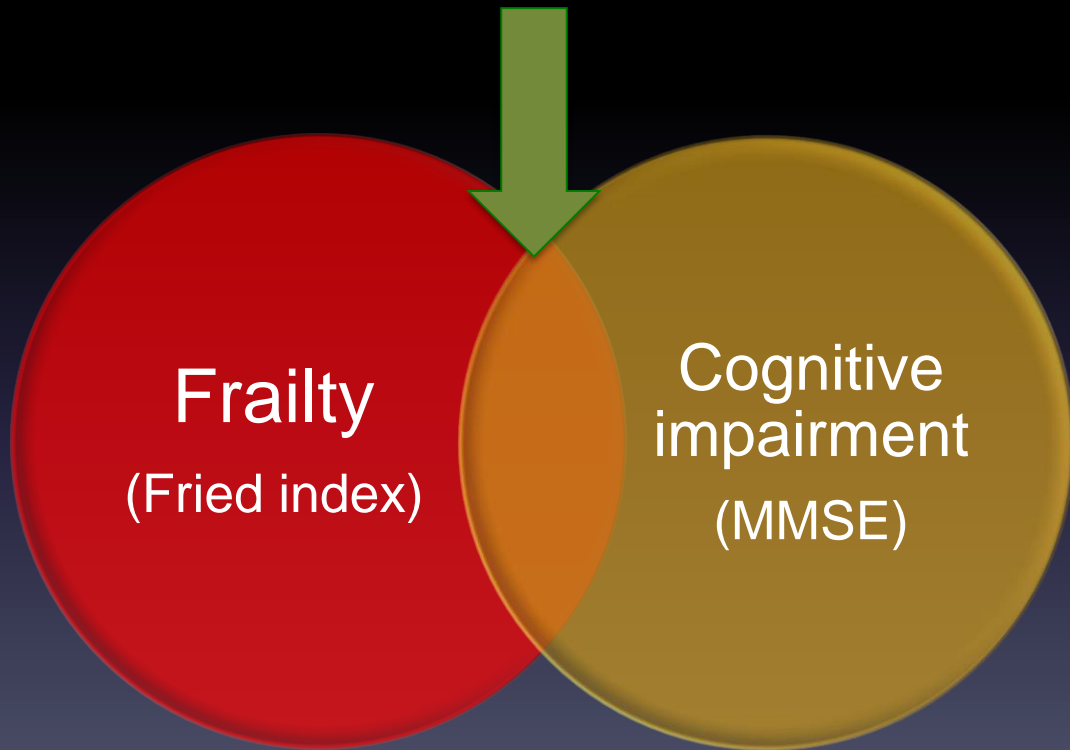
Adjusted association between pre-ICU frailty count and time to death from admission through 6 months of follow-up

Adjusted hazard ratio (95% CI)

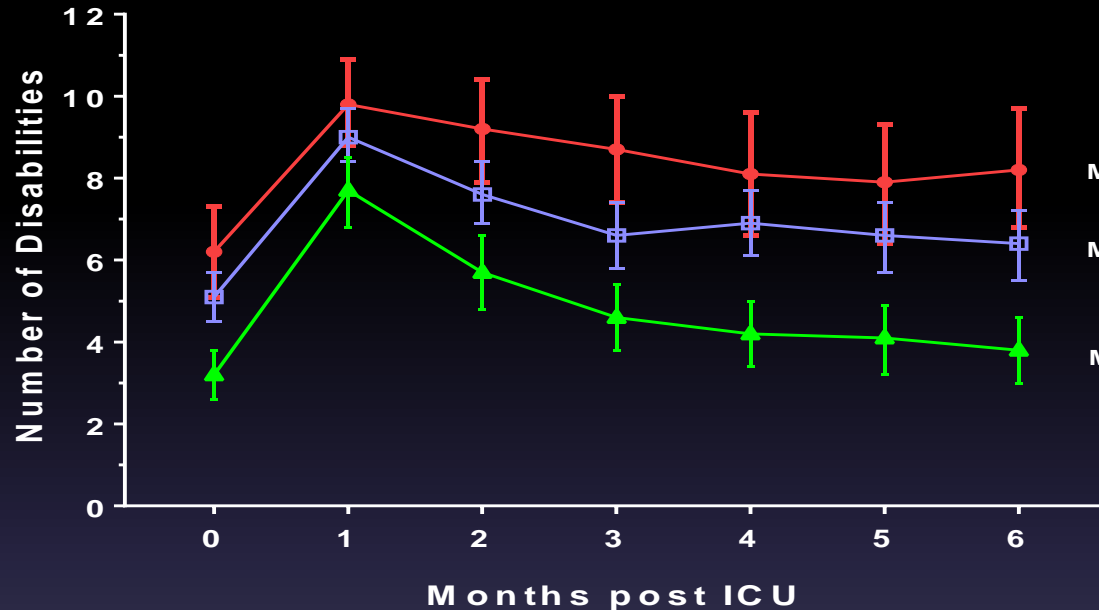
Fried frailty count (0-5), per point increase

HR 2.00 (1.33, 3.00)

Do Frailty (Physical Vulnerability) and Cognitive Impairment (Cognitive Vulnerability) Interact in their Effect on Post-ICU Disability?



Disability Count by Pre-ICU Cognitive Status (N=266)



MMSE < 24

RR 1.19 (95% CI 1.04-1.36)

MMSE 24-27

RR 1.16 (95% CI 1.02-1.32)

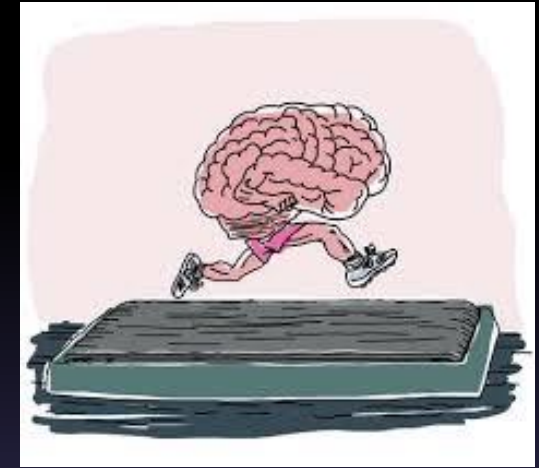
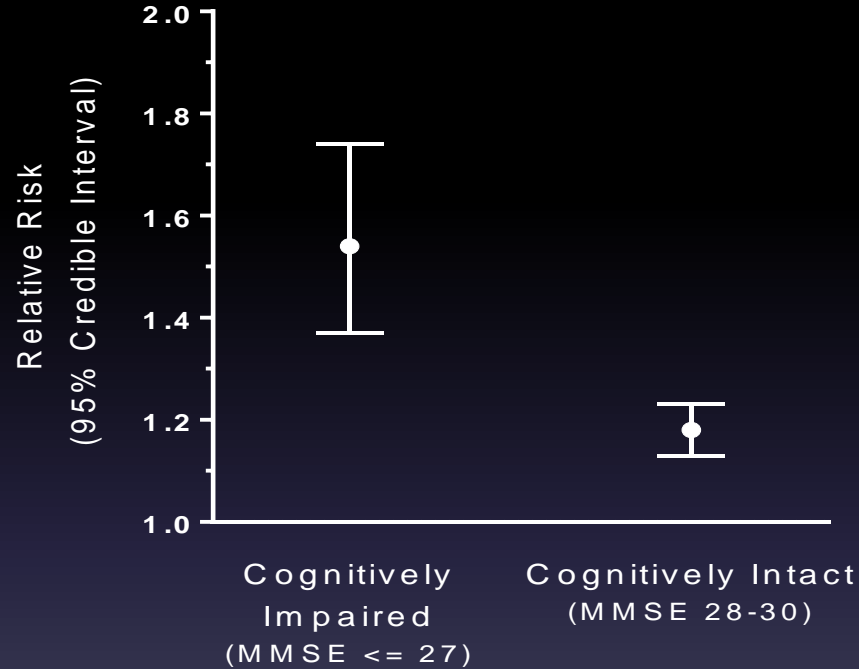
MMSE 28-30

Number of admissions

MMSE	Pre-ICU	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
<24	46	46	45	43	38	37	37
24-27	123	123	117	108	103	100	98
28-30	97	97	93	90	87	86	85

*Moderate pre-existing impairment (MMSE<24) was associated with new NH admission but not with time to death in the multivariable models

Association of Frailty (Fried count, 0-5) with Post-ICU Disability over 6 Months of Follow-Up stratified by Cognitive Status



Cognitive status	Adjusted relative risk (95% credible interval)*
Not intact (MMSE ≤ 27)	1.54 (1.37, 1.74)
Intact (MMSE 28-30)	1.18 (1.13, 1.23)

The Importance of the Pre-ICU Functional Trajectory

Adjusted probabilities (95% confidence interval) of transitioning between the pre- and post-ICU functional trajectories

Pre-ICU Trajectory	Post-ICU Trajectory			
	Minimal disability (n=44)	Mild/moderate disability (n=64)	Severe disability (n=113)	Early death (within 30 days; n=70)
Minimal disability	0.49 (0.31, 0.65)	0.27 (0.16, 0.45)	0.13 (0.04, 0.19)	0.12 (0.05, 0.19)
Mild-to-moderate disability	0.02 (0.0, 0.10)	0.32 (0.23, 0.42)	0.40 (0.28, 0.49)	0.26 (0.19, 0.35)
Severe disability	0.0 (0.0, 0.0)	0.0 (0.0, 0.07)	0.66 (0.52, 0.75)	0.34 (0.23, 0.44)

What about functional recovery after a critical illness?



Factors Associated with Functional Recovery among Older Intensive Care Unit Survivors

Lauren E. Ferrante¹, Margaret A. Pisani¹, Terrence E. Murphy², Evelyne A. Gahbauer², Linda S. Leo-Summers², and Thomas M. Gill²

- Analytic sample: Survived the ICU with INCREASED disability
- Functional recovery: return to a disability count \leq pre-ICU disability count within 6 months
- Evaluated 21 potential predictors of recovery:

Demographic	Age, sex, race, living alone, education
Health-related	Chronic conditions, hearing impairment, vision impairment, weight loss, BMI, frailty (Fried)
Cognitive-psychological	Cognitive impairment (MMSE), depression (CES-D), functional self-efficacy, social support (MOS social support survey)
Physical	Low and intermediate physical capacity (SPPB), change in disability
ICU variables	Mechanical ventilation, shock, ICU length of stay

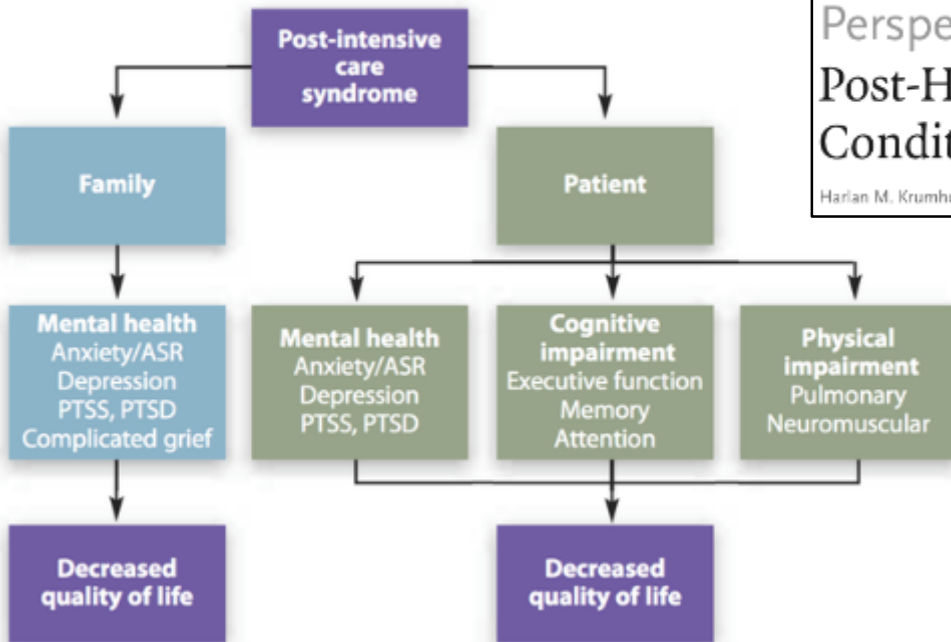
Multivariable Associations of Factors Associated with Functional Recovery within 6 months of ICU Admission in Older Adults (N=218)

Potential predictor	Operational details	n (%) or mean \pm SD	Cause-Specific Proportional hazards model	
			HR (95% CI)	p-value
Age	In years at the time of ICU admission	83.4 \pm 5.4	1.02 (0.97, 1.07) per 1 yr increment	0.454
Female sex		121 (57.9%)	0.59 (0.35, 1.00)	0.049
Non-Hispanic white	Self-identified race and ethnicity	184 (88.0%)	1.24 (0.59, 2.63)	0.571
Severe hearing impairment	4 tones missed out of 4 (1000 and 2000 Hz in right and left ears)	68 (32.5%)	0.38 (0.22, 0.66)	<0.001
Moderate to severe vision impairment	Assessed with a Jaeger card	100 (47.9%)	0.59 (0.37, 0.95)	0.031
Change in disability	Between the first-post-ICU & last pre-ICU disability count	4.4 \pm 3.4	0.80 (0.74, 0.88) per 1 unit	<0.001
BMI	Self-reported height and weight, kg/m ²	26.1 \pm 5.4	1.07 (1.03, 1.12) per 1 unit	0.003
Functional self-efficacy	On the Modified Self-Efficacy Scale: 0 (low) to 40 (high)		1.05 (1.02, 1.08) per point	0.002

Knowing how impactful these pre-existing factors are...

Is an ICU hospitalization really worse than a non-ICU hospitalization?

PICS model



Perspective

Post-Hospital Syndrome — An Acquired, Transient Condition of Generalized Risk

Harlan M. Krumholz, M.D.



The NEW ENGLAND
JOURNAL of MEDICINE

Objective: To evaluate the burden of disability incurred after an ICU hospitalization vs. a non-ICU hospitalization among older adults *while accounting for preexisting vulnerability factors*

Needham et al *Crit Care Med* 2012

Krumholz *NEJM* 2013

Photo Credit: @hughgifford

Identify hospitalizations

- 1st hospitalization (whether ICU or non-ICU) within an 18-month interval
- Participant must survive to the first interview after hospital discharge
- Admissions may not occur within 6 months of a previous admission

Non-ICU hospital admissions

ICU admissions

- Cases: controls matched 1:2 on**
1. Sex
 2. Age (± 4 years)
 3. Calendar year of admission (± 4 years)
 4. Pre-hospital function (± 1 disability on the 13-item scale)

340 controls

176 cases

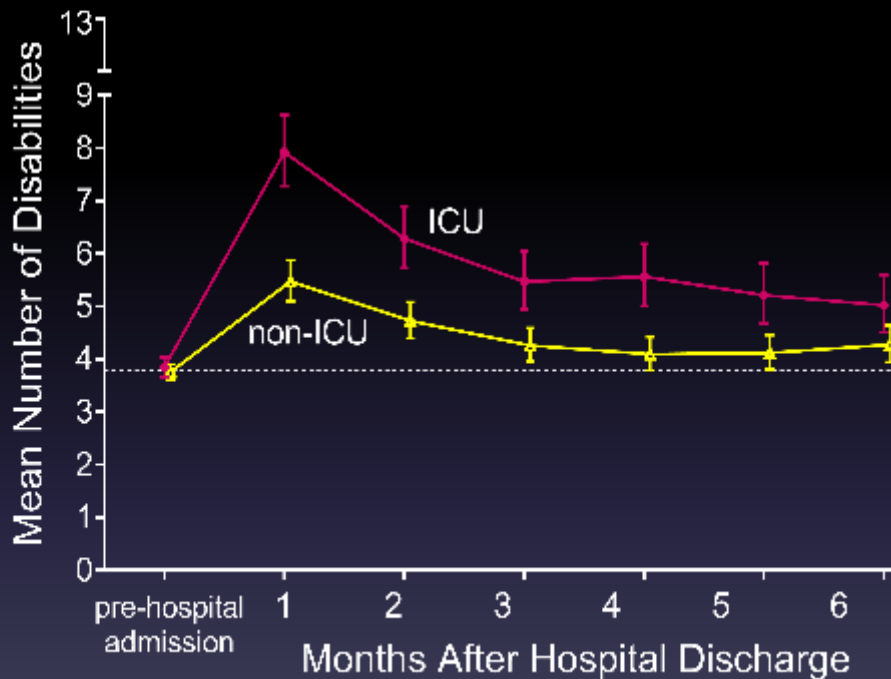
Analytic sample

Primary outcome: Disability count (0-13) over the 6 months after hospital discharge

Table 1. Comparison of ICU Admissions and Non-ICU Hospital Admissions

Characteristic	ICU admission N=176	Non-ICU admission N=340	<i>p</i> -value
	Mean (SD), median (IQR), or n (%)		
Age (years)	83.0 ± 5.7	82.7 ± 5.4	0.63
Female sex	102 (58.0)	199 (58.5)	0.90
White race & non-Hispanic ethnicity	156 (88.6)	290 (85.3)	0.29
Education (years)	12.2 ± 2.9	12.0 ± 2.8	0.44
Admitted from a nursing home	7 (4.0)	9 (2.6)	0.42
Body-mass index	26.1 ± 5.4	26.6 ± 5.5	0.27
# chronic conditions (0-9)	2 (1-3)	2 (2-3)	0.26
Disability count (0-13) in the month before admission	3 (1-6)	3 (1-6)	0.71
Cognitive function (MMSE, 0-30)	26.4 ± 3.0	26.0 ± 3.7	0.23
Depressive symptoms (CES-D, 0-60)	9.1 ± 8.8	11.4 ± 9.8	0.01
Slow gait speed	91 (51.7)	180 (52.9)	0.79

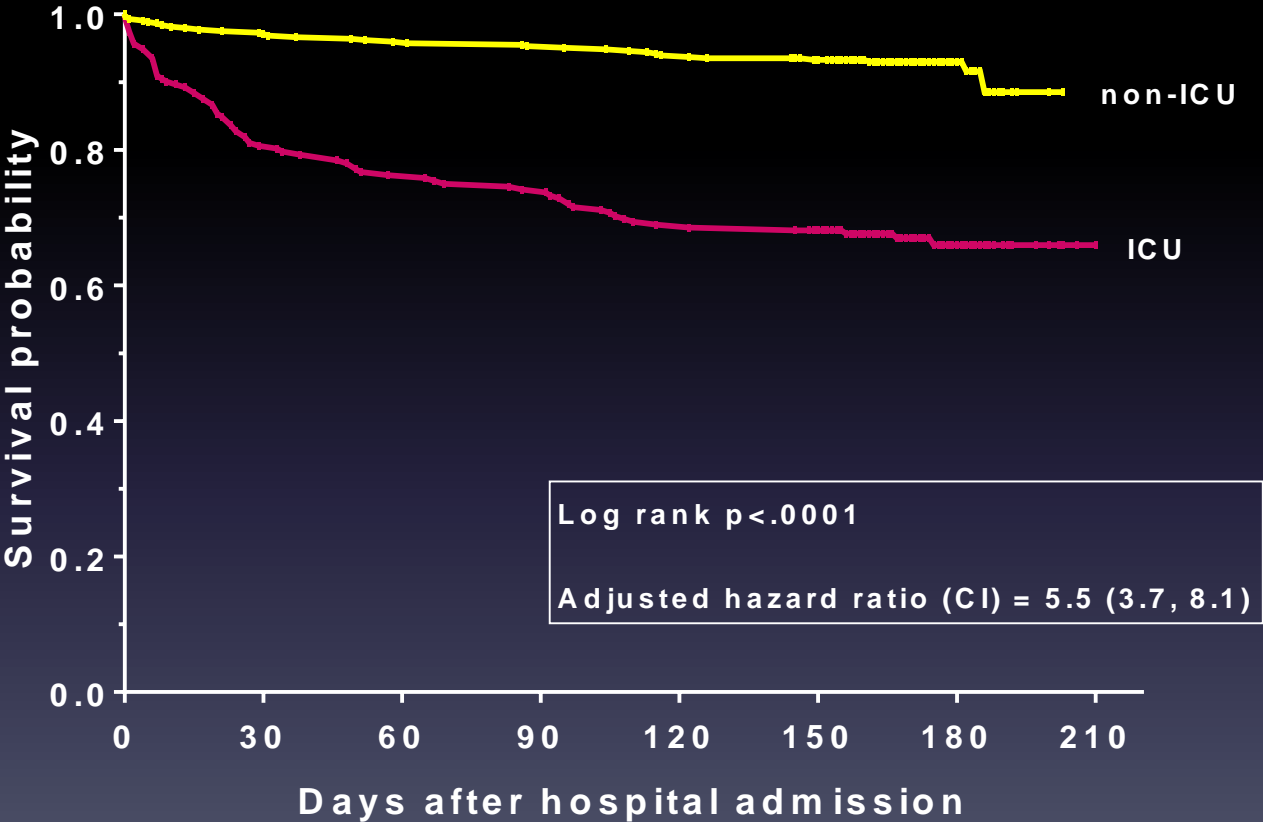
Adjusted Disability Counts (95% CI) over 6 Months after an ICU versus a Non-ICU Hospital Admission



RR 1.33 (95% CI 1.21, 1.46)

	Pre-adm	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
ICU	176	176	171	164	155	153	151
Non-ICU	340	340	336	335	329	327	322

Survival after an ICU versus Non-ICU Hospitalization



What We've Learned

- Pre-existing vulnerability factors are important determinants of post-ICU functional outcomes among older adults
- Post-ICU disability is greater than post-hospital disability – even when accounting for pre-existing vulnerability factors

How can we apply what we've learned now, and how should these findings inform future work?

First: do what we know works – mobilize!

The Old Paradigm



The New Paradigm



(All photos with patient permission)

Other changes we can make NOW



- ASK if your patient uses visual or hearing aids & USE THEM in the ICU
- Obtain portable amplifying devices for your ICU
- Large clocks & orienting devices (avoid distant, small print whiteboards)
- ASK about baseline functional status (& recent changes), frailty, & cognitive status

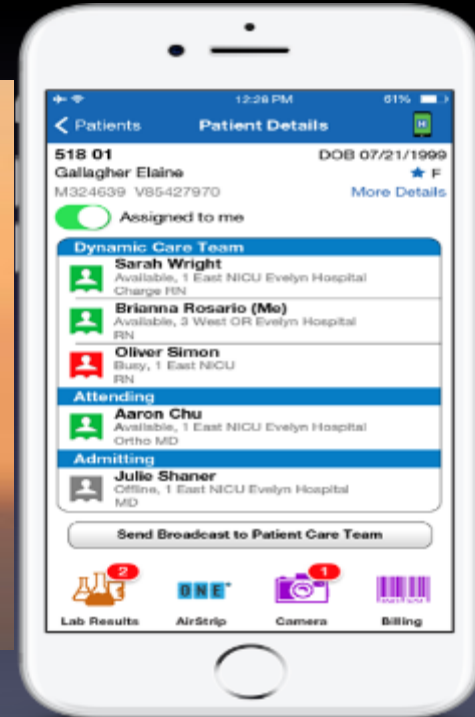


Future research in the ICU: applying what is already known in Geriatrics

- Acute Care for Elders (ACE) Units and “Mobile” ACE teams
- Care transitions
- Should the “dose” of rehab be adjusted for patients who are frail?
 - Lessons from the LIFE study



Looking ahead: The PREDICT Study (PRE-ICU Determinants of Post-ICU FunCTional Outcomes)





Yale Geriatrics

Thomas Gill, M.D.

Yale Pulmonary, Critical Care, and Sleep Medicine

Margaret Pisani, M.D., M.P.H.

Yale Program on Aging

Biostatistics Core: Terry Murphy, Ph.D.

Data Management and Informatics Core:

Evelyne Gahbauer, M.D., M.P.H.

Linda Leo-Summers, M.P.H.

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