réanimation 2024
PARIS 12-14 JUIN

Redflags : pas de soucis, mobilisons !

Objectiver et suivre la fonction physique

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Pontificia Universidad Católica de Chile

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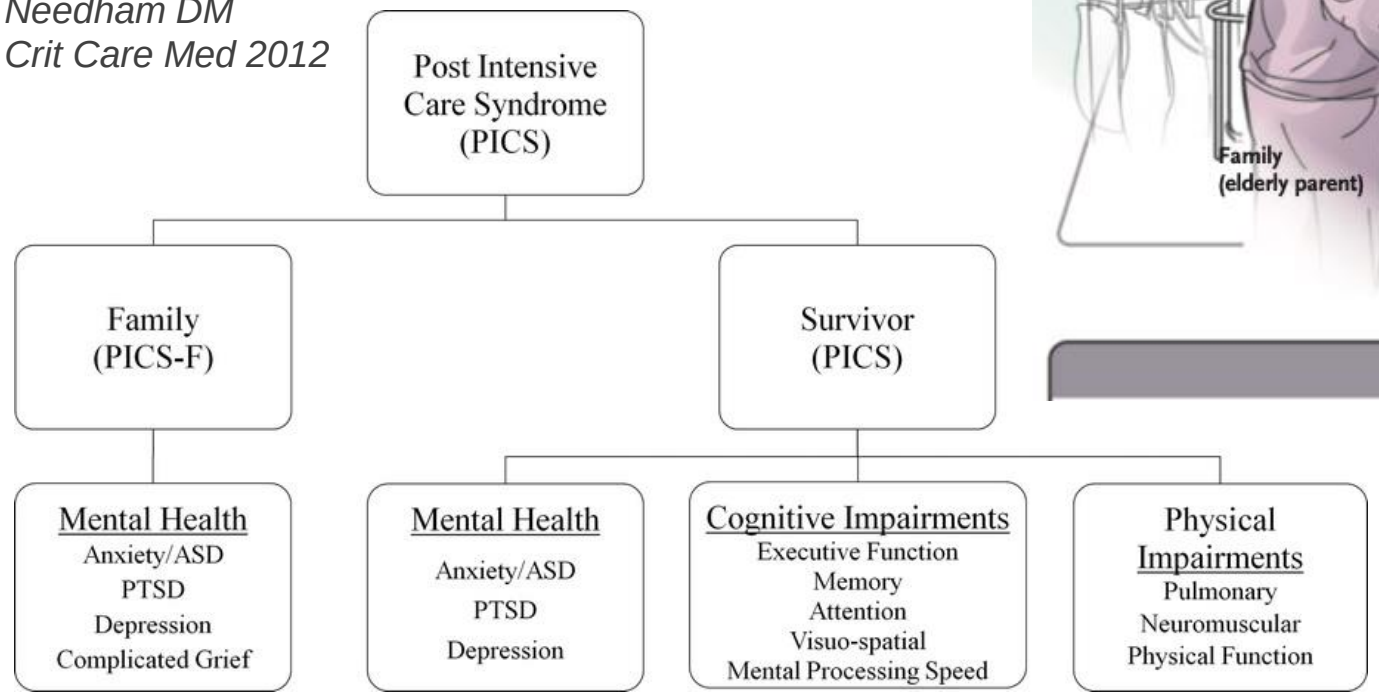
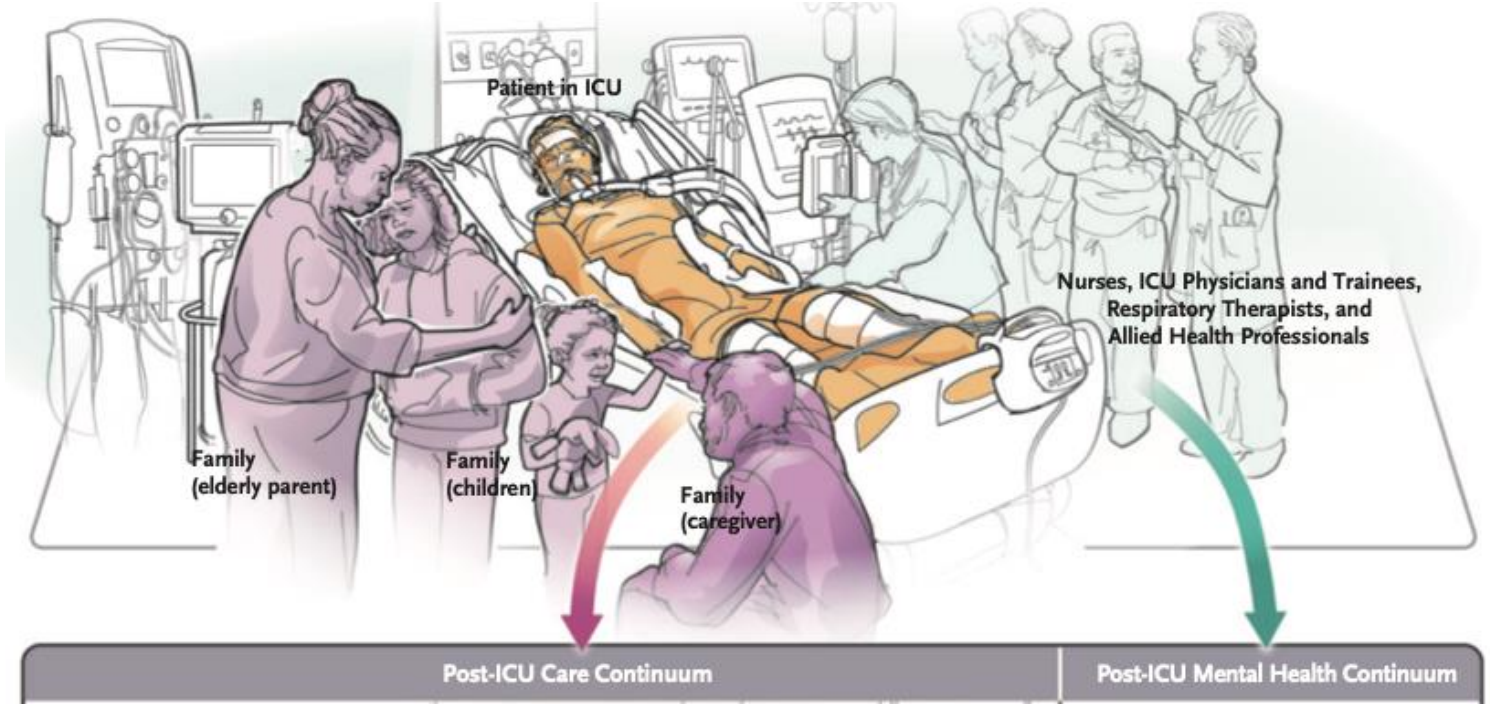
“SURVIVORS of CRITICAL ILLNESS: VICTIMS OF OUR SUCCESS?”

McGovern M. et al. British Journal of General Practice, 2011

Post Intensive Care Syndrome

Needham DM
Crit Care Med 2012





Herridge SM. and Azoulay E.
NEJM 2023

ASD: acute stress disorder, PTSD: post traumatic stress disorder

Post Intensive Care Syndrome

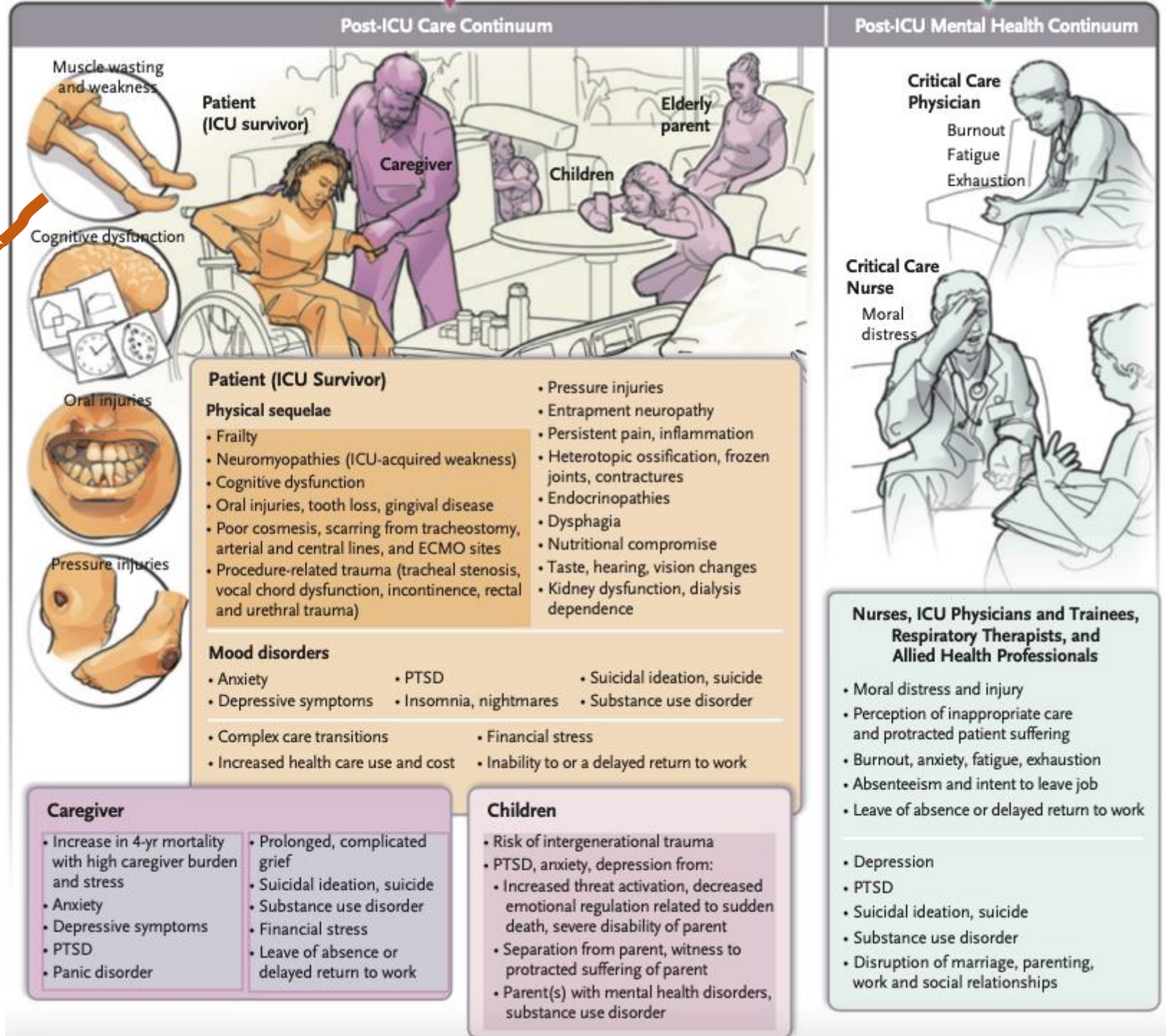
Neuromyopathies (ICU-acquired weakness)

↓

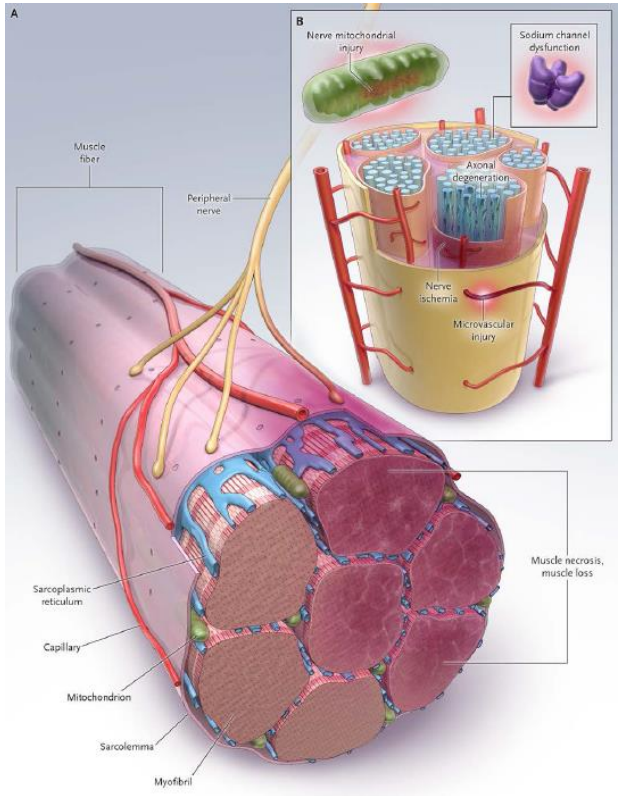
Critical illness weakness (CIW)

Latronico N.
Crit Care 2023

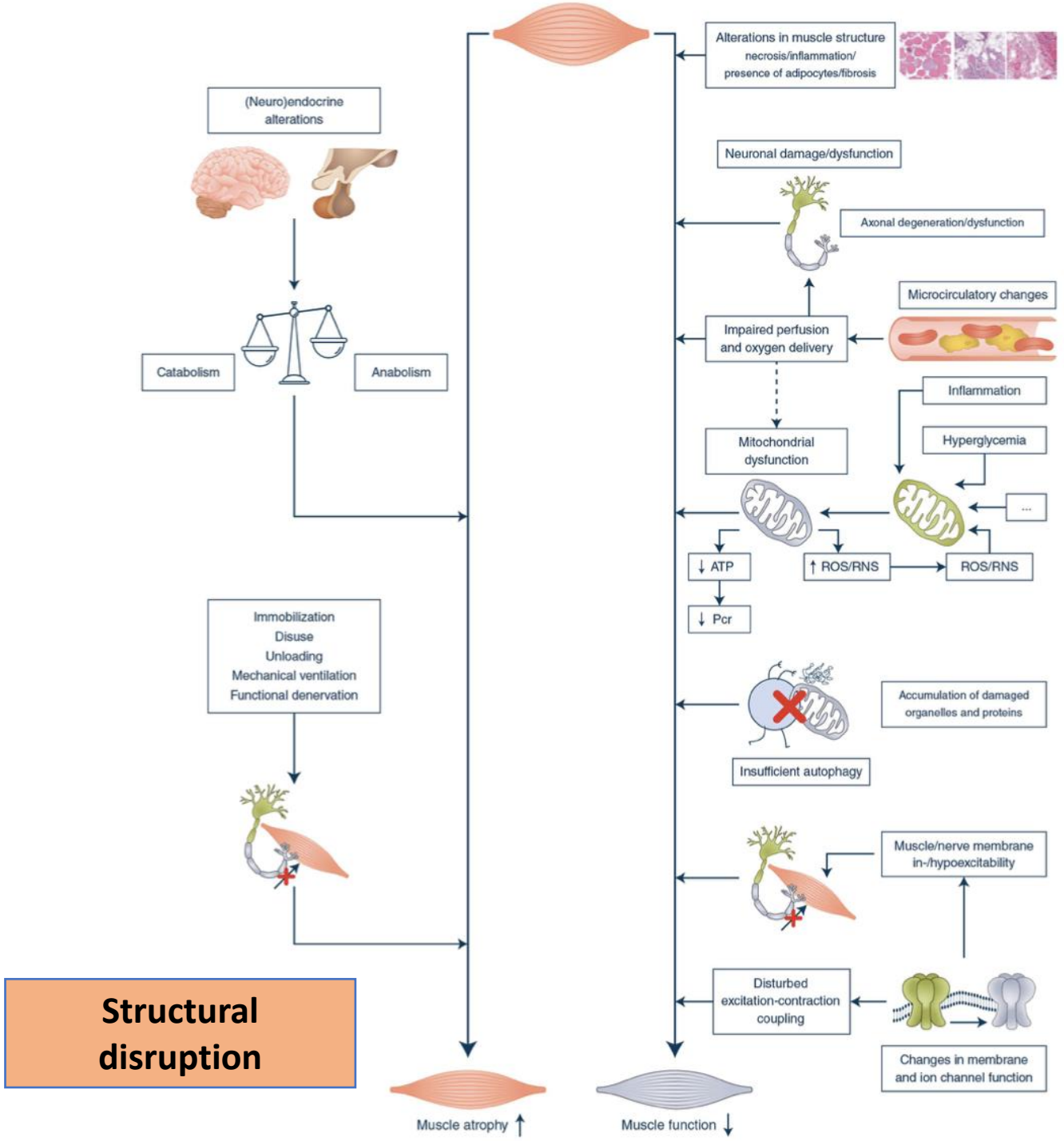
Herridge SM. and Azoulay E.
NEJM 2023



CIW



Kress and Hall. NEJM 2014



Structural disruption

Functional disruption

Vanhorebeek et al. Intensive Care Med. 2020

ICUAW/ CIW diagnosis

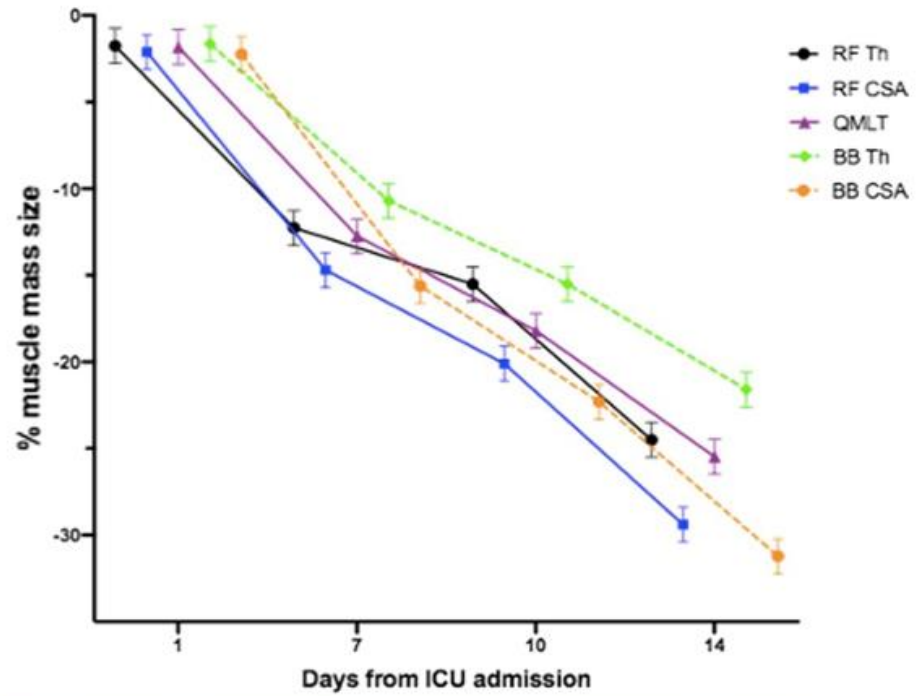
MRC sum score
Dynamometry
Twich
US

Table 1. Definition and diagnostic criteria of intensive care unit–acquired weakness, diaphragmatic weakness, critical illness polyneuropathy, critical illness myopathy, and combined critical illness polyneuropathy and myopathy.

Condition	Definition	Diagnosis
Intensive care unit–acquired weakness (ICU-AW)[1,2]	Clinically detected, diffuse, symmetric weakness involving all extremities and respiratory muscles arising after the onset of critical illness	c) Medical Research Council (MRC) sum score of less than 48/60 or mean MRC score of 4 in all testable muscle groups d) Dominant-hand handgrip dynamometry scores of less than 11 kg (interquartile range (IQR) 10–40) in males and less than 7 kg (IQR 0–7.3) in females
Diaphragmatic weakness (DW)[9]	Reduced pressure-generating capacity of the diaphragm and a decreased diaphragm thickness and thickening fraction after initiation of mechanical ventilation	d) Endotracheal tube pressures less than 11 cm H_2O after bilateral phrenic nerve magnetic stimulation during airway occlusion e) Diaphragm excursion at muscle ultrasound less than 11 mm during tidal breathing f) Diaphragm thickening fraction at muscle ultrasound less than 20%
Critical illness polyneuropathy (CIP)[1]	An axonal, sensory-motor polyneuropathy with reduced nerve excitability and loss of axons with preserved myelin sheet	Reduced amplitude of compound muscle action potentials and sensory nerve action potentials with normal or mildly reduced nerve conduction velocity on electroneurography
Critical illness myopathy (CIM)[1]	A primary acute myopathy with reduced muscle membrane excitability and loss of myosin filaments, fiber atrophy, and necrosis	Reduced amplitude of compound muscle action potentials and normal sensory nerve action potentials on electroneurography and reduced muscle excitability on direct muscle stimulation and myopathic motor unit potentials on needle electromyography
Combined critical illness polyneuropathy and myopathy (CRIMYNE)[1]	Combined CIP and CIM	Reduced amplitude of compound muscle action potentials and sensory nerve action potentials combined with myopathic features on needle electromyography

Piva S., et al.
F1000Research 2019

Skeletal muscle wasting



% RF th	-1.75	-12.25	-15.5	-24.5
% RF CSA	-2.10	-14.7	-20.1	-29.4
% QMLT	-1.82	-12.74	-18.2	-25.48
% BB Th	-1.64	-10.7	-15.5	-21.6
% BB CSA	-2.23	-15.61	-22.30	-31.22

Fig. 2 Loss in muscle mass from day 1 to day 14 of ICU admission. Abbreviations: percentage, %; rectus femoris: RF; cross-sectional area: CSA, thickness: Th, quadriceps muscle layer thickness: QMLT; biceps brachii: BB

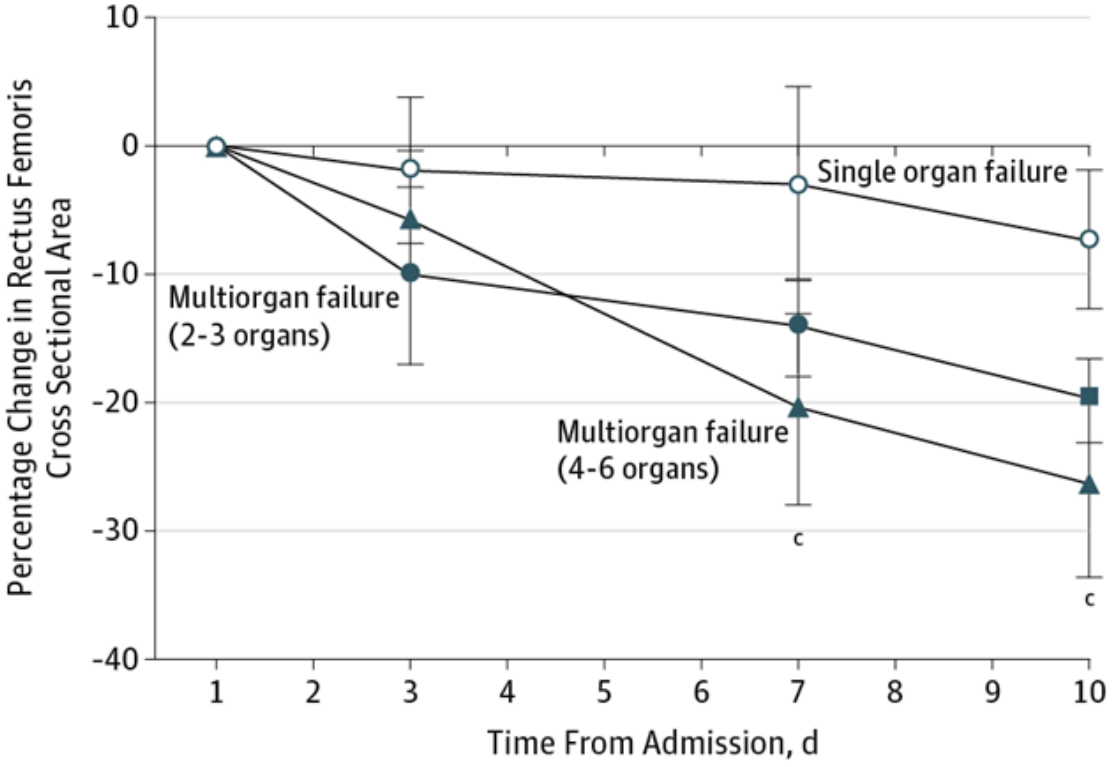
Conclusion

Critically ill patients suffer from early and marked muscle wasting. Ultrasound is the most used assessment tool in evaluating loss in muscle mass over time. The muscle mass is about 2% per day, but this rate is different between muscles and depends upon the measurement taken. The prevalence of ICU-AW is 50% amongst critically ill and those have worst outcomes.

Fazzini *et al. Critical Care (2023)*

Severity

Muscle wasting occurred early and rapidly during the first week of critical illness and was **more severe** among those with **multiorgan failure** compared with single organ failure.



Puthucheary ZA. *Jama* 2013

Low muscle mass

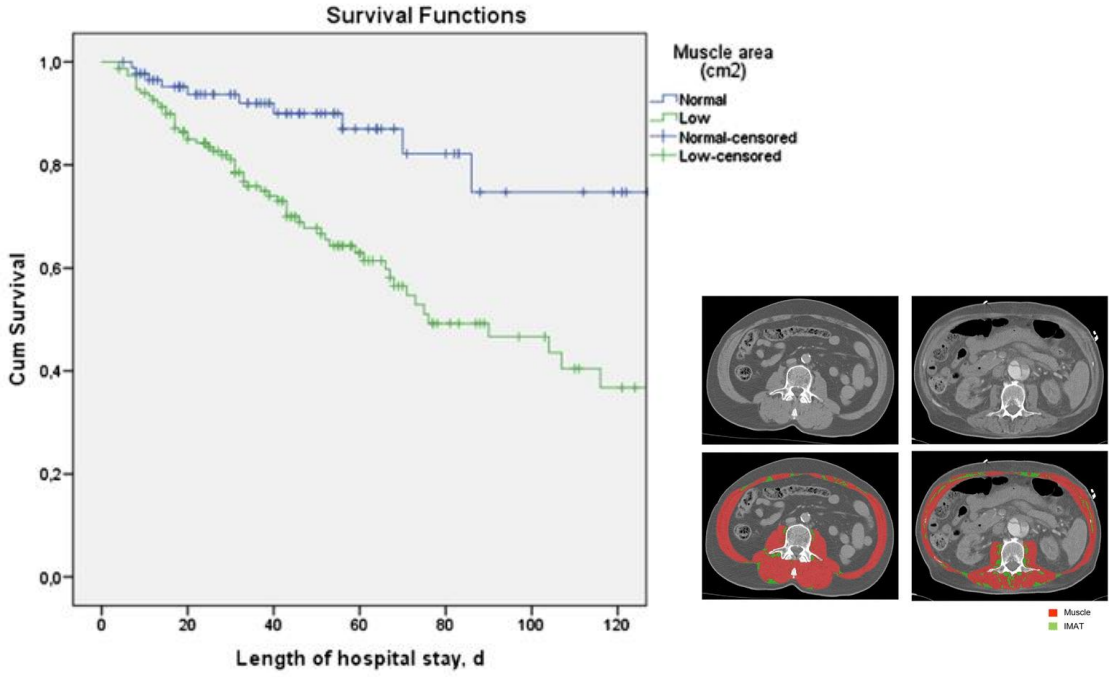
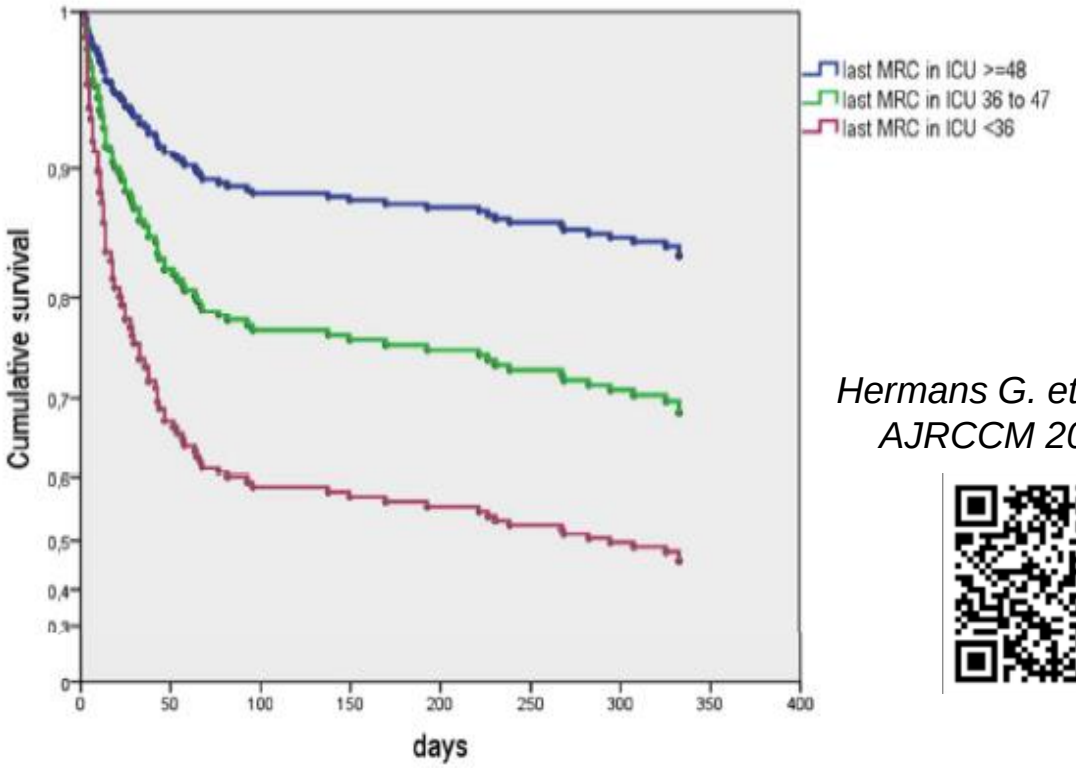


Table I. Consequences of lean body mass loss in critically ill patients hospitalized in intensive care unit

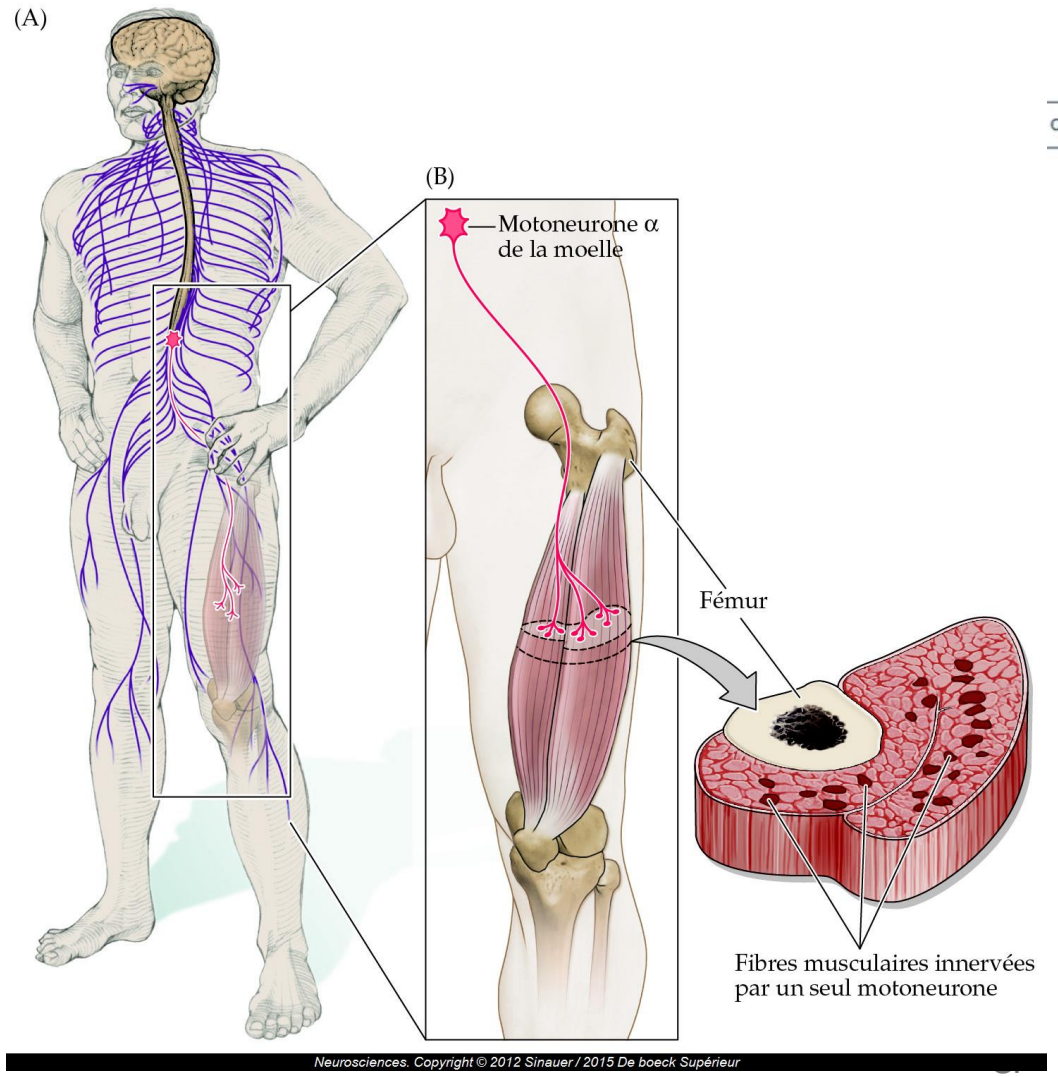
Loss of lean body mass	Consequences
10%	Impaired immune system function
20%	Reduced vital lung capacity
30%	Dependence on mechanical ventilation
>30%	High risk of mortality

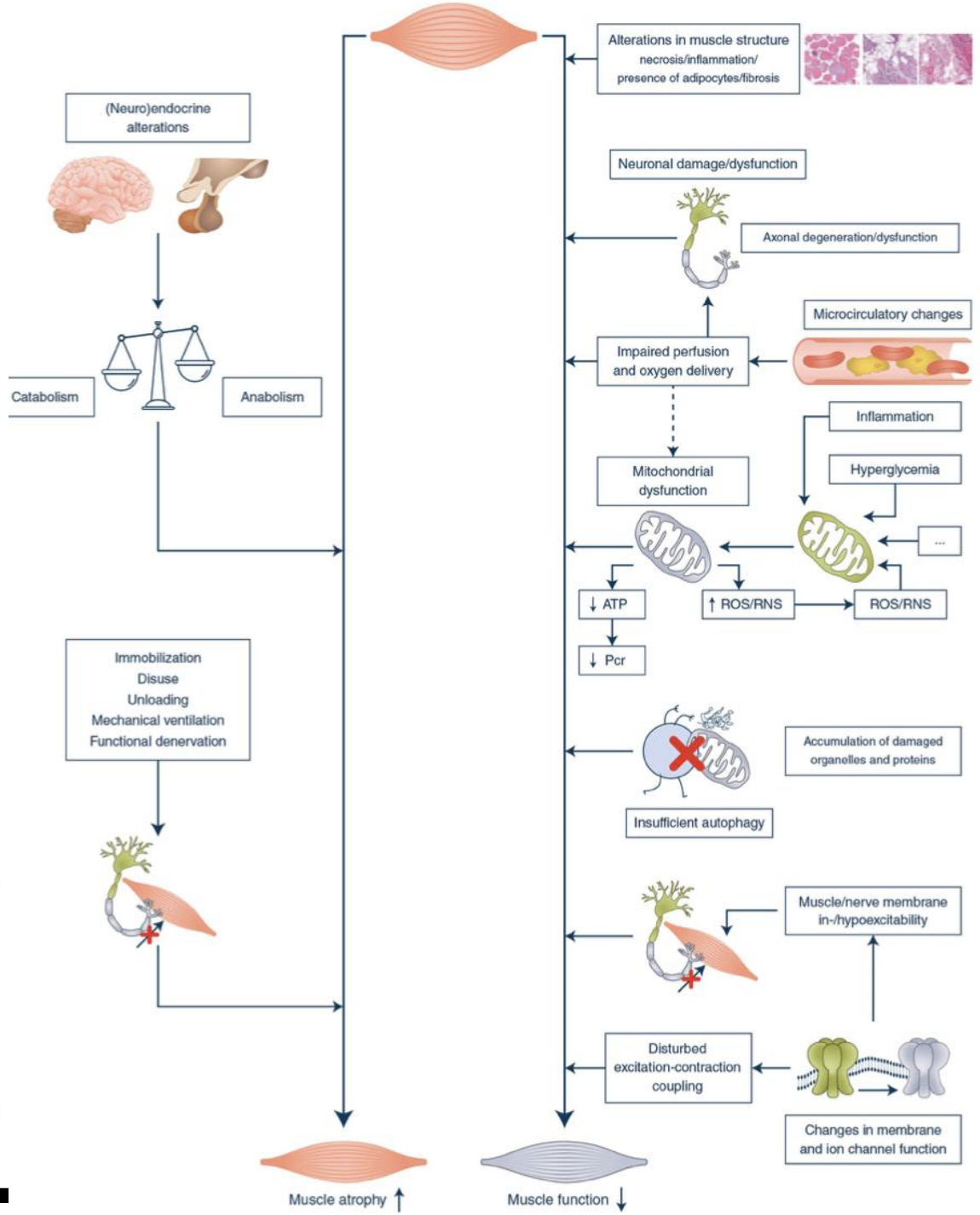
Weijs et al. Critical Care 2014,

Low muscle strenght



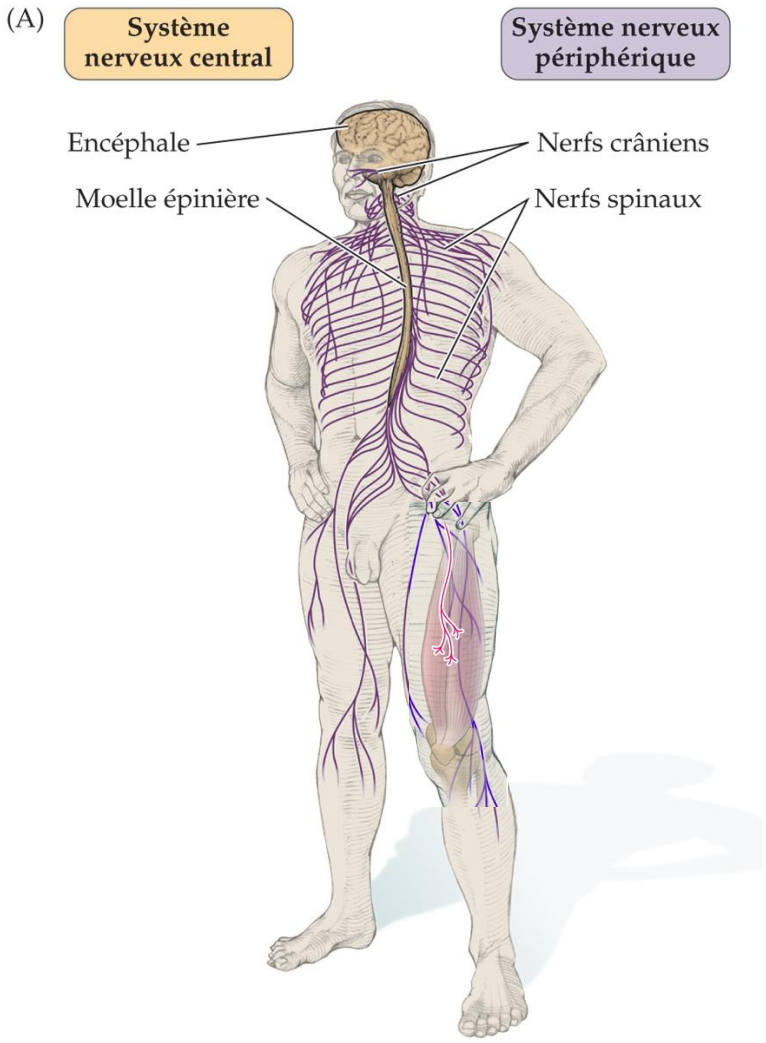
Hermans G. et al. AJRCCM 2014

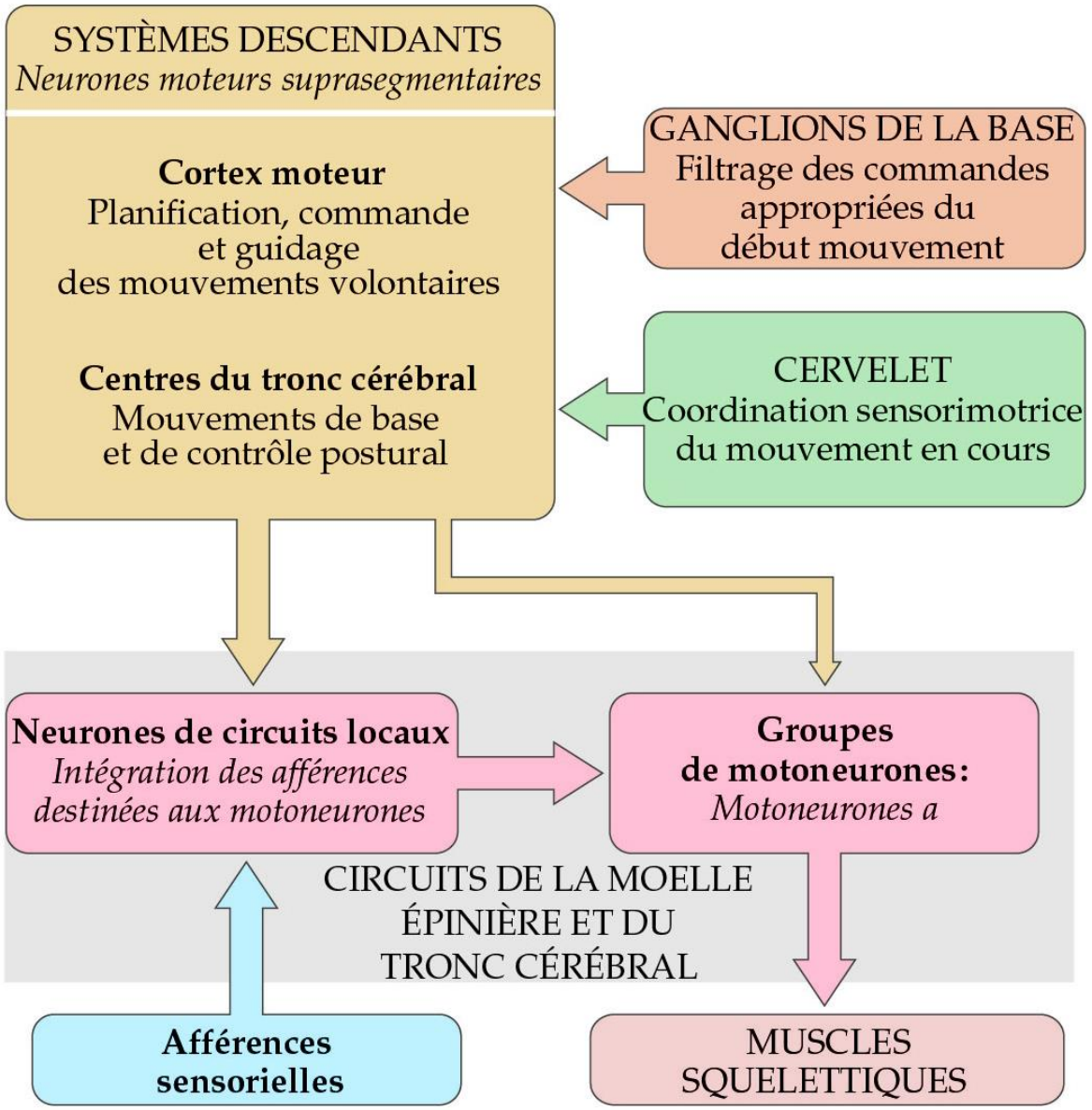




Vanhorebeek et al. Intensive Care Med. 2020

Motor control





Cheryl Hickmanr

CIW - Evaluation methods

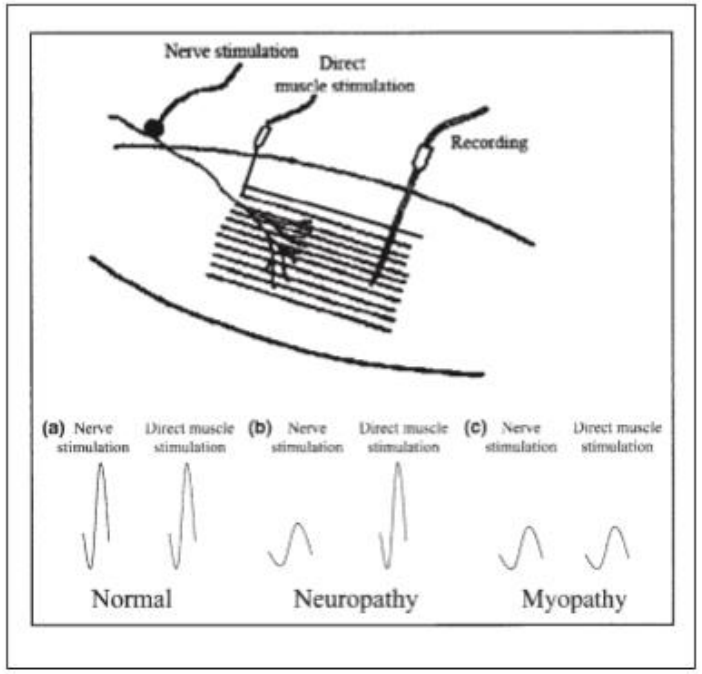


Fig. 4.—Estimulación mixta, nerviosa y muscular directa (Ref. 45).

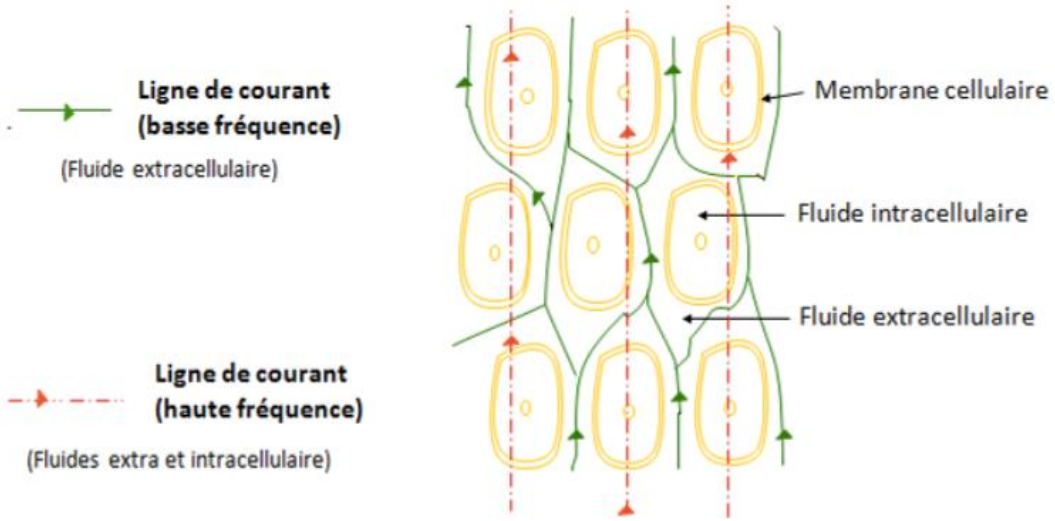
The majority of patients had reduced nerve conduction amplitudes within **3 days** of hospital admission for **sepsis**.
We report here that patients with low NCS amplitudes early in the course of sepsis have **an increase in mortality**.

Khan J, *Neurology 2006*

Muscle evaluation methods	
Non volitional methods	
- EMG	Gold standard CIP/CIM diagnosis
- BIA	Fat free mass, hydric balance
- TAC	Gold standard muscle mass
- Skeletal muscle/nerve biopsy	Gold standard Structural disruption Biochemical analyses
- Ultrasound (peripheric /respiratory muscles)	Qualitative (echogenicity) Quantitative (Cross sectional area (CSA), thickness, thickening fraction)
- Inspiratory Muscle evaluation	Diaphragmatic function (twitch, US, invasive pressure monitoring…)
Volitional methods	
- Skeletal muscle strength	MRC-sum Dynamometry (hand, some movements)
- Functional scores	**<u>During ICU:</u>** PFIT-s, FSS-ICU, CPAx… **<u>Ward/Rehabilitation > Community:</u>** 6-min walking test Movement sensor technologies Frailty scales SPPB… SF-36 physical dimension

CIW - Evaluation methods

Bio-impédance (BIA)



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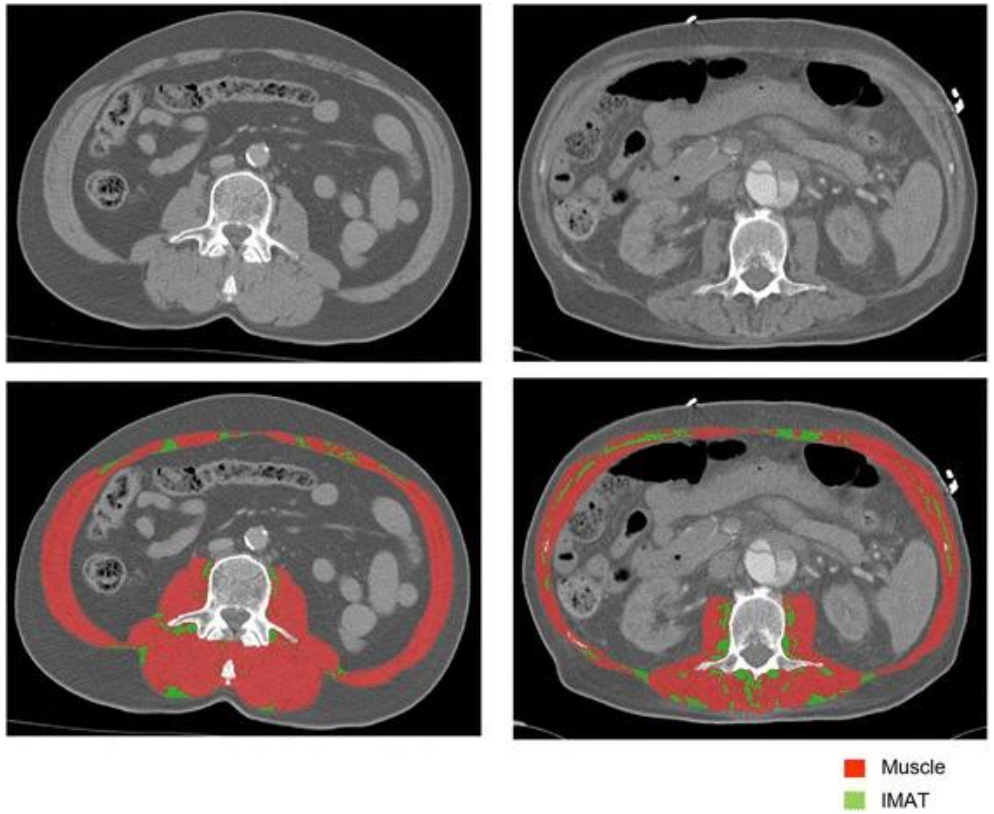
Kyle UG,
Clin nutrition 2004

CIW - Evaluation methods



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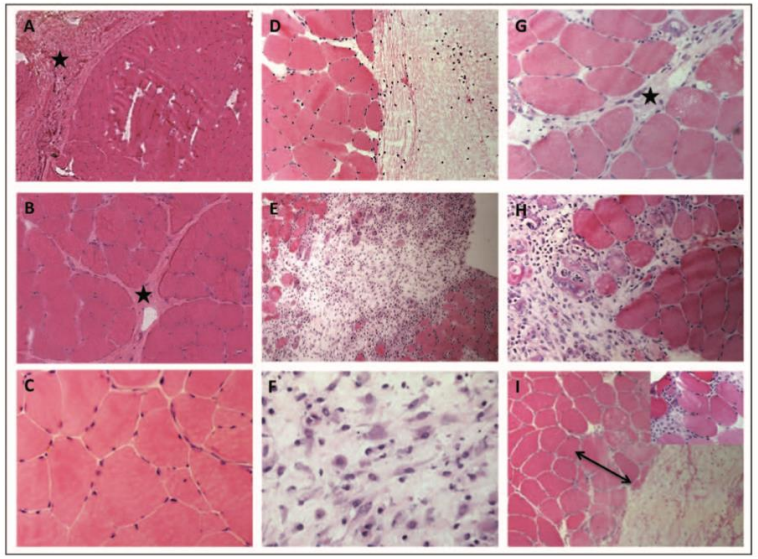
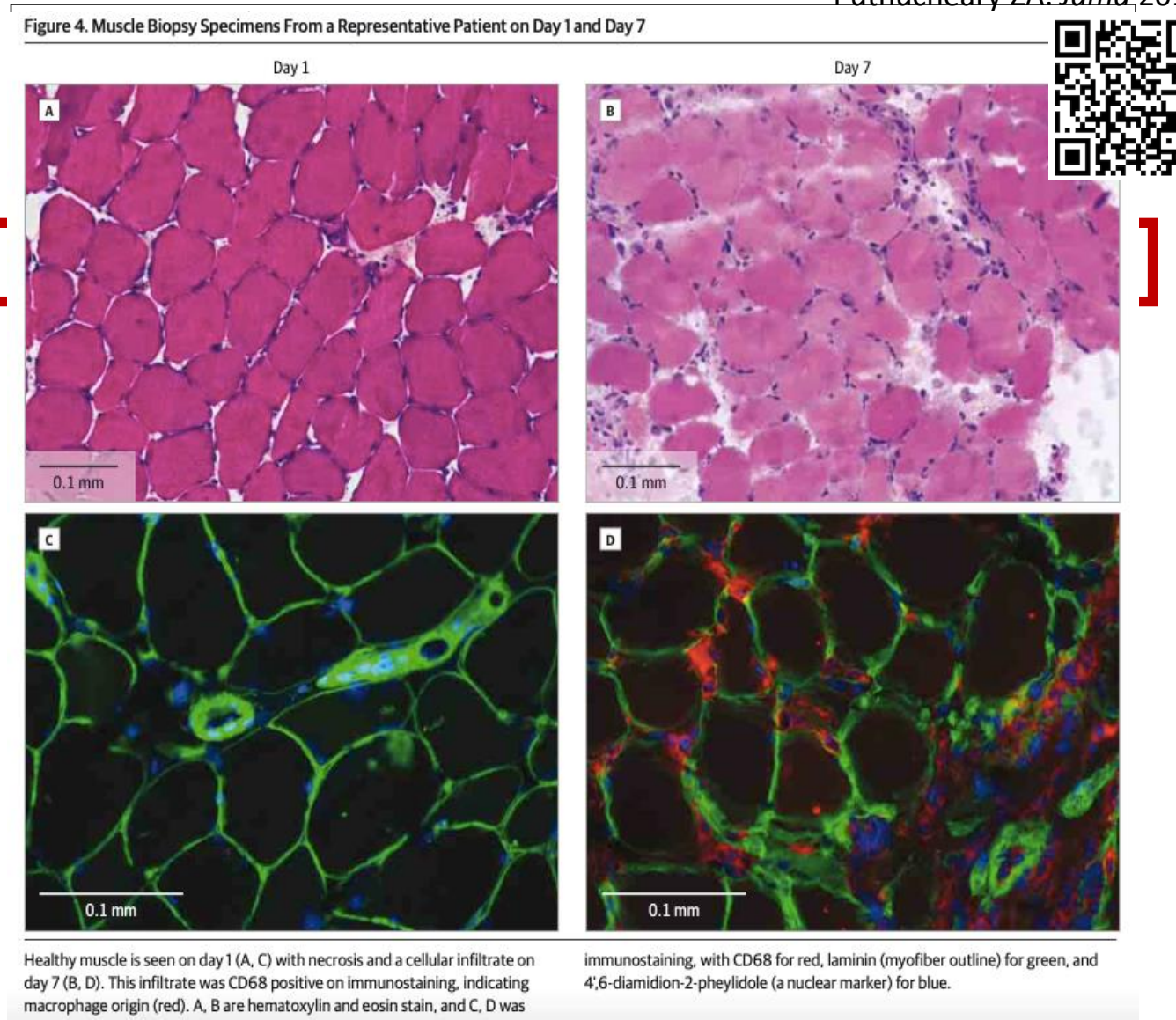
Looijaard et al. Critical Care (2016)

CIW - Evaluation methods

Biopsie Musculaire



Puthucheary ZA. *Jama* 2013



Puthucheary ZA. *CCM 2015*

Biopsie musculaire

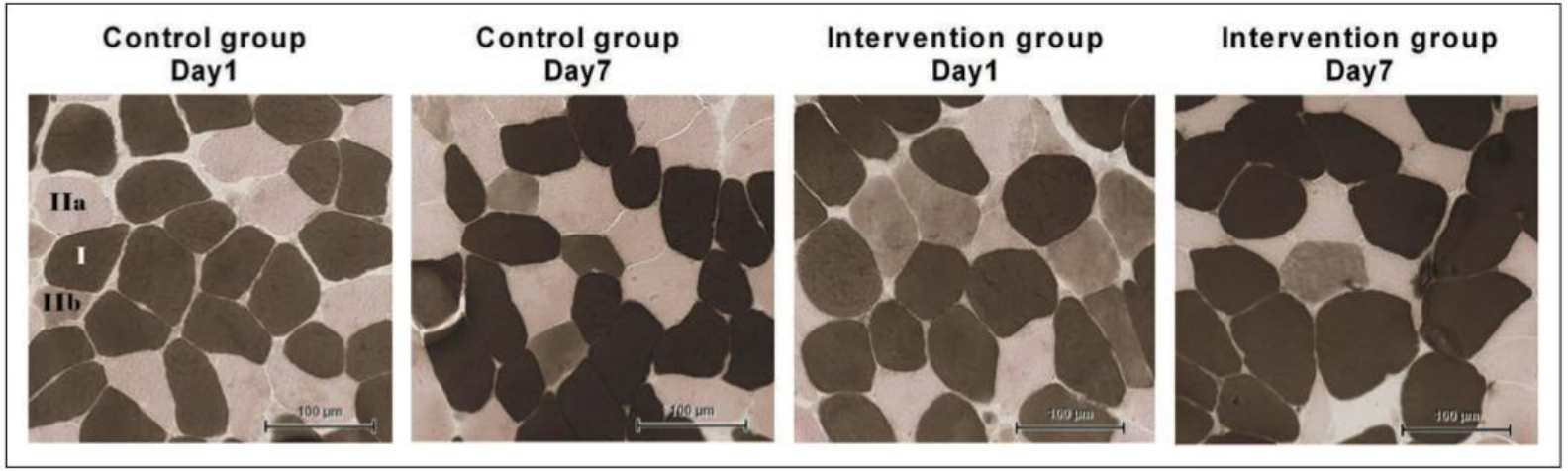


Figure 3. Muscle fiber cross-sectional area changes by group. Skeletal muscle sections stained with adenosine triphosphatase pH 4.50; *black* fibers correspond to type-I fibers; *gray* fibers are type-IIb fibers and; *pink* fibers correspond to type-IIa.

TABLE 2. Changes in Cross-Sectional Area by Groups

Fiber Type	Control Group ($n = 9$), Mean ± SD		Intervention Group ($n = 8$), Mean ± SD		p^b
	Day 1	Day 7	Day 1	Day 7	
All fibers types (µm²)	3,603 ± 1,284	2,629 ± 1,174[a]	3,448 ± 1,993	3,770 ± 1,473	0.01
Type I fibers (µm²)	4,236 ± 1,379	3,135 ± 1,103[a]	4,250 ± 1,977	4,678 ± 1,189	0.02
Type-IIa fibers (µm²)	3,949 ± 1,447	2,744 ± 1,260[a]	2,574 ± 856	2,920 ± 745	0.003
Type-IIb fibers (µm²)	2,624 ± 1,243	2,006 ± 1,286[a]	2,082 ± 1,083	2,576 ± 948	0.04

[a]Different than day 1 ($p < 0.05$).
[b]p of the difference between groups changes, no differences were detected between groups at day 1 in any fibers type.

Hickmann CE, *Crit Care Med 2019*

CIW - Evaluation methods

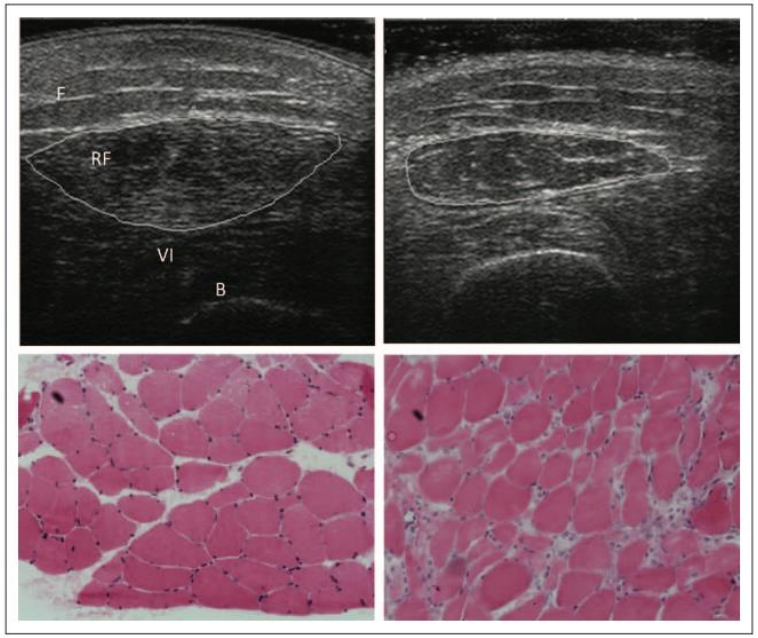


Figure 3. Representative paired ultrasound and hematoxylin and eosin stained sections of a patient on day 1 and day 10, demonstrating the reduction in rectus femoris (RF) cross-sectional area, an increase in RF echogenicity and the presence of myofiber necrosis with cellular infiltrate on day 10. B = femoral bone, F = fascial layer, VI = vastus intermedius.

Puthucheary ZA.
CCM 2015

Muscle evaluation methods	
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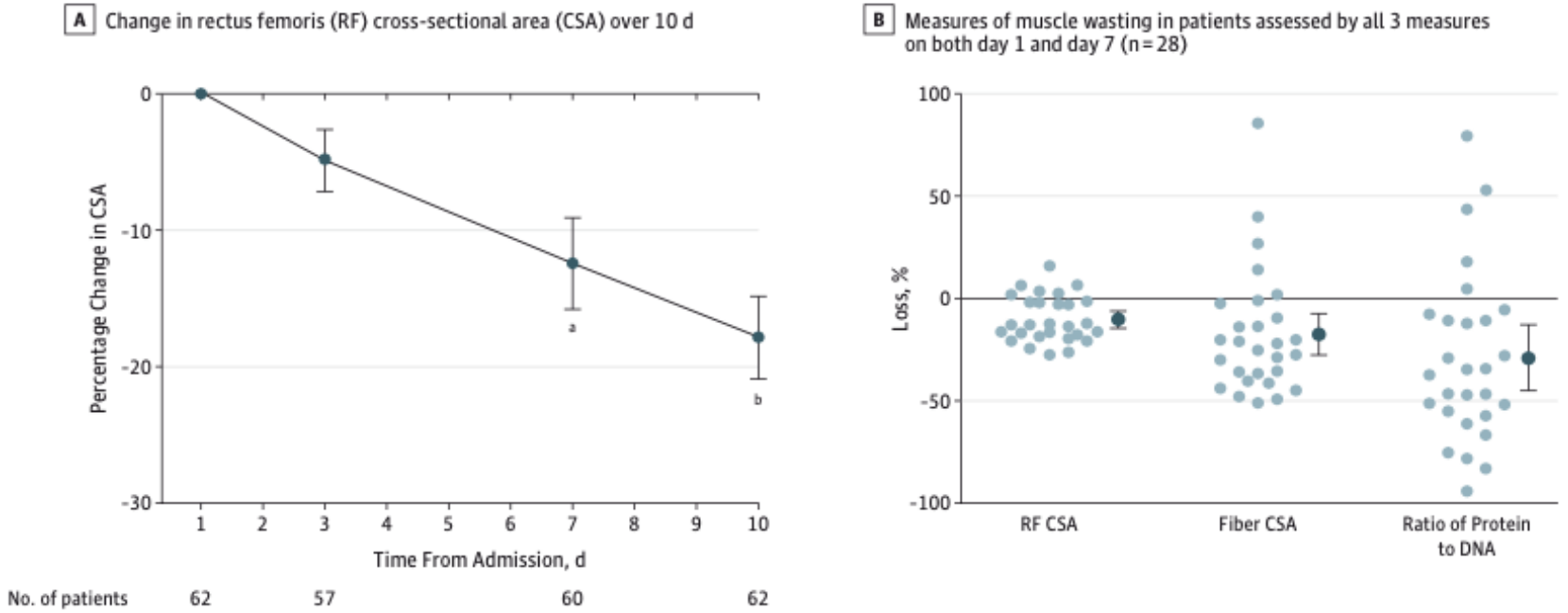
Figure 2. Measurements of Muscle Wasting During Critical Illness

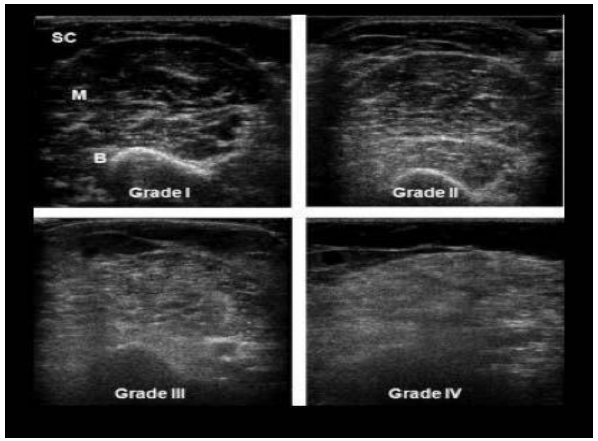


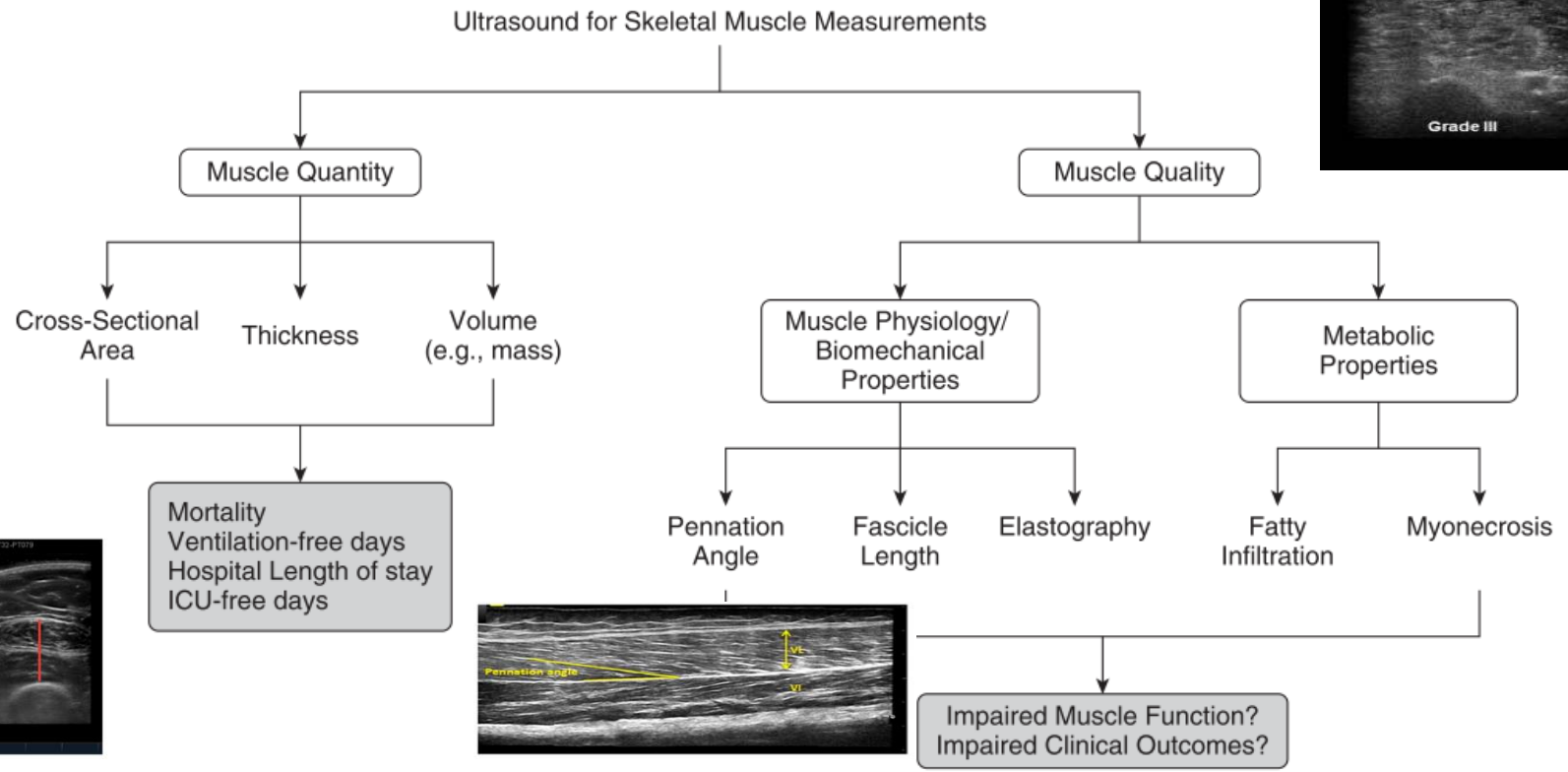
	Movement sensor technologies Frailty scales SPPB… SF-36 physical dimension

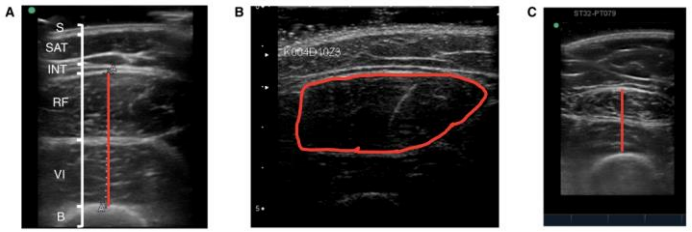
Ultrasonography

Skeletal Muscle Ultrasound in Critical Care: A Tool in Need of Translation

Marina Mourtzakis[1], Selina Parry[2], Bronwen Connolly[2,3,4,5], and Zudin Puthucheary[4,6]







AnnalsATS Volume 14 Number 10 | October 2017

US peripheral qualitative and qualitative

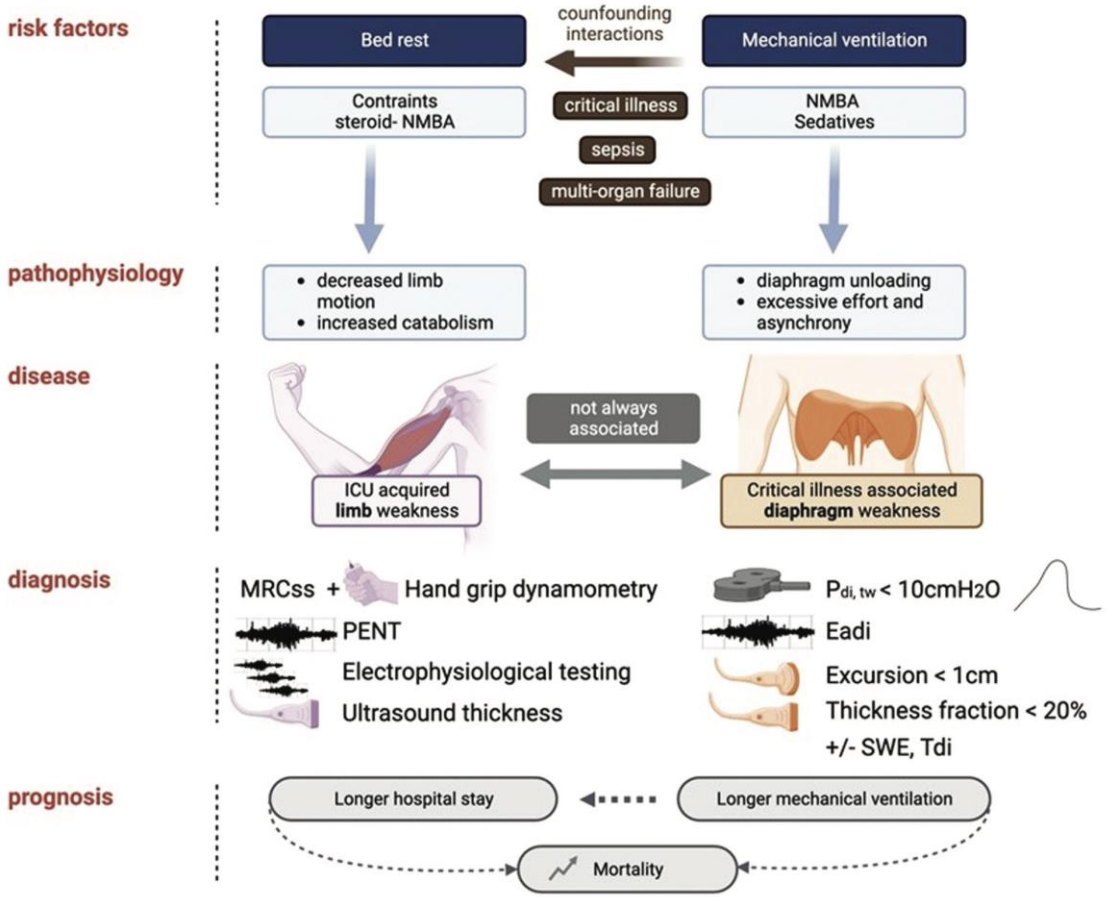
Table 2
Percentage change in ultrasound muscle parameters over the first 10 days of the ICU admission

US muscle parameter measured	Day 3	Day 5	Day 7	Day 10
RF thickness	−8.7%	−16.6%	−24.9%	−30.4%
VI thickness	−1.3%	−18.1%	−20.0%	−29.7%
VL thickness	−0.2%	−5.7%	−6.0%	−14.1%
RF CSA	−1.0%	−11.8%	−16.8%	−29.9%
RF echogenicity	+2.8%	+8.8%	+9.6%	+12.7%
VI echogenicity	+4.0%	+7.1%	+13.6%	+25.2%
VL pennation angle	+4.9%	+18.9%	+1.4%	−7.3%
Subcutaneous tissue thickness	+7.3%	+15.7%	+30.4%	+39.4%

Day 3 measure is a percentage change from baseline.

Parry S. Journal of Critical Care 2015

CIW - Evaluation methods



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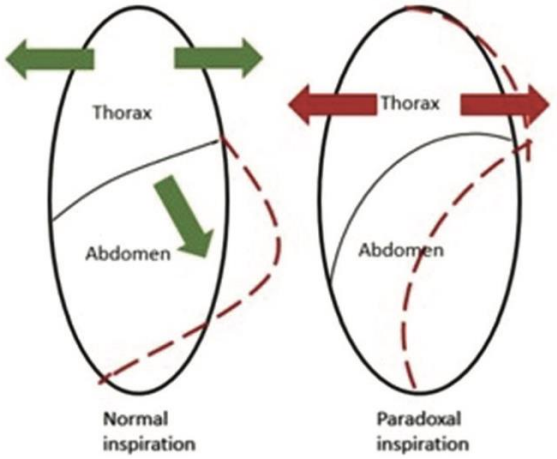
Le Stang V. Curr Op critical care 2024

Diaphragmatic dysfunction

Clinical symptoms

- Paradoxical abdominal breathing



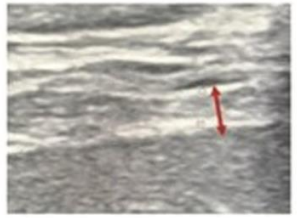
- Orthopnea

Le Stang V. Curr Op critical care 2024

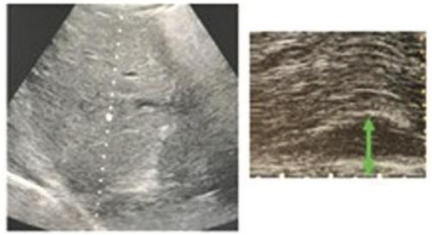
Ultrasound

- Thickening fraction < 20%

$$TF = \frac{TEI - TEE}{TEE}$$



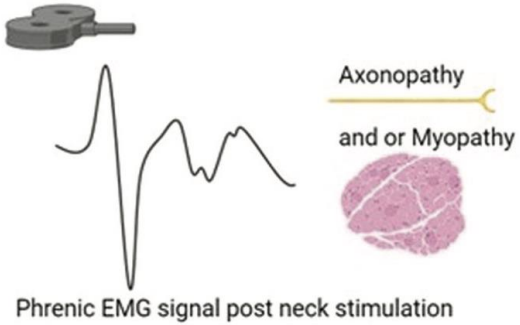
- Diaphragm excursion < 1cm



Evaluation during spontaneous ventilation with PEEP 0cmH2O and no pressure support

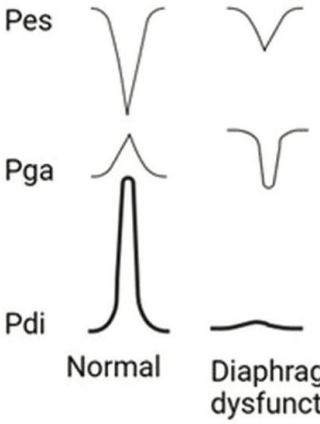
Electrophysiological

- EMG post phrenic stimulation

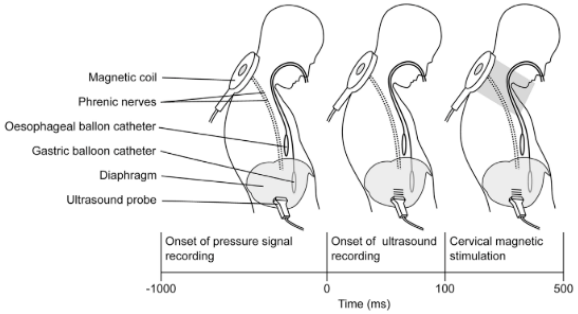


Phrenic EMG signal post neck stimulation

- **Twitch Pdi** post phrenic nerve stimulation < 10cmH_2O



Poulard et al. J Physiol 2020



Stimulation magnétique transcutanée

Published in final edited form as:
Muscle Nerve. 2018 May ; 57(5): 784–791. doi:10.1002/mus.26026.

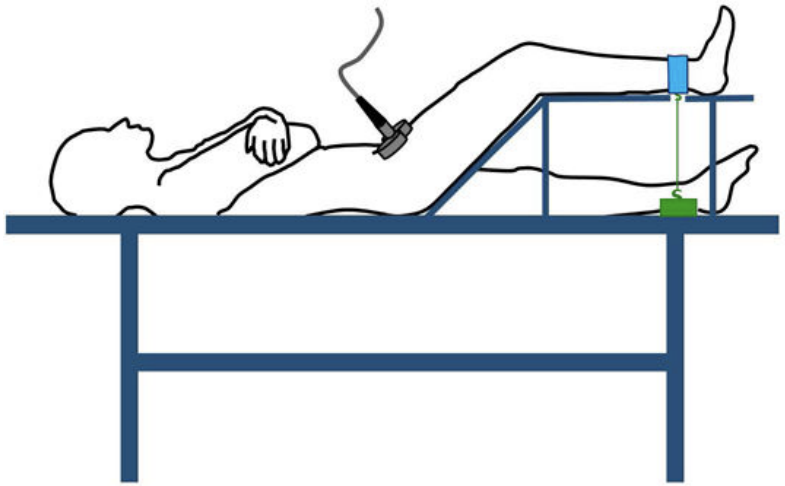
New device for non-volitional evaluation of quadriceps force in ventilated patients

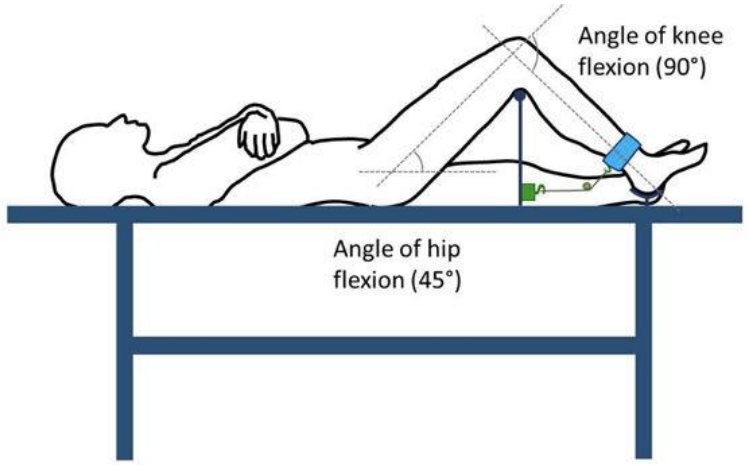
Franco Laghi, MD[1,2], Najeeb Khan, BS[1], Thimothy Schnell, MD[1,2], Dinas Alexonis, MD[1,2], Kendra Hammond, MD[3], Hameeda Shaikh, MD[1,2], Eileen Collins, PhD[1], Amal Jubran, MD[1,2], and Martin Tobin, MD[1,2]

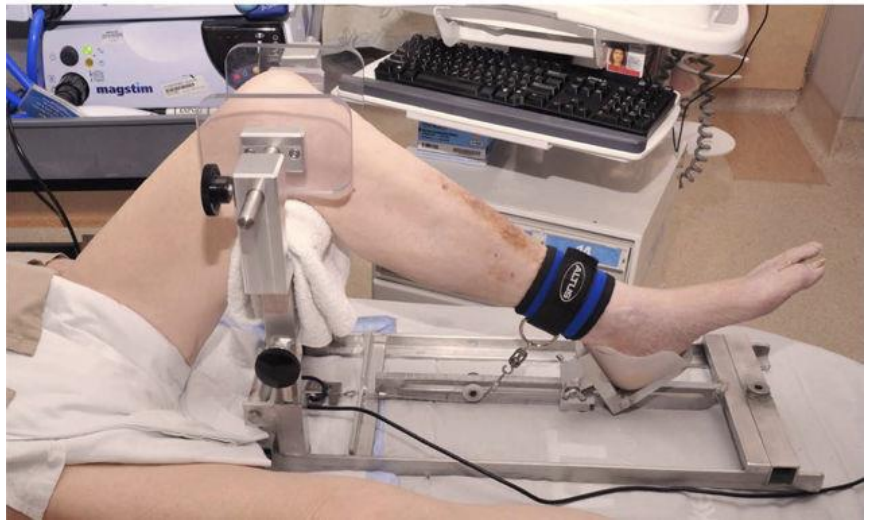
[1]Hines, Veterans Affairs Hospital (111N), 5th Ave & Roosevelt Rd, Hines, IL 60141

[2]Loyola University, 2160 South First Ave, Building 54, Room 131A, Maywood, IL 60153

[3]National Jewish Health, 1400 Jackson St., M329, Denver, CO 80206







Lien thérapeutique

- Contact direct, stimulation tactile et verbale.
  Connexion thérapeute-patient = Empathie (soft skills)

5 questions standardisées" (S5Q)

pour évaluer la coopération.

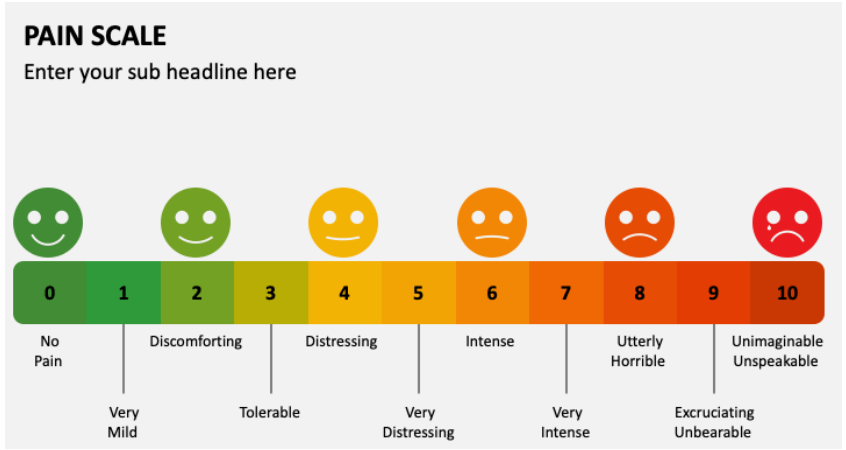
Cinq commandes :

Ouvrez/fermez vos yeux
Regardez-moi
Ouvrez votre bouche et tirez la langue
Faites un signe de tête
Levez les sourcils lorsque j'aurai compté jusqu'à cinq

Ces mouvements impliquent les muscles du cou et du visage, qui sont généralement épargnés dans le contexte d'une faiblesse musculaire à la suite d'une maladie critique.

De Jonghe B. crit care med 2007

Douleur



Delirium

Escala	Acrónimo	Estudio validación
Cognitive test for delirium	CTD	Hart et al.[32]
Abbreviated cognitive test for delirium	Abbreviated CTD	Hart et al.[33]
Confusion assessment metod for the Intensive care unit	CAM - ICU	Ely et al.[34]Ely et al.[35]Pun et al.[36]
Intensice care unit delirium screening checklist	ICDSC	Bergeron et al.[37]
NEECHAM scale	NEECHAM	Csokasy et al.[38]Immers et al.[39]
Delirium detection score	DDS	Otter et al.[40]

Douleur

Behavioural Pain Scale (BPS)		
	Description	Score
Facial expression	Relaxed	1
	Partially tightened	2
	Fully tightened	3
	Grimacing	4
Upper limbs	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Compliance with ventilation	Tolerating movement	1
	Coughing but tolerating ventilation for most of the time	2
	Fighting ventilator	3
	Unable to control ventilation	4

Pain grade: presence of pain ≥6/unacceptable pain >7/objective <6.

Testing musculaire MRCsum-score:

<48/60 significant weakness
<36/60 severe weakness

Hermans G. Muscle Nerve, 2012

Muscle evaluation methods	
Non volitional methods	
- EMG	Gold standard CIP/CIM diagnosis
- BIA	Fat free mass, hydric balance
- TAC	Gold standard muscle mass
- Skeletal muscle/nerve biopsy	Gold standard Structural disruption Biochemical analyses
- Ultrasound (peripheric /respiratory muscles)	Qualitative (echogenicity) Quantitative (Cross sectional area (CSA), thickness, thickening fraction)
- Inspiratory Muscle evaluation	Diaphragmatic function (twitch, US, invasive pressure monitoring…)
Volitional methods	
- Skeletal muscle strength	MRC-sum Dynamometry (hand, some movements)
- Functional scores	**<u>During ICU:</u>** PFIT-s, FSS-ICU, CPAx… **<u>Ward/Rehabilitation > Community:</u>** 6-min walking test Movement sensor technologies Frailty scales SPPB… SF-36 physical dimension

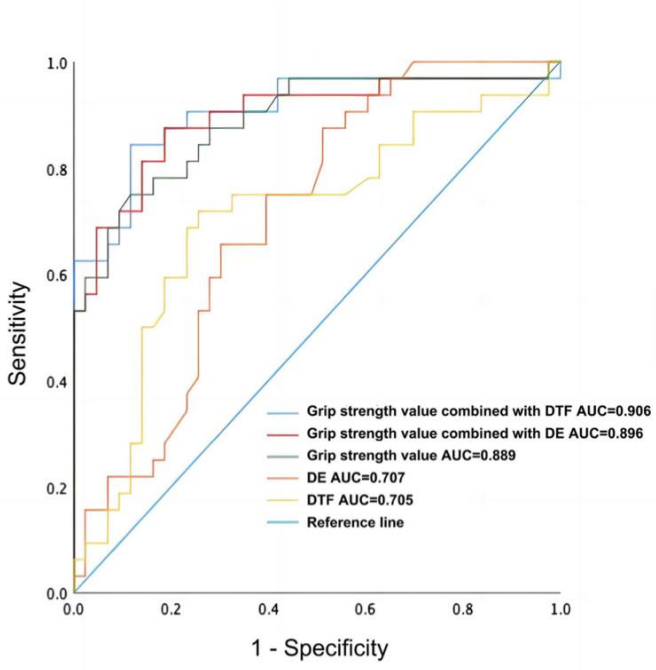
Dynamométrie

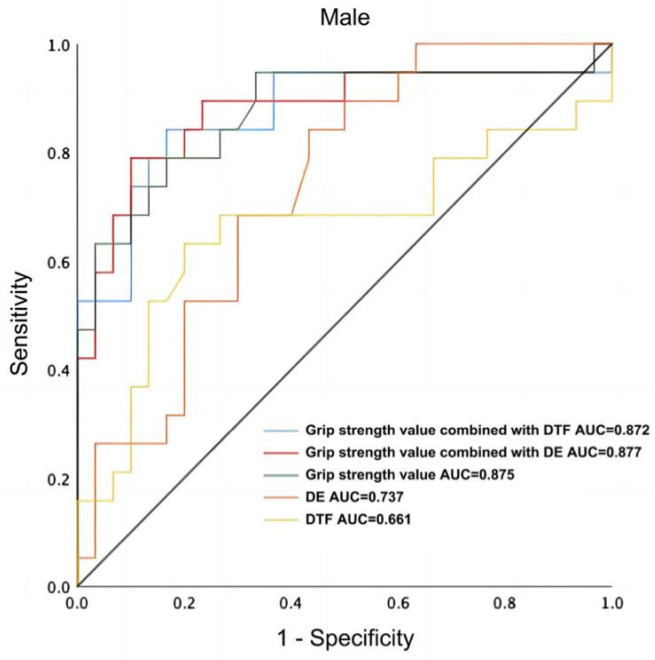
Handgrip

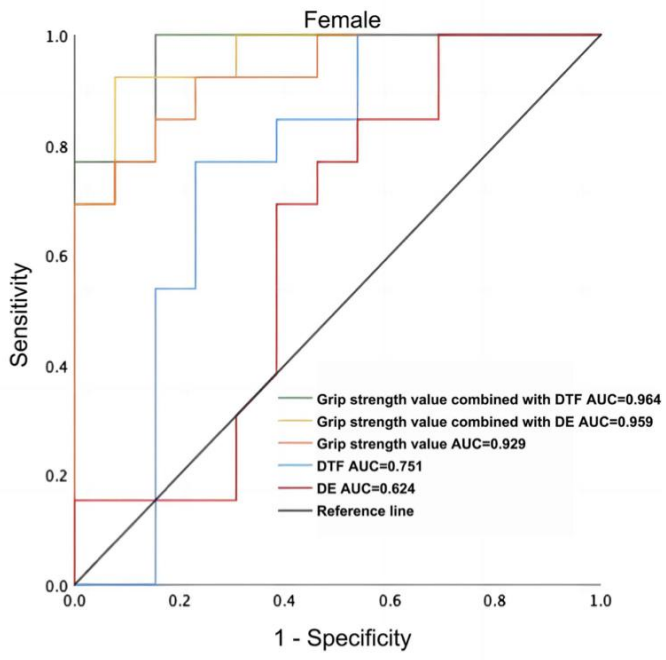
MESURE la Force de préhension isométrique maximale du côté dominant.

The integration of **grip strength** with **diaphragm ultrasound** exhibited a heightened capacity to enhance the diagnostic value specifically in patients diagnosed who are critically ill with ICU-AW.

Zhang Q. J Multidiscip Healthc . 2024







Comparison of diaphragm ultrasonography and handgrip dynamometer ROC curves for the identification of ICU-AW in patients who are mechanically ventilated. **Abbreviations**: ICU-AW, ICU Acquired Weakness; DE, Diaphragmatic excursion; DTF, Diaphragm thickening fraction.

Dynamométrie

Handheld

Valeurs exprimées en pourcentage des valeurs de référence.

Collaboration (S5Q)

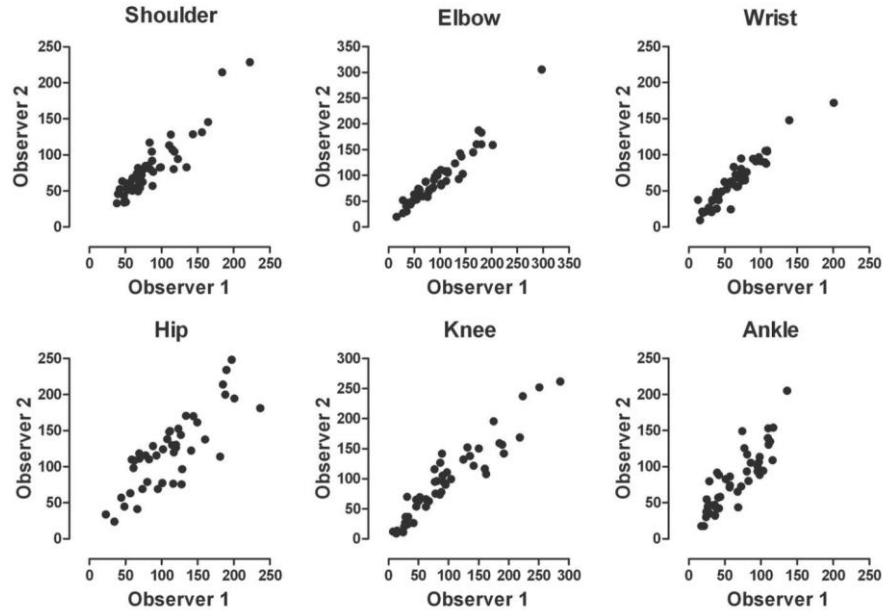
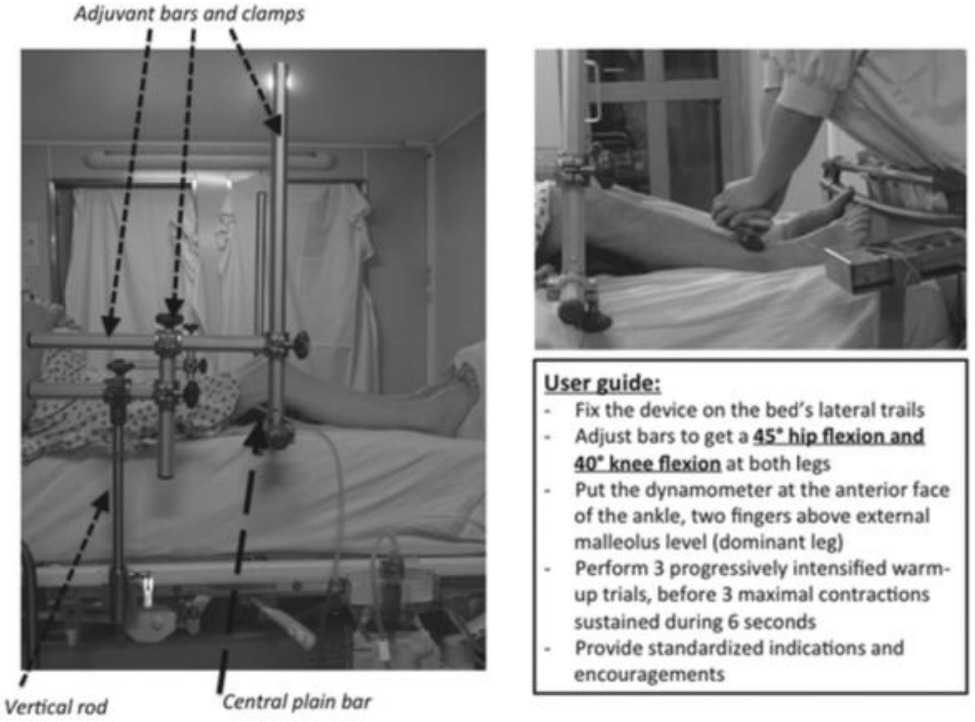


Figure 1. Identity plots of six muscle groups: shoulder abduction, elbow flexion, wrist extension, hip flexors, knee extension, and ankle dorsiflexion.

Vanpee, G. et al.
Crit. Care Med. **2011**

Dynamométrie

Adaptations en réanimation



User guide:

- Fix the device on the bed's lateral trails
- Adjust bars to get a **45° hip flexion and 40° knee flexion** at both legs
- Put the dynamometer at the anterior face of the ankle, two fingers above external malleolus level (dominant leg)
- Perform 3 progressively intensified warm-up trials, before 3 maximal contractions sustained during 6 seconds
- Provide standardized indications and encouragements

Rousseau, A.F et al. *Acta Anaesthesiol. Belg.* **2018**,

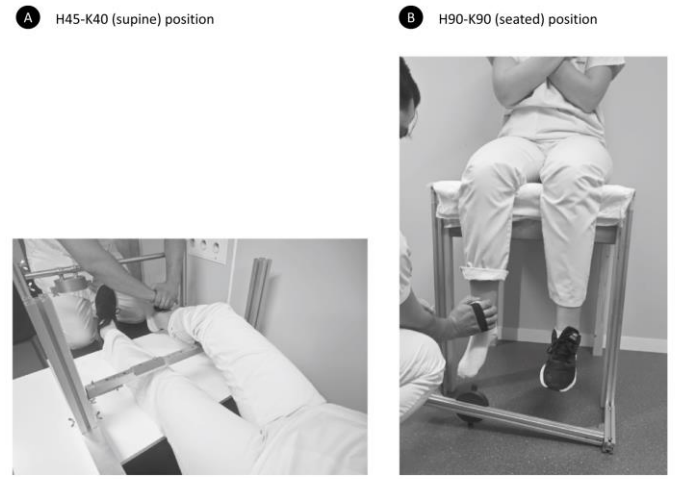
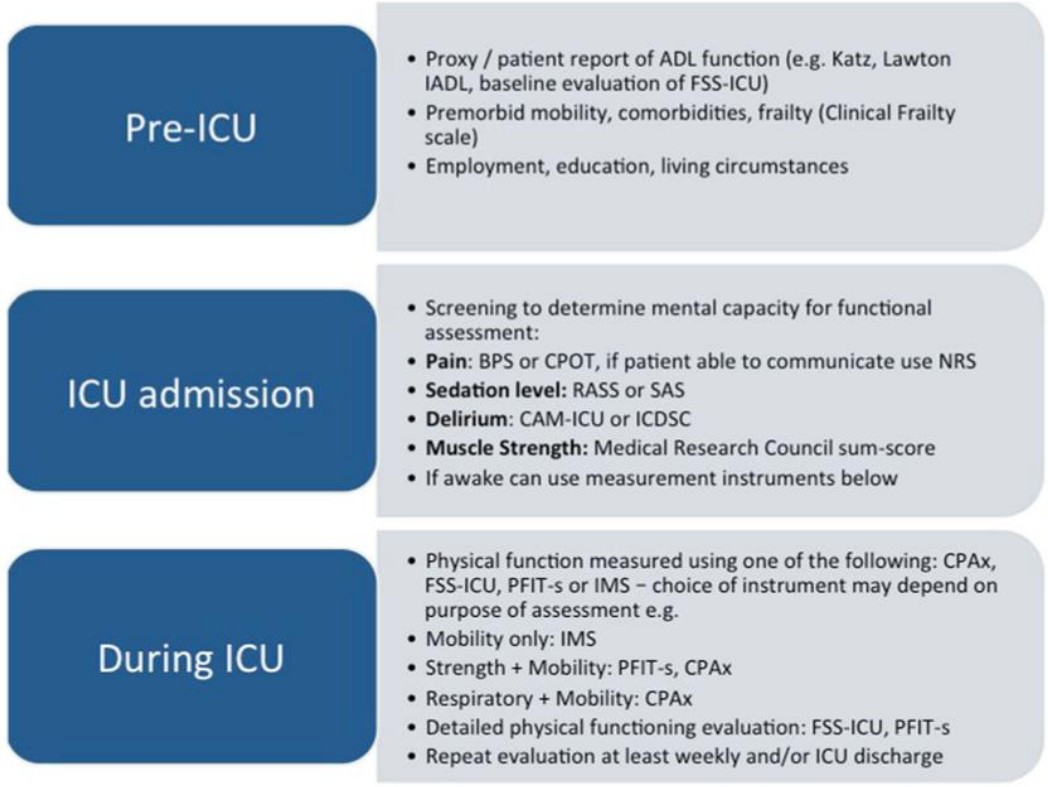


Fig. 1 Illustration of the testing structure, participant positioning and operator positioning in the H45–K40 (**A**) and H90–K90 (**B**) positions

In the ICU, the conditions make it easier to measure QS in supine position for an early assessment, and **further measurements** should be performed in **the very same position**, even if patients could then be tested in other positions.

Rousseau *et al. Intensive Care Medicine Experimental 2023*



Parry et al. Critical Care (2017)

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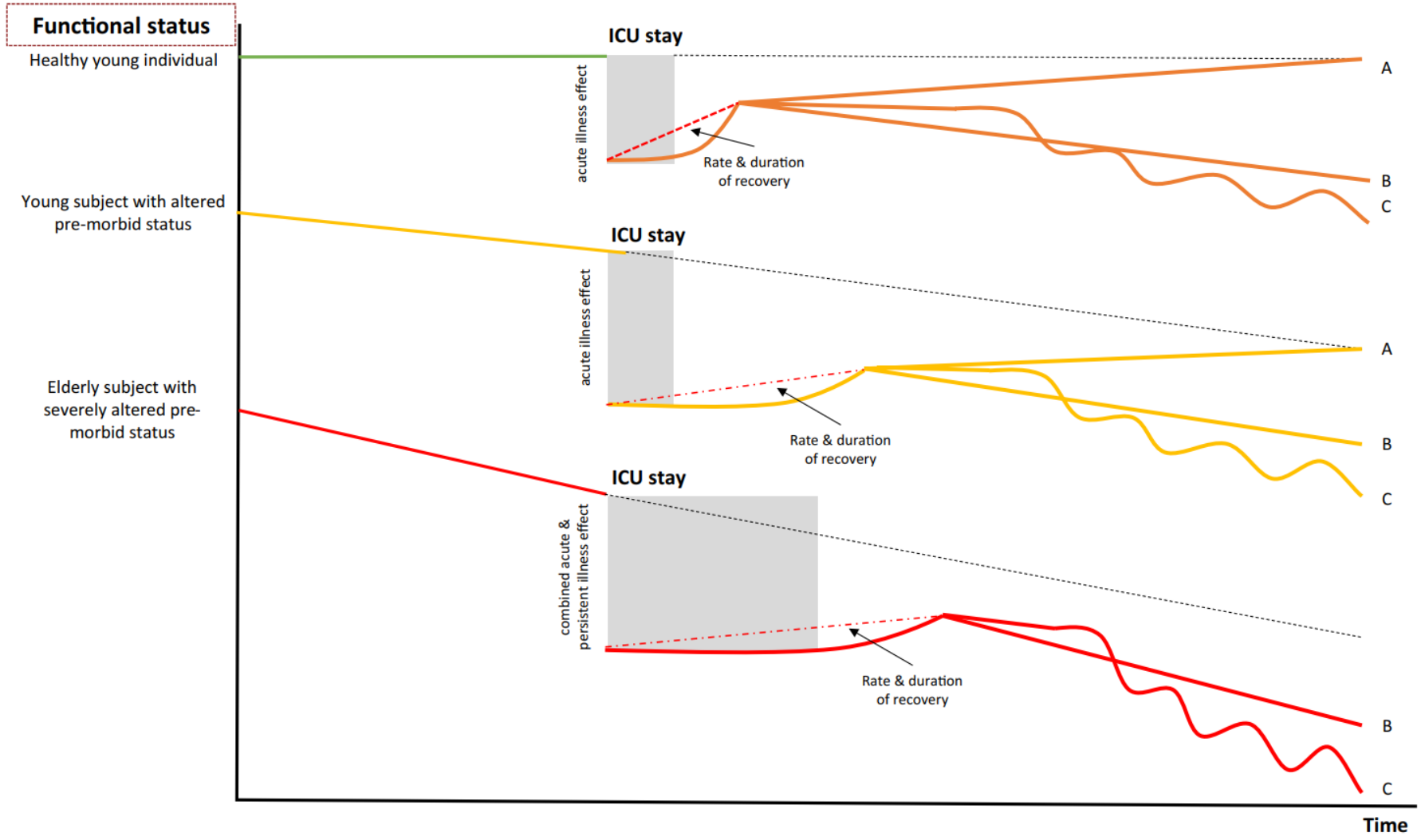
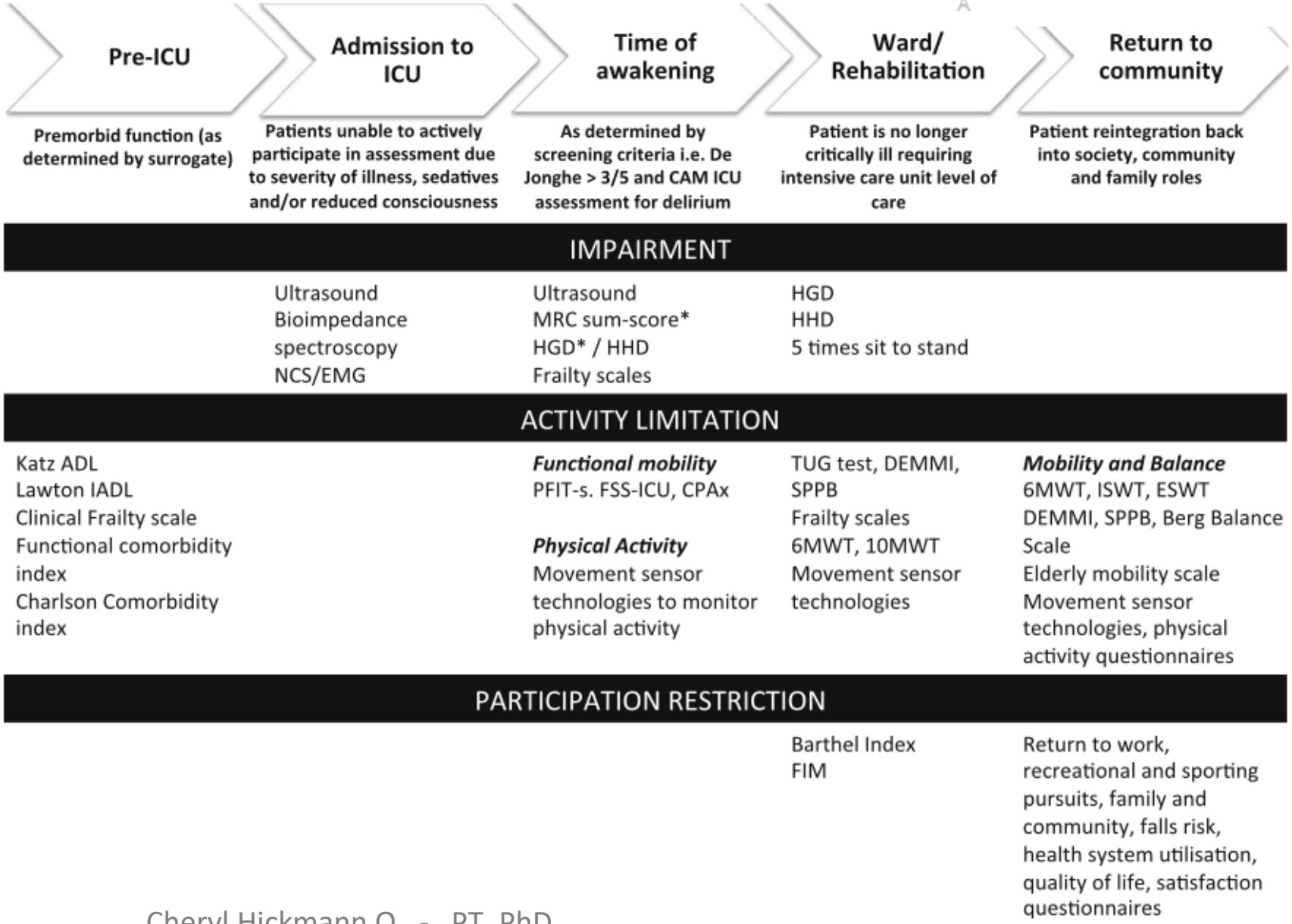
La perte de fonctionnalité et nos objectifs de traitement.

Dépendent également de l'état préalable à la maladie critique.



Latronico N. et al. Intensive Care Med.2017

Algorithme

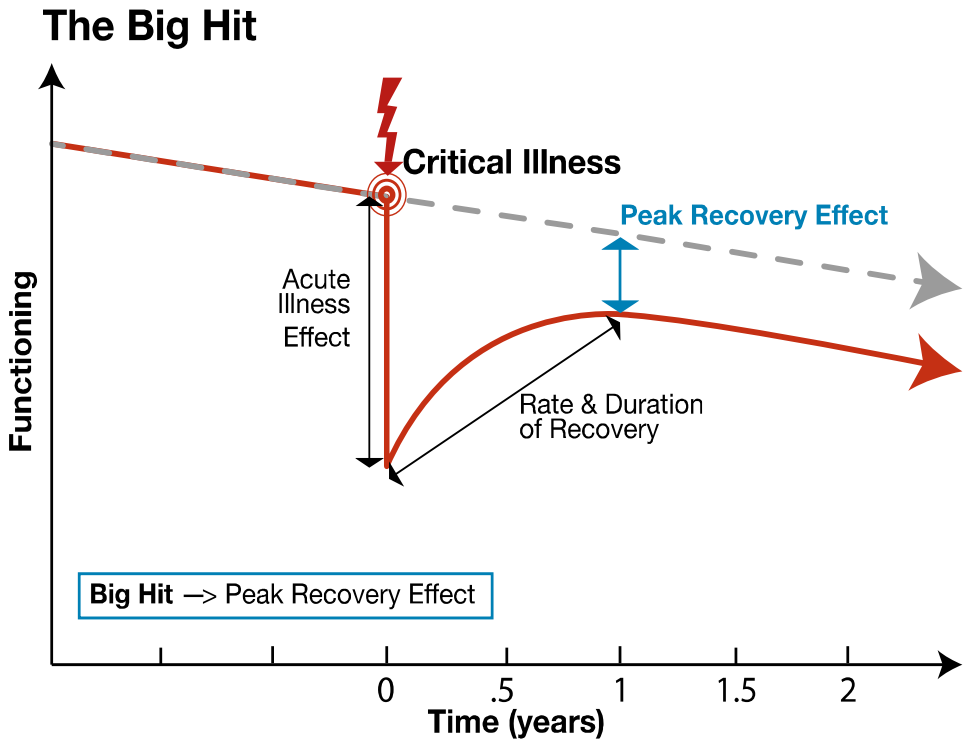


Pre-ICU	Admission to ICU	Time of awakening	Ward/ Rehabilitation	Return to community
Premorbid function (as determined by surrogate)	Patients unable to actively participate in assessment due to severity of illness, sedatives and/or reduced consciousness	As determined by screening criteria i.e. De Jonghe > 3/5 and CAM ICU assessment for delirium	Patient is no longer critically ill requiring intensive care unit level of care	Patient reintegration back into society, community and family roles
IMPAIRMENT				
	Ultrasound Bioimpedance spectroscopy NCS/EMG	Ultrasound MRC sum-score* HGD* / HHD Frailty scales	HGD HHD 5 times sit to stand	
ACTIVITY LIMITATION				
Katz ADL Lawton IADL Clinical Frailty scale Functional comorbidity index Charlson Comorbidity index		***Functional mobility*** PFIT-s. FSS-ICU, CPAx ***Physical Activity*** Movement sensor technologies to monitor physical activity	TUG test, DEMMI, SPPB Frailty scales 6MWT, 10MWT Movement sensor technologies	***Mobility and Balance*** 6MWT, ISWT, ESWT DEMMI, SPPB, Berg Balance Scale Elderly mobility scale Movement sensor technologies, physical activity questionnaires
PARTICIPATION RESTRICTION				
			Barthel Index FIM	Return to work, recreational and sporting pursuits, family and community, falls risk, health system utilisation, quality of life, satisfaction questionnaires

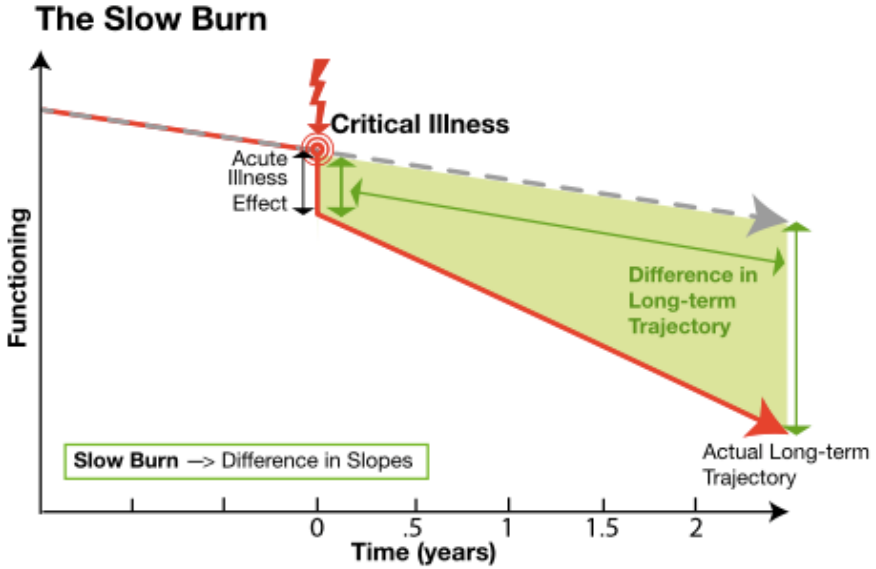
Parry SM. Intensive Care Med (2015)

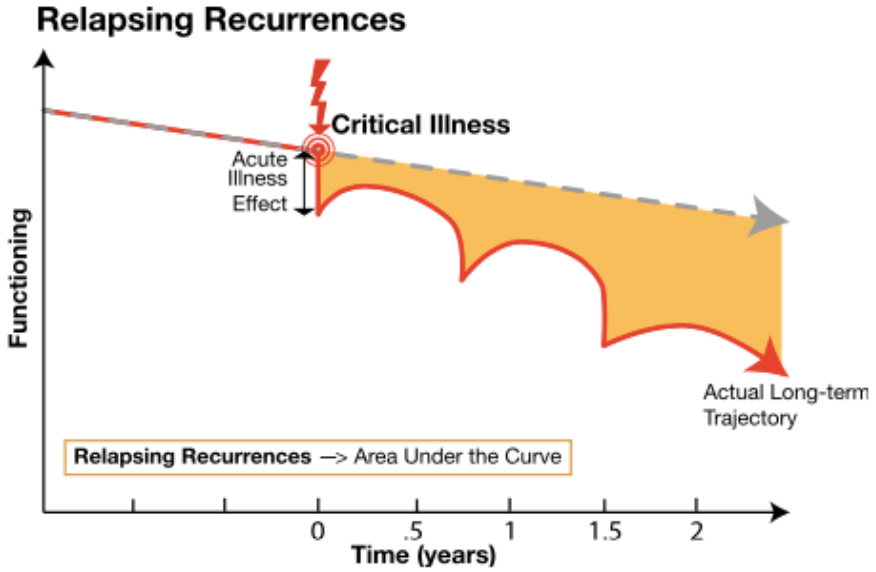
La perte de fonctionnalité.

- Les trajectoires individuelles sont différentes.



Iwashyna TJ. AJRCCM 2012





Take home messages:

L’évaluation et le suivi de la fonction neuromusculaire du patient critique revêt une grande utilité pour :

Prévention des complications: **surveillance rapprochée**

Permet de **personnaliser** les soins en fonction des besoins individuels du patient.

Evaluer est essentiel pour optimiser les soins, favoriser la récupération et améliorer les résultats à long terme pour les patients.

URICE
Unité de recherche et d'innovation Condorcet Epicura

réanimation 2024
PARIS 12-14 JUIN

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