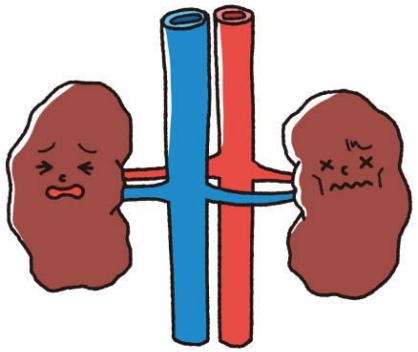
THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

Update of ICU rehabilitation

서울성모병원 호흡기내과
이종민

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

The *Disease*



2013

- PAD GUIDELINE
- PAIN, AGITATION/SEDATION, DELIRIUM

2018

- PAD"IS"
- + IMMOBILITY, SLEEP DISRUPTION

Patient Outcome (PICS, ICUAW…)

Sedation & Delirium

Physiotherapy

Environment & Equipment

Dysphagia & Nutrition

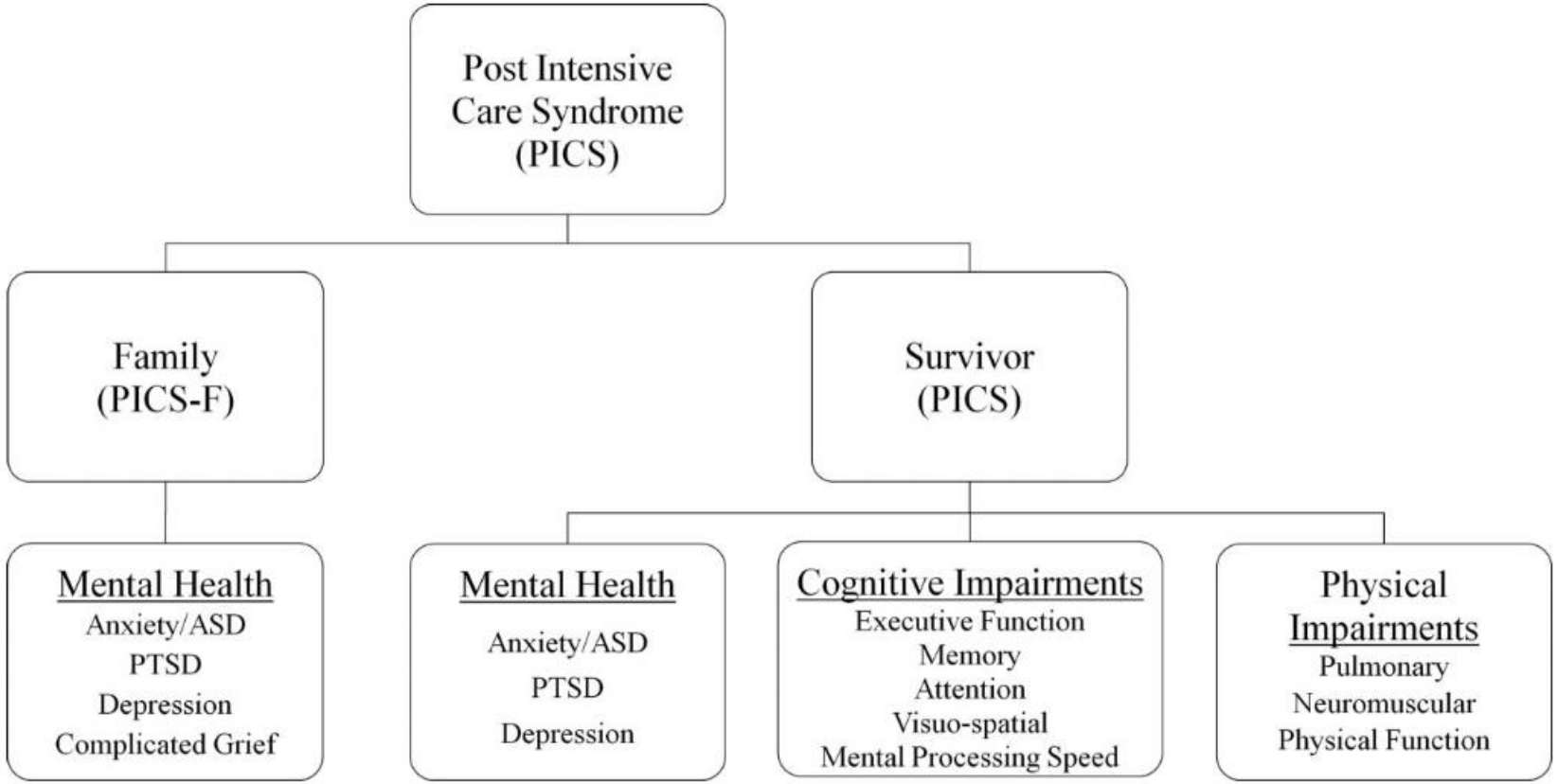
Early Mobilization

COVID-19

Table of Contents

Table of Contents

Post Intensive Care Syndrome (PICS)



Needham et al., Crit Care Med 2012 Vol 40, No 2.

New Physical, Mental, and Cognitive Problems 1 Year after ICU Admission

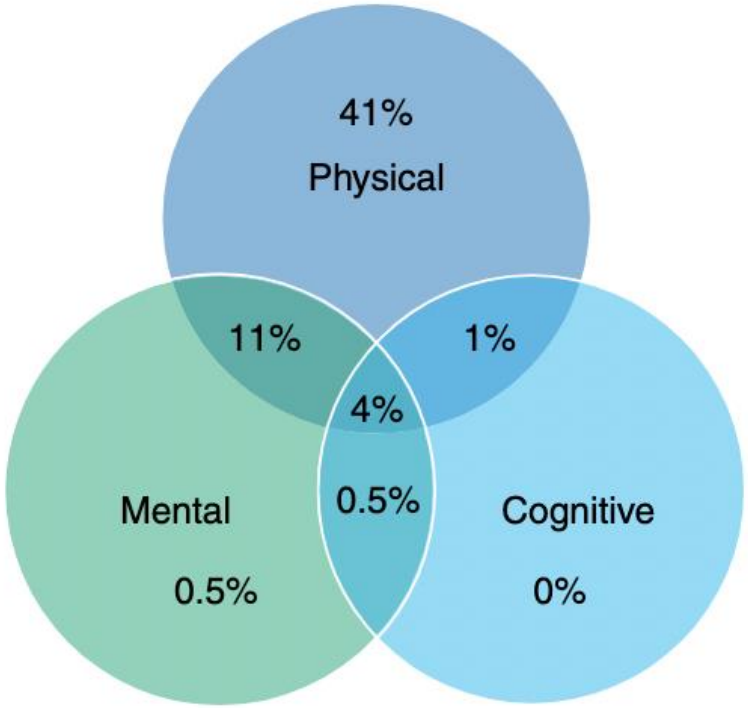
A Prospective Multicenter Study

Wytske W. Geense[1], Marieke Zegers[1], Marco A. A. Peters[2], Esther Ewalds[3], Koen S. Simons[4], Hester Vermeulen[5,6], Johannes G. van der Hoeven[1], and Mark van den Boogaard[1]

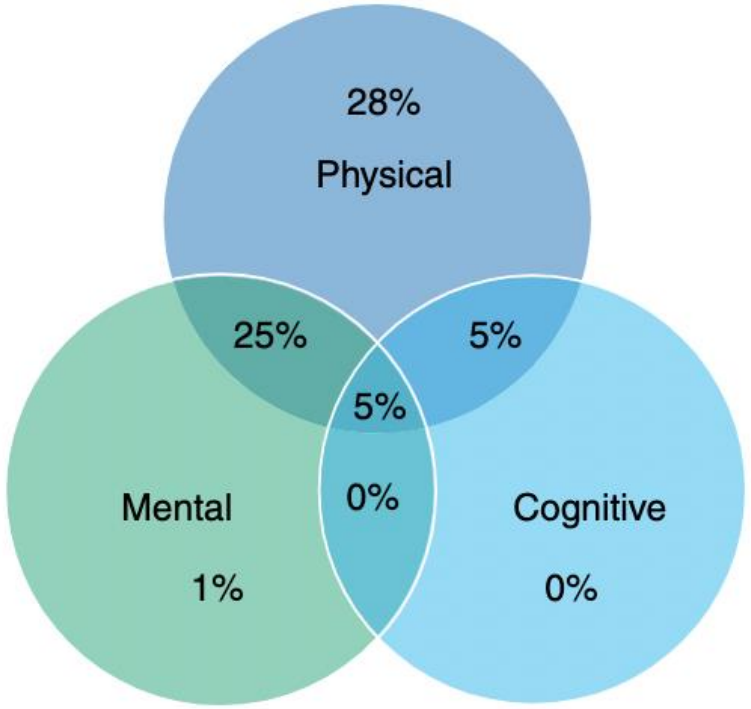
- Prospective cohort, 4 hospitals (Nethelands), 2016 – 2019, N = 2,345
- Medical (28%) Urgent Surgical (12%) Elective Surgical (60%)
- Exposure: > 12 hr ICU admission
- Outcome: Physical, Frailty, Fatigue, Anxiety, Depression, PTSD, Cognition

AJRCCM, 2021

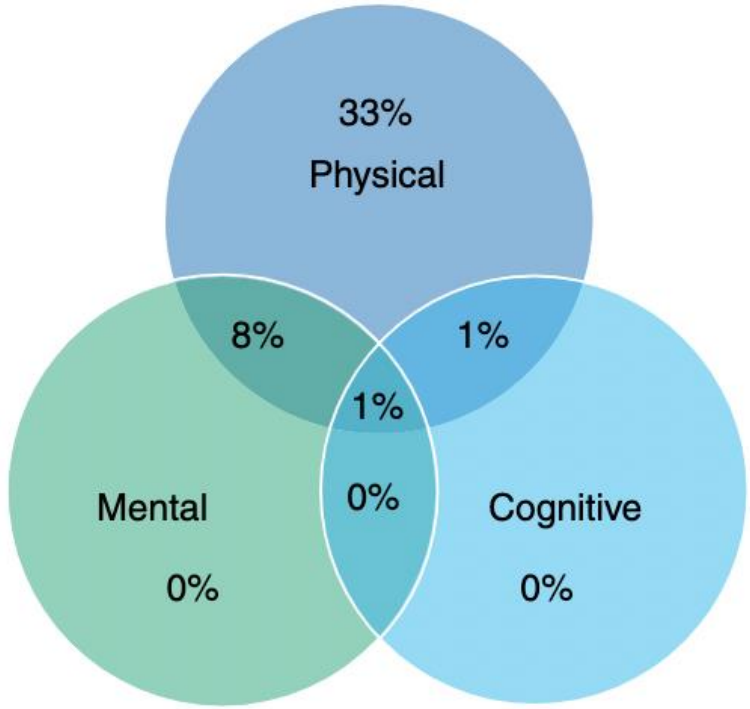
Medical



Urgent surgical



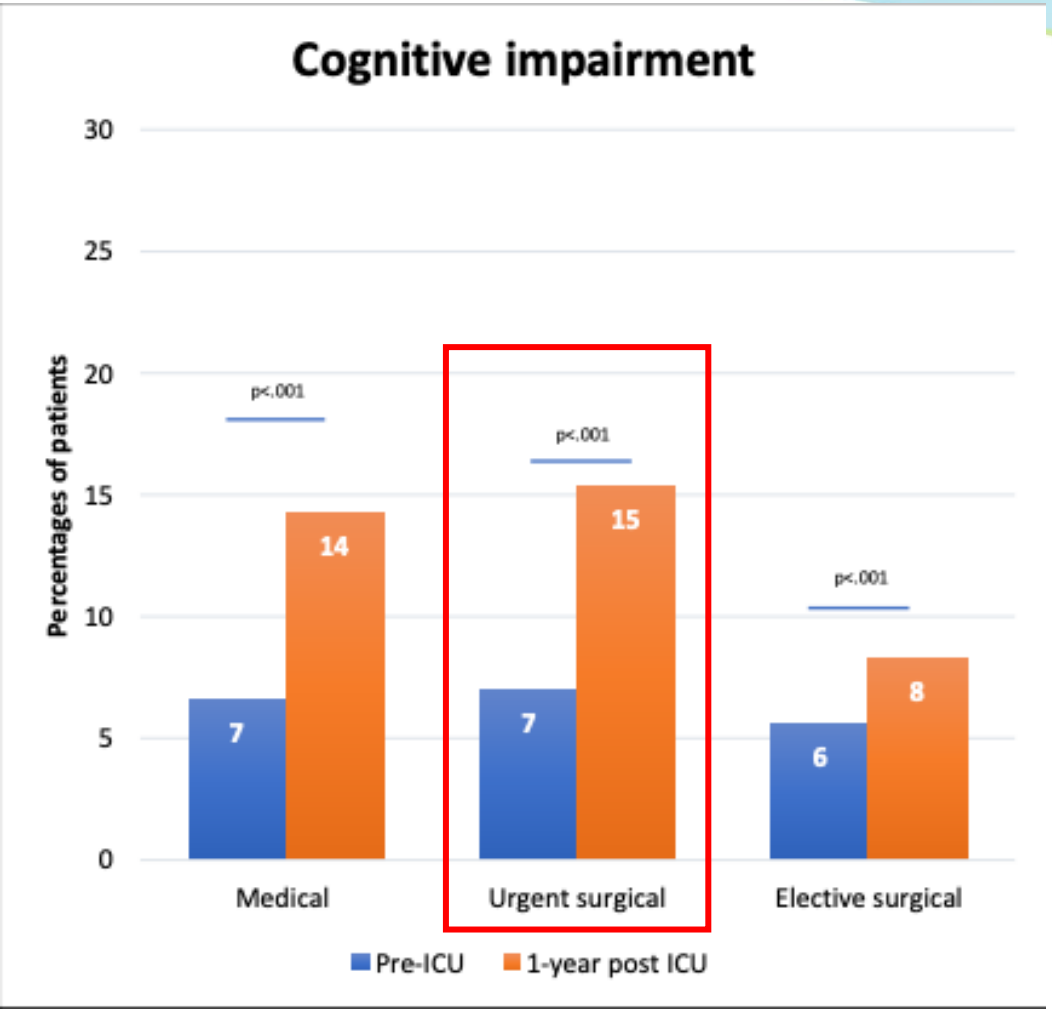
Elective surgical

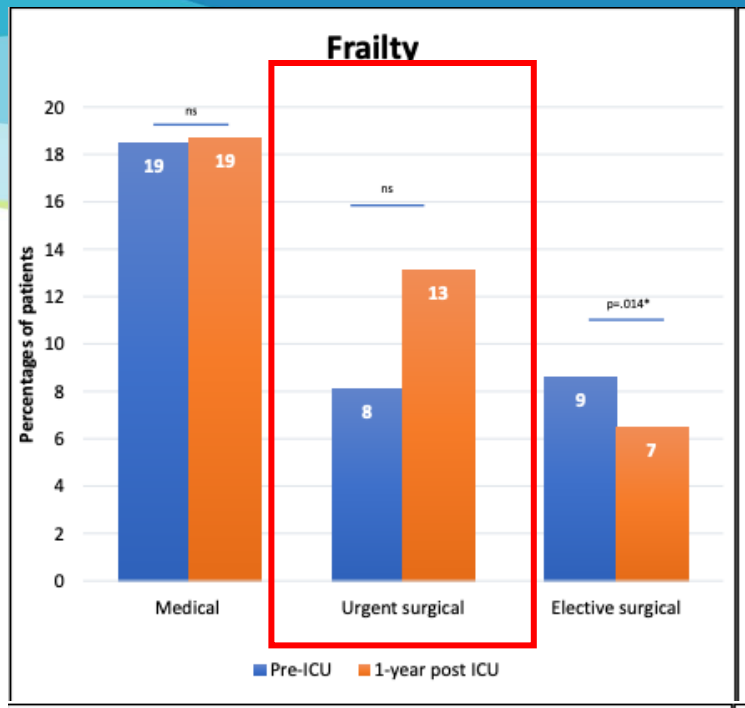


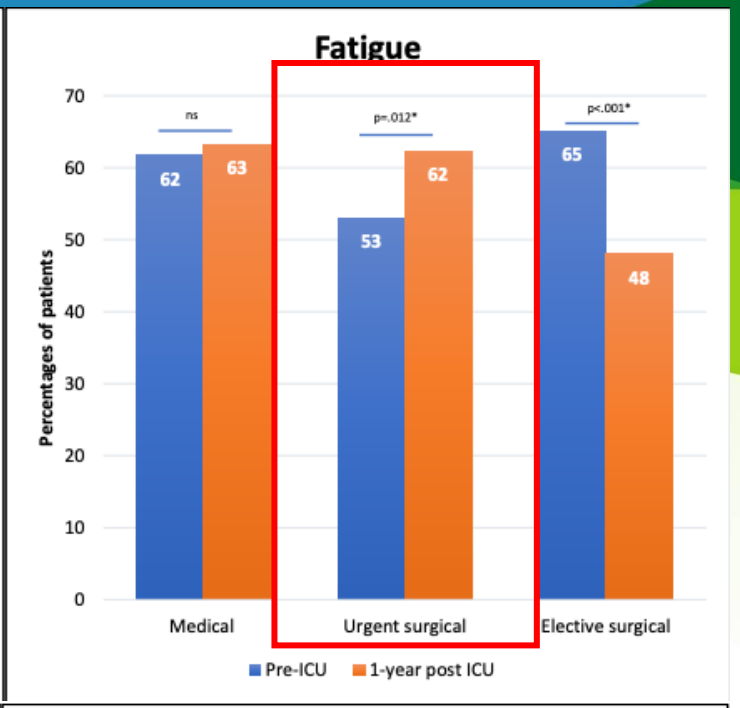
Medical: 58%

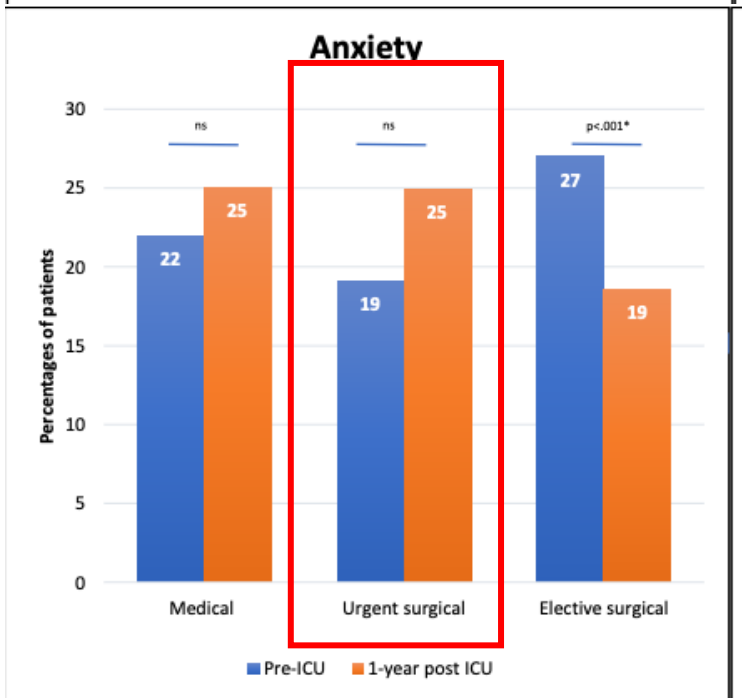
Urgent Surgical: 64%

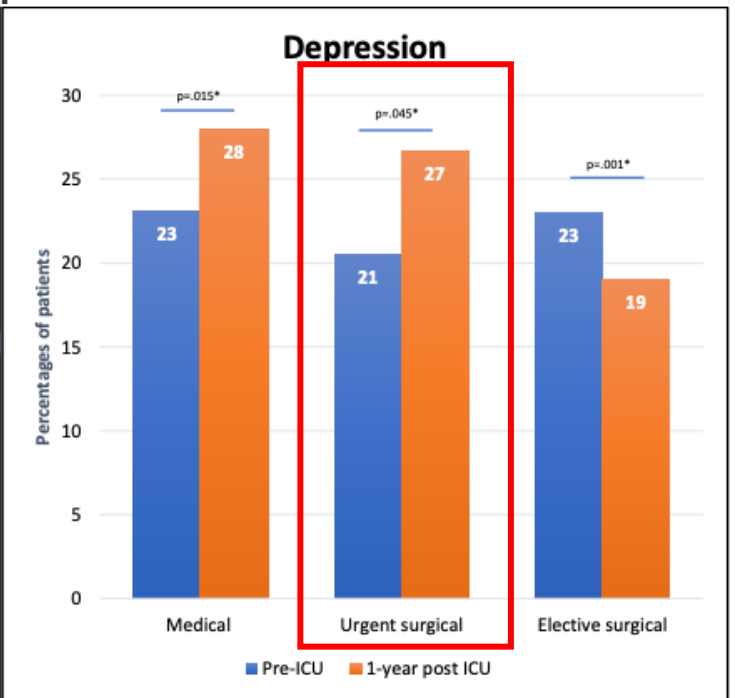
Elective surgical: 43%


Cognitive impairment
Percentages of patients
30
25
20
15
10
5
0
p<.001
p<.001
p<.001
14
7
15
7
8
6
Medical
Urgent surgical
Elective surgical
Pre-ICU
1-year post ICU


Frailty
Percentages of patients
20
18
16
14
12
10
8
6
4
2
0
ns
ns
p=.014*
19
19
8
13
9
7
Medical
Urgent surgical
Elective surgical
Pre-ICU
1-year post ICU


Fatigue
Percentages of patients
70
60
50
40
30
20
10
0
ns
p=.012*
p<.001*
62
63
53
62
65
48
Medical
Urgent surgical
Elective surgical
Pre-ICU
1-year post ICU


Anxiety
Percentages of patients
30
25
20
15
10
5
0
ns
ns
p<.001*
22
25
19
25
27
19
Medical
Urgent surgical
Elective surgical
Pre-ICU
1-year post ICU


Depression
Percentages of patients
30
25
20
15
10
5
0
p=.015*
p=.045*
p=.001*
23
28
21
27
23
19
Medical
Urgent surgical
Elective surgical
Pre-ICU
1-year post ICU

Review Paper

Risk factors for post–intensive care syndrome: A systematic review and meta-analysis

Minju Lee, PhD [a]
Jiyeon Kang, PhD [b, *]
Yeon Jin Jeong, PhD [c]

- English articles from 2008 – 2018 (2/3 from last 5 years)

- Results: 119,049 articles scrrened; 89 eligible studies
  - Quality: 80% "good" (Newcastle-Ottawa scale)
  - Sample size: 61% N = 100 – 300; 30% single ICU

- Risk factor of PICS (most not modifiable)
  - Physical: older age, severity of illness
  - Mental health: Female, prior mental health problem, negative ICU experience
  - Cognitive: Delirium

Aust Crit Care, 2020

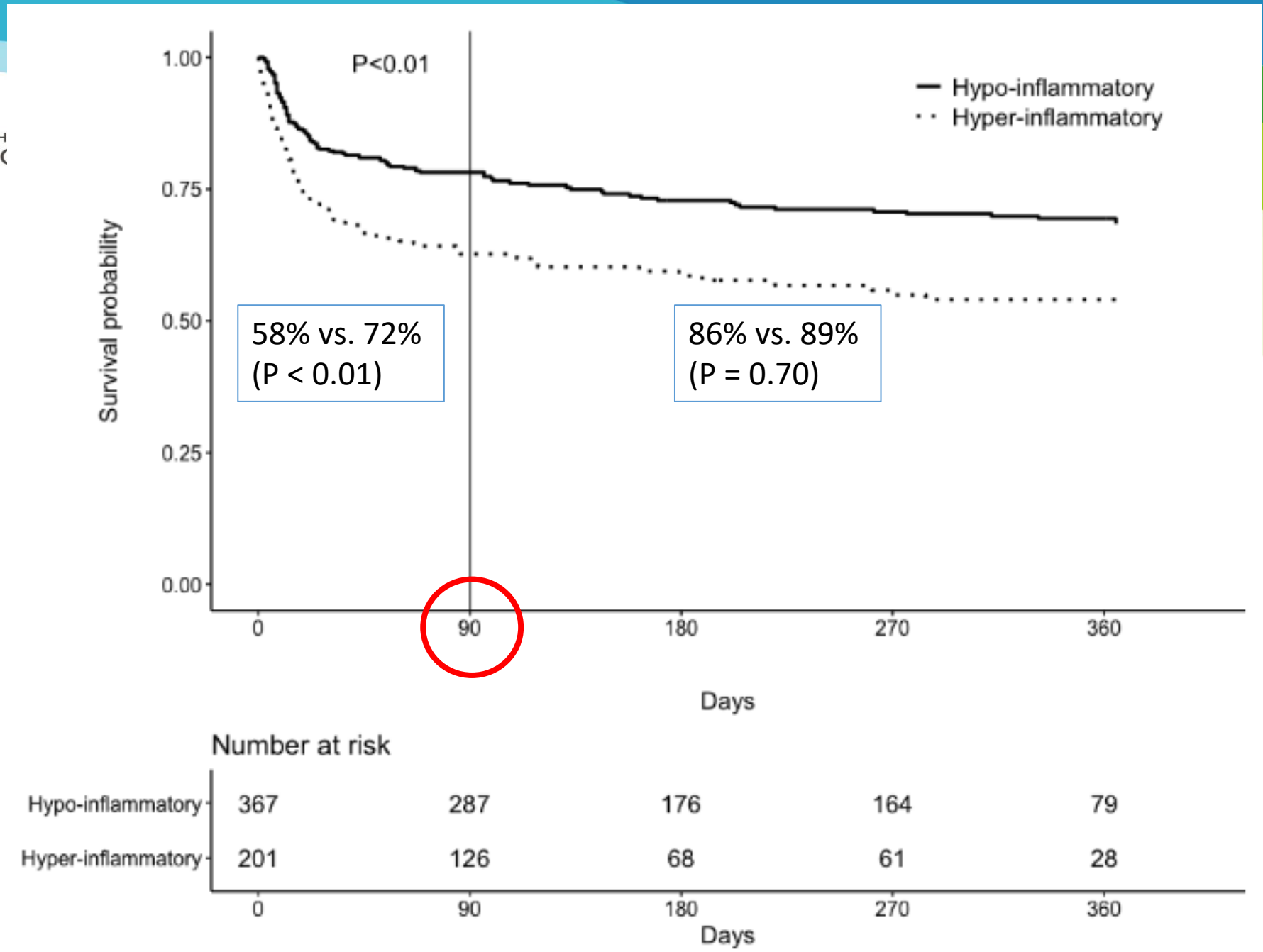
Original research

Six-month and 12-month patient outcomes based on inflammatory subphenotypes in sepsis-associated ARDS: secondary analysis of SAILS-ALTOS trial

Mohamed D Hashem ,[1] Ramona O Hopkins,[2,3] Elizabeth Colantuoni,[4,5] Victor D Dinglas,[5,6] Pratik Sinha,[7] Lisa Aronson Friedman,[5,6] Peter E Morris,[8] James C Jackson,[9,10] Catherine L Hough,[11] Carolyn S Calfee,[12] Dale M Needham [5,6]

- Effect of inflammation in mid-long term prognosis
- SAILS trial
  - Rosuvastatin vs Placebo on ARDS (NEJM 2014)
- Hyper- vs. Hypo-inflammation

Thorax, 2021


P<0.01
Hypo-inflammatory
Hyper-inflammatory
Survival probability
1.00
0.75
0.50
0.25
0.00
58% vs. 72%
(P < 0.01)
86% vs. 89%
(P = 0.70)
0
90
180
270
360
Days
Number at risk
Hypo-inflammatory
367
287
176
164
79
Hyper-inflammatory
201
126
68
61
28
0
90
180
270
360
Days

Patient-related outcome 6 mon after	Total (N = 232)	Hypo-inflammatory (N = 165)	Hyper-inflammatory (N = 67)	P value
Health-realated QoL (SF-36 score)	36 (23 – 48)	36 (23 – 49)	34 (21 – 47)	0.12
Physical functioning (FPI-SF)	1.9 (1.3 – 2.5)	2.0 (1.4 – 2.6)	1.7 (1.2 – 2.4)	0.14
6 min walk distance (%)	66 (48 – 80)	66 (48 – 80)	66 (49 – 79)	0.76
Hand Grip (%)	78 (63 – 105)	84 (65 – 107)	77 (62 – 90)	0.28
Language	32 (23 – 39)	33 (24 – 39)	29 (23 – 38)	0.48

Check for updates

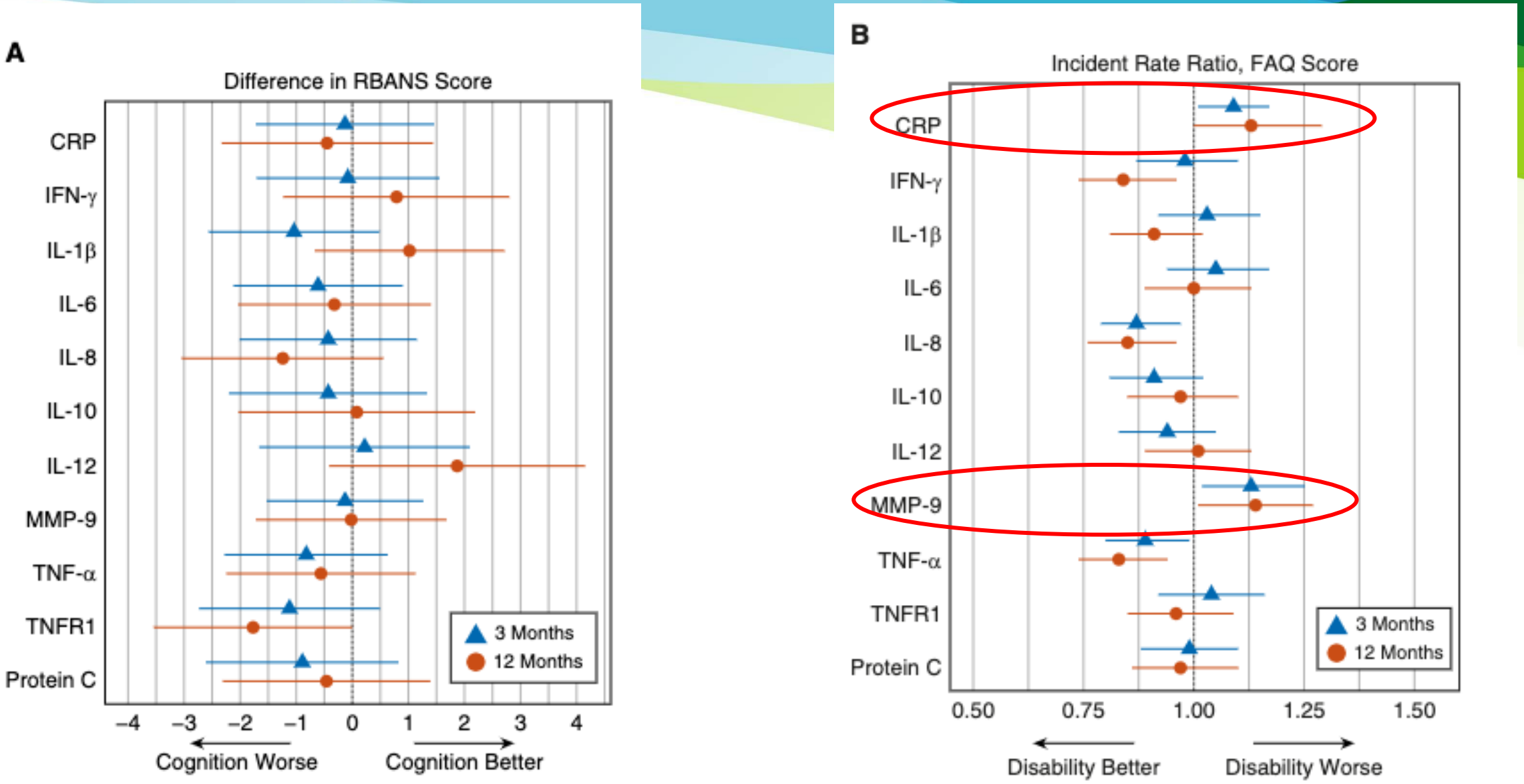
ORIGINAL ARTICLE

Inflammation and Coagulation during Critical Illness and Long-Term Cognitive Impairment and Disability

Nathan E. Brummel[1,2,3], Christopher G. Hughes[3,4], Jennifer L. Thompson[3], James C. Jackson[3,5,6,7], Pratik Pandharipande[3,4], J. Brennan McNeil[3,5], Rameela Raman[3,8], Onur M. Orun[3,8], Lorraine B. Ware[3,5], Gordon R. Bernard[3,5], E. Wesley Ely[3,5,7,9,10], and Timothy D. Girard[3,11]

- Association of Inflammation & Coagulation Biomarkers & Cognitive impairment
- Day 1, 3, 5
  - CRP, IFN-r, IL-1, IL-6, IL-8, IL-19, IL-12, MMP-9, TNF-a, TNF-receptor 1, Protein C
- 3 & 12 mon cognition, activity, daily living

AJRCCM, 2021


A
Difference in RBANS Score
CRP
IFN-γ
IL-1β
IL-6
IL-8
IL-10
IL-12
MMP-9
TNF-α
TNFR1
Protein C
−4 −3 −2 −1 0 1 2 3 4
3 Months
12 Months
Cognition Worse
Cognition Better
B
Incident Rate Ratio, FAQ Score
CRP
IFN-γ
IL-1β
IL-6
IL-8
IL-10
IL-12
MMP-9
TNF-α
TNFR1
Protein C
0.50 0.75 1.00 1.25 1.50
3 Months
12 Months
Disability Better
Disability Worse

Fatigue Symptoms During the First Year Following ARDS

Karin J. Neufeld, MD, MPH; Jeannie-Marie S. Leoutsakos, PhD, MHS; Haijuan Yan, PhD; Shihong Lin, MS; Jeffrey S. Zabinski, MD; Victor D. Dinglas, MPH; Megan M. Hosey, PhD; Ann M. Parker, MD; Ramona O. Hopkins, PhD; and Dale M. Needham, MD, PhD

- Prospective study at 38 US hospitals (2008 – 2014)
- ARDS patients (n = 732)
- 6 & 12 mon outcomes
  - Fatigue (FACIT-F)
  - Physical (SF-36, FPI-SF)
  - Cognitive (MMSE)
  - PTSD (IES-R)
  - Anxiety & depress (HADS)

Chest, 2020

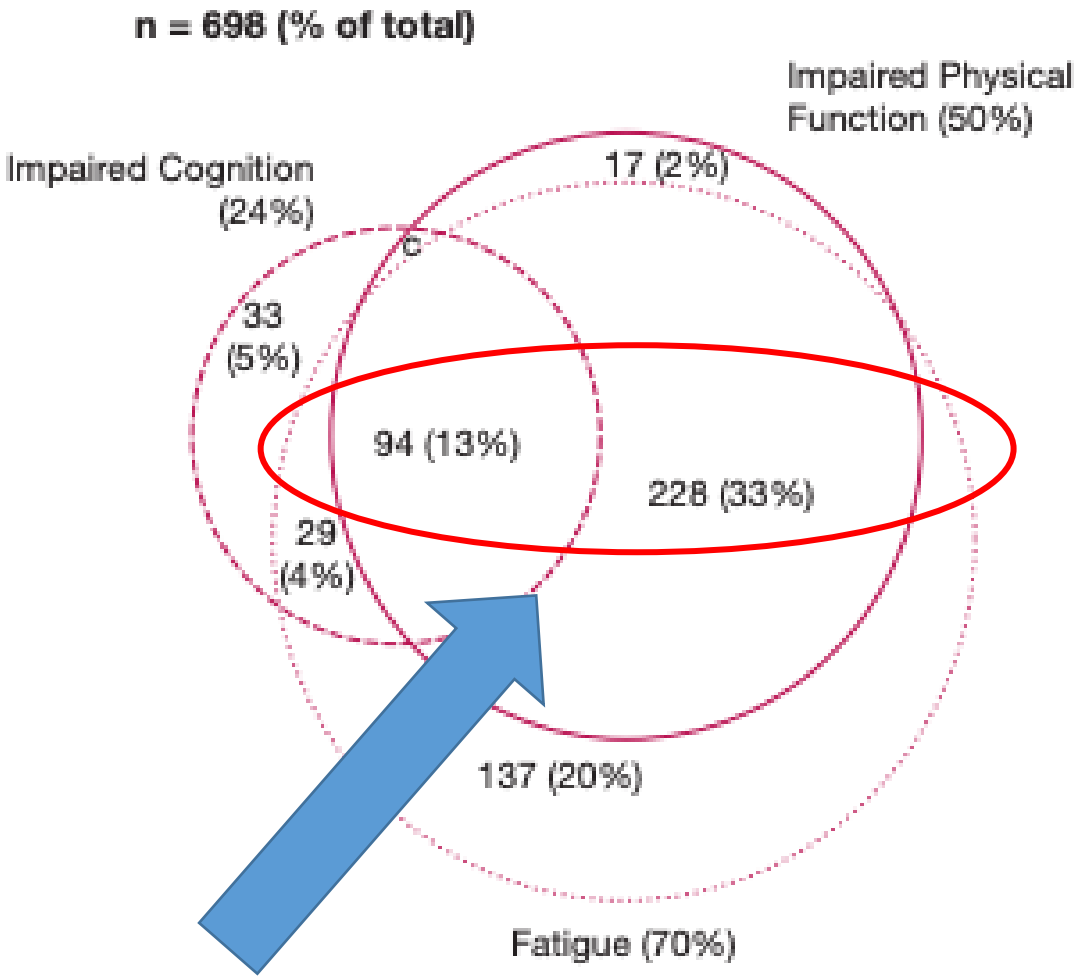
Results

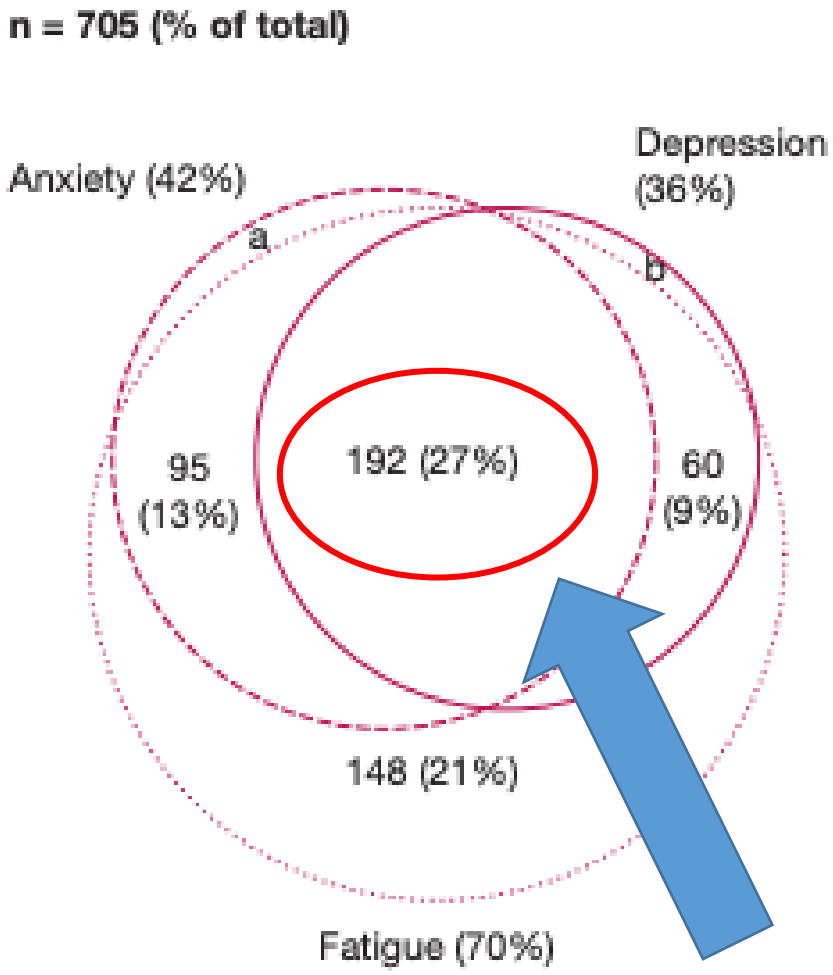
- Fatigue
  - 6 mon: 70%
  - 12 mon: 66% (28% worsen, 31% no change, 41% improved)

- No association with
  - ICU / ARDS severity

- Increased fatigue associated with
  - Baseline: Female & Unemployed status
  - 6 / 12 mon: ↓ Physical function & ↑ Psychologic symptoms

Chest, 2020





46%: Fatigue & Physical impairment

27%: Fatigue & Psychologic symptom

Chest, 2020

Bodily pain in survivors of acute respiratory distress syndrome: A 1-year longitudinal follow-up study

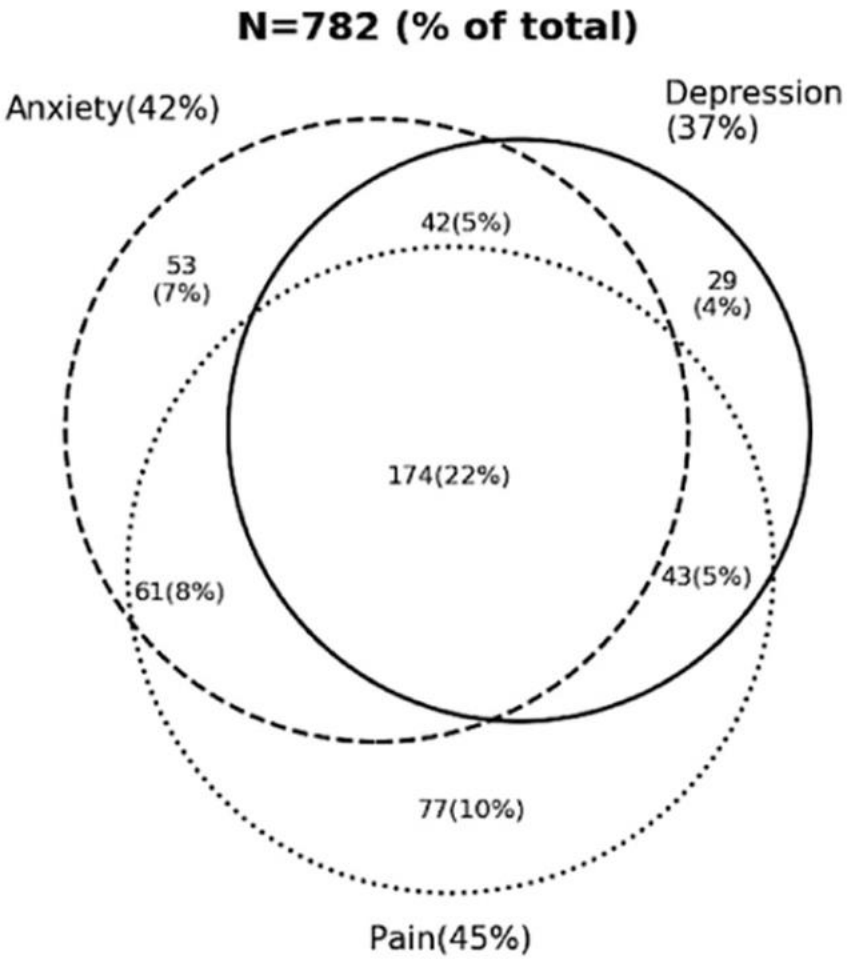
Julia M. Probert [a], Shihong Lin [g], Haijuan Yan [b], Jeannie-Marie S. Leoutsakos [b], Victor D. Dinglas [c], Megan M. Hosey [d], Ann M. Parker [c], Ramona O. Hopkins [e], Dale M. Needham [c,d,1], Karin J. Neufeld [f,1,*]

- Prospective study at 38 US hospitals (2008 – 2014)
- ARDS patients (n = 826), Opioids use: 95%
- Outcome
  - Bodily pain
  - Physical (SF-36, FPI-SF)
  - Cognitive (MMSE)
  - Anxiety & depress (HADS)

Journal of Psychosomatic Research, 2021

Results

- Pain
  - 6 mon: 45% / 12 mon: 42%
- Of patients with Pain
  - 78%: anxiety or depressive Sx
  - 78%: cognitive & physical impairment
- Risk factors for pain
  - Smoker
  - Unemployment
  - Opioids use in ICU

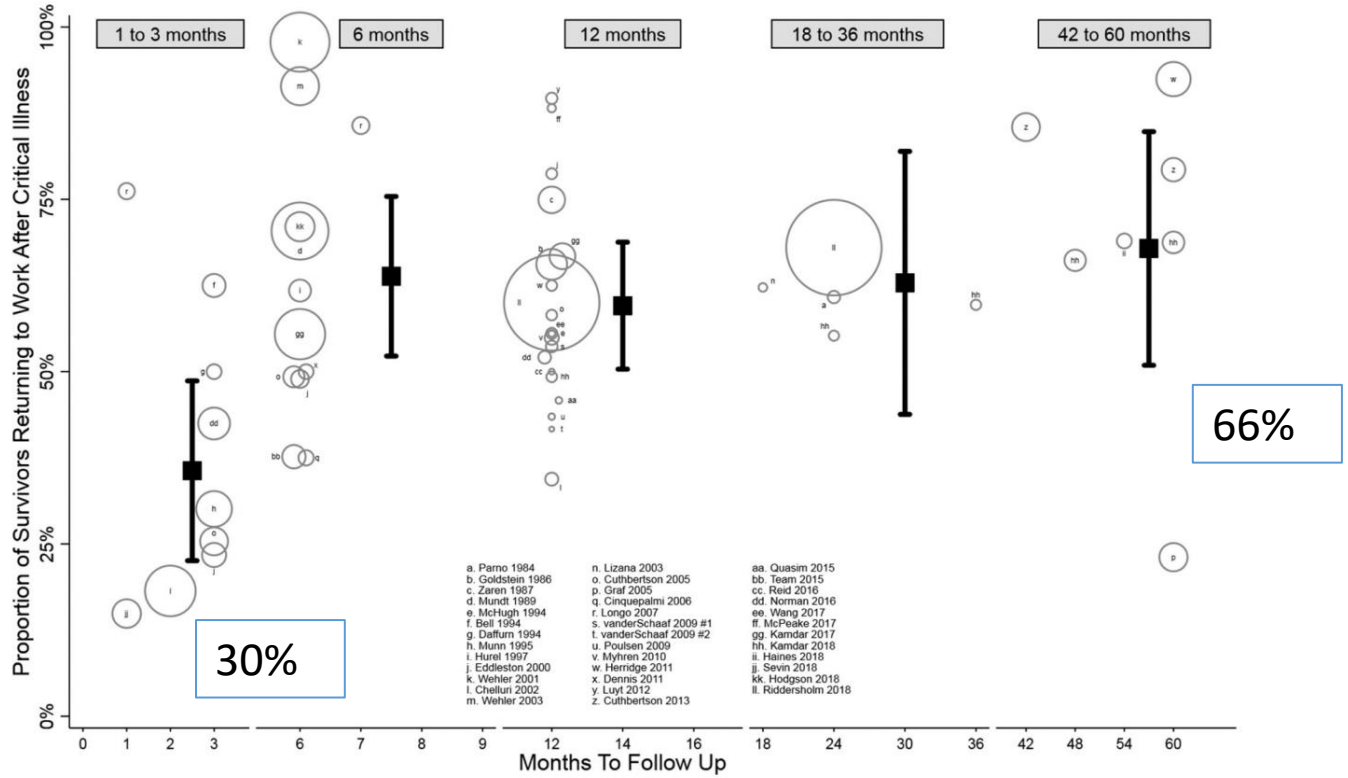


Journal of Psychosomatic Research, 2021

Return to Work After Critical Illness: A Systematic Review and Meta-Analysis

Biren B. Kamdar, MD[1], Rajat Suri, MD[2], Mary R. Suchyta, DO[3], Kyle F. Digrande, MD[1,4], Kyla D. Sherwood, MD[5], Elizabeth Colantuoni, PhD[6,7], Victor D. Dinglas, MPH[6,8], Dale M. Needham, MD PhD[6,8,9], Ramona O. Hopkins, PhD[10,11,12]

- 52 studies in 10,015 previously-employed ICU survivors



Thorax, 2020

Additional outcomes

- No difference for ARDS severity

- 20 – 36%: lost job after returning to work
- 17 – 66%: occupation change
- 5 – 84%: worsening employment status
- - 70%: accrued lost earnings

→ Vocational interventions needed for ICU survivors

Thorax, 2020

Table of Contents

Bed rest

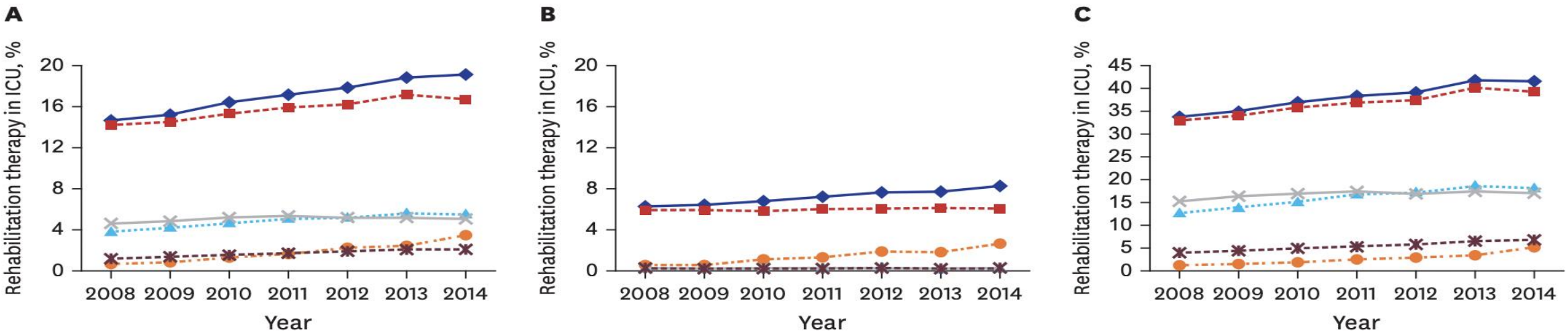
Problem	How fast
Maximal oxygen uptake and muscle strength	1 – 1.5% per day
Blood volume	5% in 24 hrs, 10% in 6 days
Bone Density	Decreased mineralization within days
Respiratory Tract	Increased risk of pneumonia within a day
Continence & constipation	17 – 50% become incontinent after 24 hrs Constipation within days
Blood Glucose	Within 3 days

Convertino, Med Sci Sports Exerc. 1997 Feb;29(2):191-6
Fortney et al., J Clin Pharmacol. 1994 May;34(5):434-9
Guedes et al., Rev. bras. Geriatr. Gerontol. 21 (04)

Relationship between Use of Rehabilitation Resources and ICU Readmission and ER Visits in ICU Survivors: the Korean ICU National Data Study 2008–2015

Yun Hee Park [# 1], Ryoung Eun Ko [# 2], Danbee Kang [3 4], Jinkyeong Park [2], Kyeongman Jeon [2 5], Jeong Hoon Yang [2 6], Chi Min Park [2 7], Joongbum Cho [2], Young Sook Park [1], Hyejung Park [3 4], Juhee Cho [3 4], Eliseo Guallar [3 4 8], Gee Young Suh [2 5], Chi Ryang Chung [2 9]

- 2008 – 2015, Korean ICU, n = 1,465,776, HIRA data
- 17.1% patients received rehab



JKMS, 2020

Results

- Type of rehabilitation
  - Physical therapy (91.9%)
  - Neuromuscular electrical stimulation (29.6)
  - Occupational (28.6), Respiratory (11.6), Swallowing (10.3)

Outcomes	No rehabilitation	Rehabilitation	Univariable Cox regression		Multivariable Cox	
	No (%)	No (%)	HR (95% CI)	P value	**HR (95% CI)**	**P value**
ICU readmission	67,166 (5.7)	13,250 (5.4)	0.95 (0.97 – 1.04)	0.281	**0.70 (0.65 – 0.75)**	**< 0.001**
ER Revisit	115,144 (9.7)	23,622 (9.6)	0.99 (0.91 - 1.07)	0.768	**0.83 (0.77 – 0.88)**	**< 0.001**

JKMS, 2020

Barriers to mobilizing patients with life-support devices

- Patient safety concerns (cath. dislocation, bleeding …)
- Limited resources (time, staff, equipment)
- Unit culture
- Lack of nursing knowledge …

Review paper

Rehabilitation of adult patients on extracorporeal membrane oxygenation: A scoping review

Kate Hayes, PT, MPT [a, b, *], Carol L. Hodgson, PT, PhD [a, c], Melissa J. Webb, PT, BPT [a], Lorena Romero, Research Librarian, MBIT [d], Anne E. Holland, PT, PhD [a, e]

- 185 studies – small retrospective studies

Type of rehab (136 studies)	Studies (%)
Bed-based	60 (44%)
Sitting on the bed edge	44 (32%)
Standing	55 (40%)
Ambulation	95 (70%)

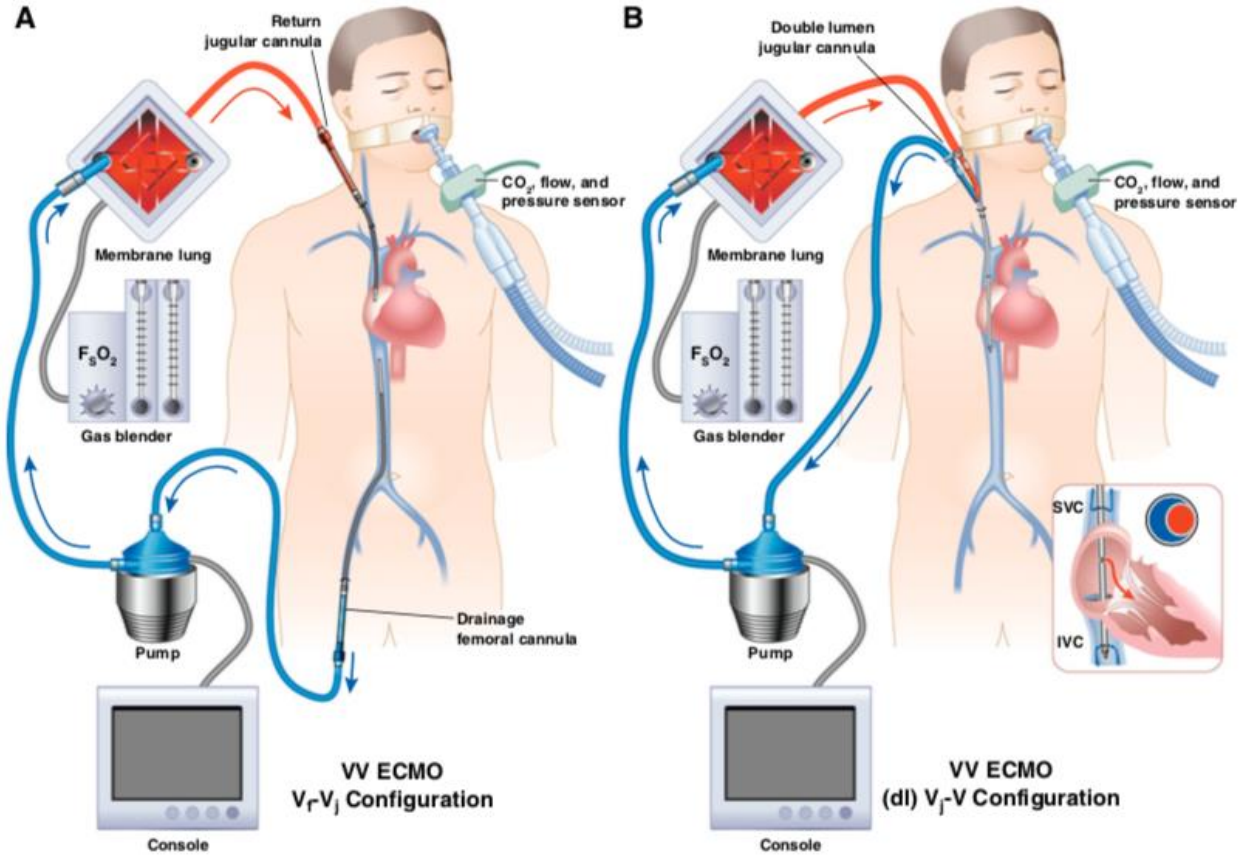
Safety issues (60)	Studies (%)
Zero adverse events	30 (50%)
Adverse not linked to rehab	15 (25%)
Adverse associated with rehab	15 (25%)

Equipment for rehab (49)	Studies (%)
In-bed cycle ergometer	15 (31%)
Upright cycle	13 (27%)
Tilt table	12 (24%)
Gait aid / walking frame	9 (18%)
Treadmill	8 (16%)
Rehabilitation chairs	8 (16%)
EMS including FES	5 (10%)
Hand weights	5 (10%)

Australian Critical Care, 2021

Facilitator of rehab	Studies (%)
Upper body cannulation	336 (38)
Weaning of sedation	332 (34)
Multidisciplinary team	231 (33)
Vent weaning / extubation	123 (24)
Tracheostomy	115 (16)
Screening tool for rehab	913 (14)
Method to secure cannula (sutures …)	59 (10)
Appropriate equipment for rehab	44 (4)

Barrier to rehab	Studies (%)
Femoral cannulation	115 (37)
Sedation level	912 (29)
Medical instability/bleeding	810 (24)
Resources (Staffing, time, equipment)	410 (24)
Psychological issues	33 (7)



Australian Critical Care, 2021

Conrad SA et al., AJRCCM, 2018, 198(4); 447-451

ORIGINAL RESEARCH

Early Mobilization during Extracorporeal Membrane Oxygenation for Cardiopulmonary Failure in Adults

Factors Associated with Intensity of Treatment

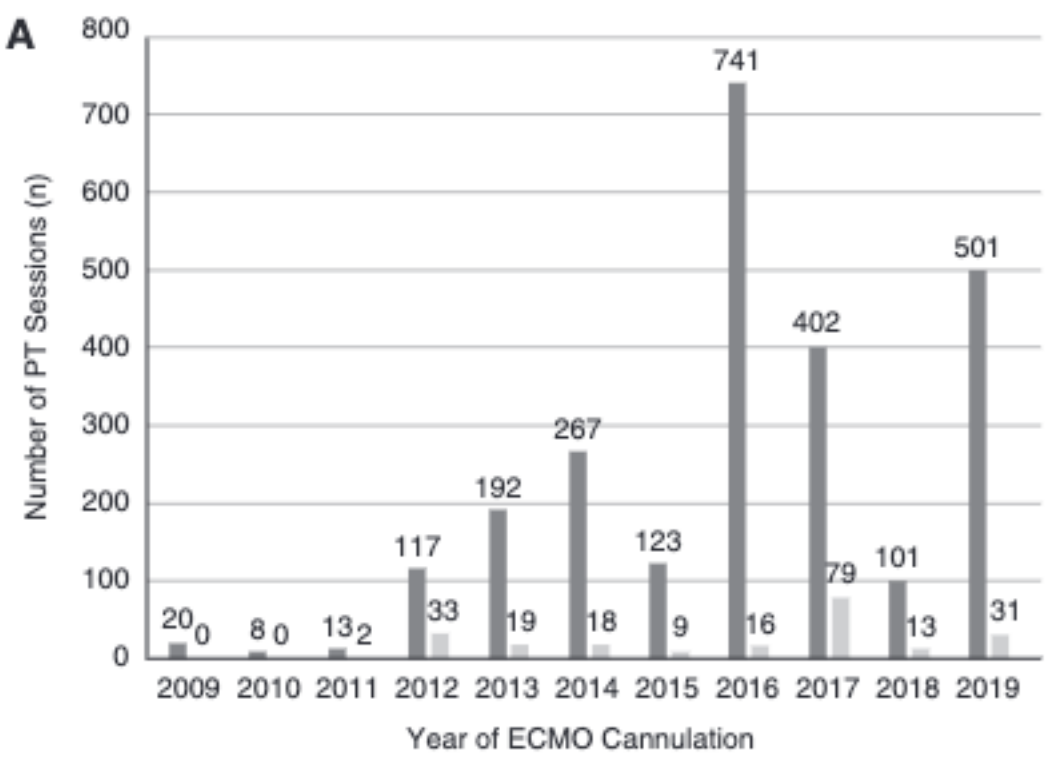
- Single center retrospective, 10 yrs, n = 511
- Factors associated with out-of-bed rehabilitation
- Factors
  - Reason for performing ECMO (Bridge to LT vs. Bridge to recovery)
  - Location of cannulation (Upper body vs. Femoral cannulation)
  - ICU severity
  - With or without ventilator …

AnnalsATS, 2022

Predictors of out-of-bed physical therapy

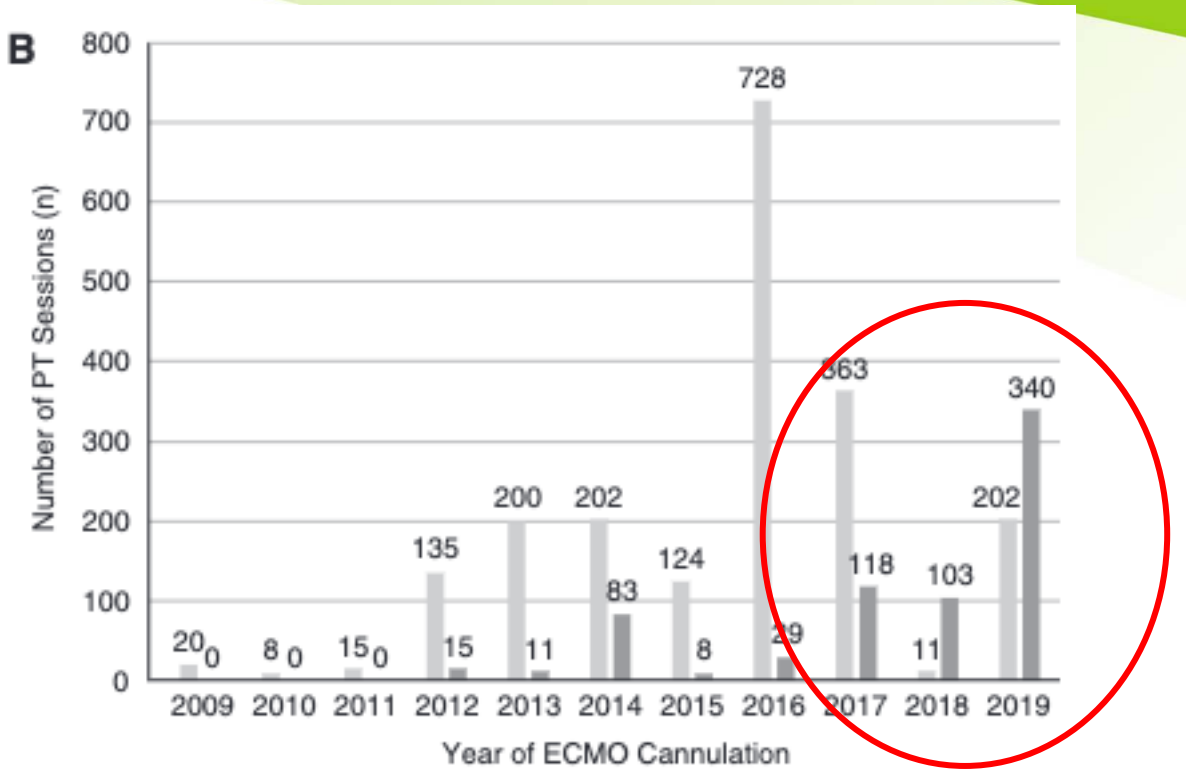
Adjusted model	All physical therapy sessions		
	OR	95% CI	P value
Incremental age	1.0	0.97 – 1.02	0.99
APACHE II score	1.05	0.97 – 1.14	0.23
SOFA score	1.08	0.92 – 1.27	0.36
Charlson comorbidity index	1.53	1.07 – 2.19	0.02
Bridge to lung transplantation	17.2	4.12 – 72.1	< 0.001
Incremental days on ECMO	0.99	0.97 – 1.0	0.06
Venovenous configuration	2.83	1.29 – 6.22	0.01
Femoral cannula present	0.19	0.04 – 0.92	0.04
On ventilator during PT	0.11	0.05 – 0.25	< 0.001

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER



: Bridge to lung T

: Bridge to recovery



: Presence of femoral cannula

: absence of femoral cannula

AnnalsATS, 2022

Early mobilization in neurocritical care patients

Monisha A. Kumar[a,b,c], Francisco G. Romero[a], and Kiruba Dharaneeswaran[a]

- Hemodynamic instability
- Acute hemiplegia
- Altered consciousness, visual field deficit
- Cerebral ischemia – may be exacerbated when upright or active

Curr Opin Crit Care 2020

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

Specific consideration in neurocritical patients

Diagnosis	Time to mobilization	Consideration	Proposed solution
Ischemic stroke	> 24h	Cerebral perfusion	Close BP monitoring Avoid mobilization with vasopressors
Subarachnoid hemorrhage	24 – 48h after Ruptured aneurysm secured	EVD dislocation ICP elevation	Ensure EVD secure Single transient spike → can mobilize
Intracranial hemorrhage	> 24 h Hemorrhagic stable	ICP elevation	Close BP monitoring Avoid mobilization with vasopressors
Spinal cord injury	24 h post spine stabilization	Orthostatic hypotension	Close BP monitoring Avoid mobilization with vasopressors
Traumatic brain injury	24 h after hemorrhage stable	ICP elevation	Monitor ICP closely Single transient spike → can mobilize

Curr Opin Crit Care 2020

Criteria for mobilization in neurocritical patients

Organ system	Inclusion criteria	Abort criteria
Neurological	GCS > 3 Spinal stability	Reduced consciousness Lightheadedness Agitation Fall Device dislodgement
Cardiovascular	HR 60 – 130 bpm SBP 90 – 180 mmHg MAP 60 – 100 mmHg	Brady / Tachycardia Hypo/Hypertension Arrythmia development New chest pain
Respiratory	RPM 5 – 40 O2 Sat > 88% FiO2 < 60% PEEP < 10	RPM < 5 or > 40 Desaturation Vent dys-synchrony Airway device dislodgement

Curr Opin Crit Care 2020
CCM 2018

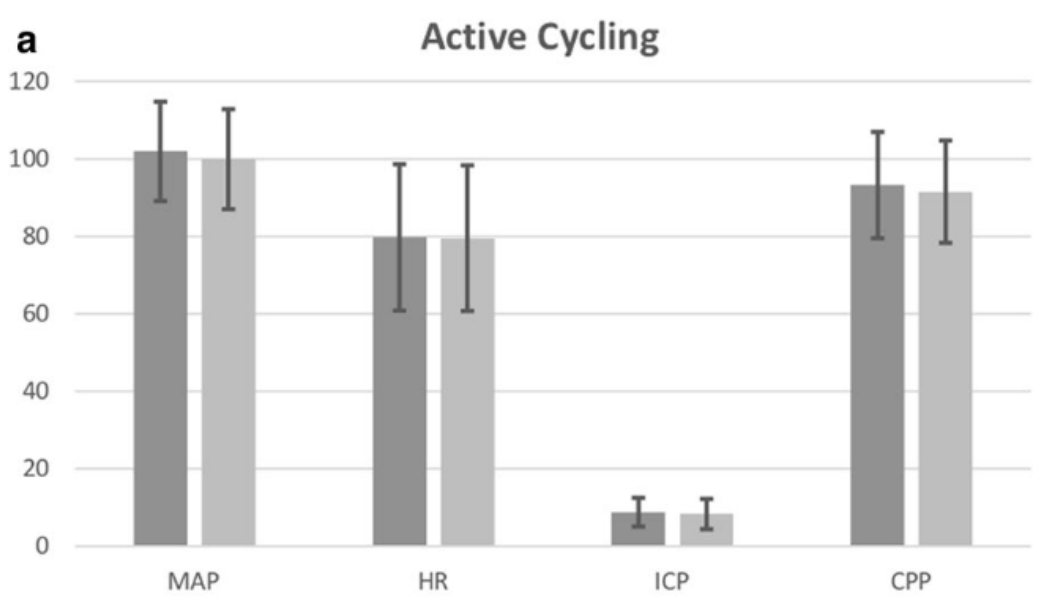
ORIGINAL WORK

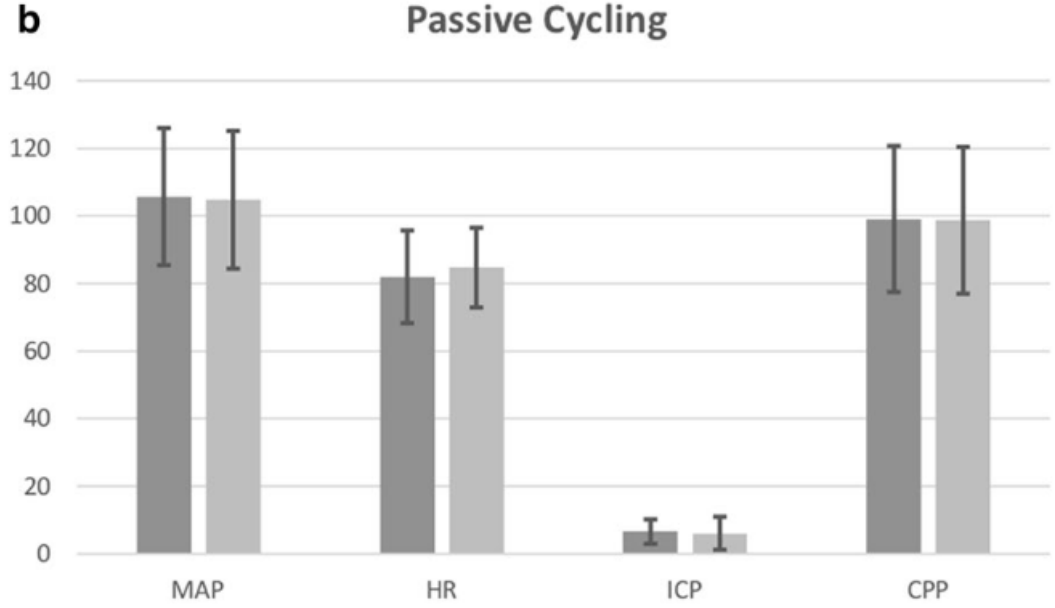
Physiological Responses to In-Bed Cycle Ergometry Treatment in Intensive Care Unit Patients with External Ventricular Drainage

Elizabeth K. Zink[1,5*], Sowmya Kumble[2], Meghan Beier[2], Pravin George[3], Robert D. Stevens[4,5] and Mona N. Bahouth[5]

- Active or passive in-bed cycle ergometry in patients with EVD
- N = 27

Neurocrit Care, 2021





: Pre-cycling session

: Post-cycling session

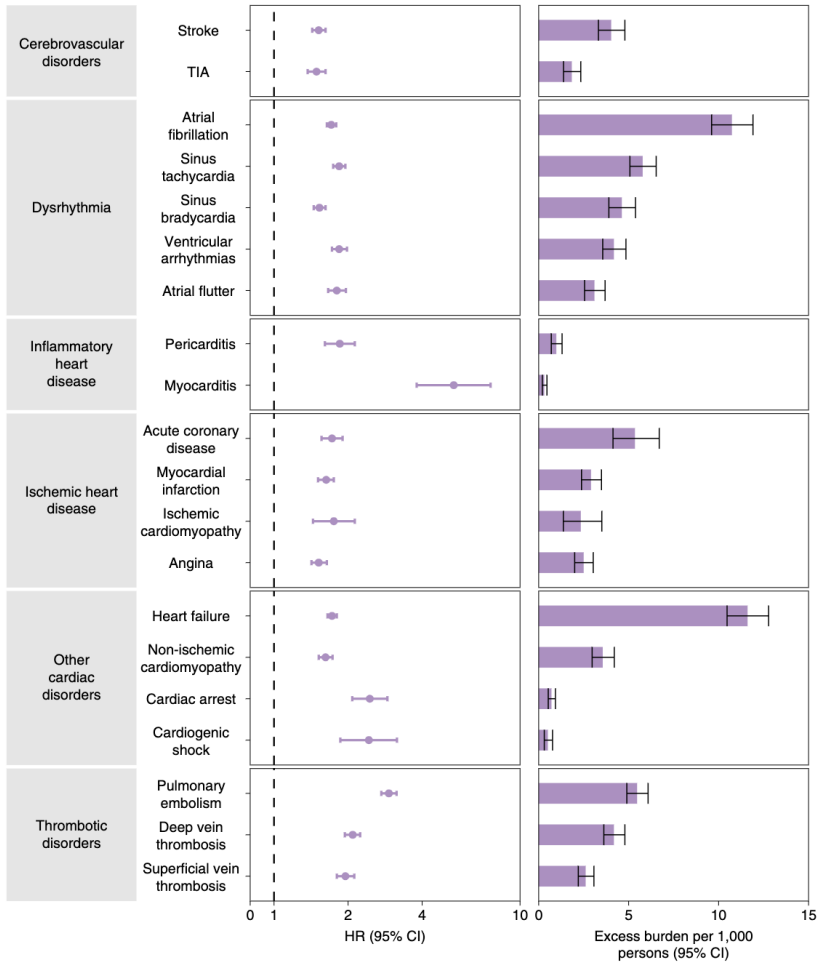
Neurocrit Care, 2021

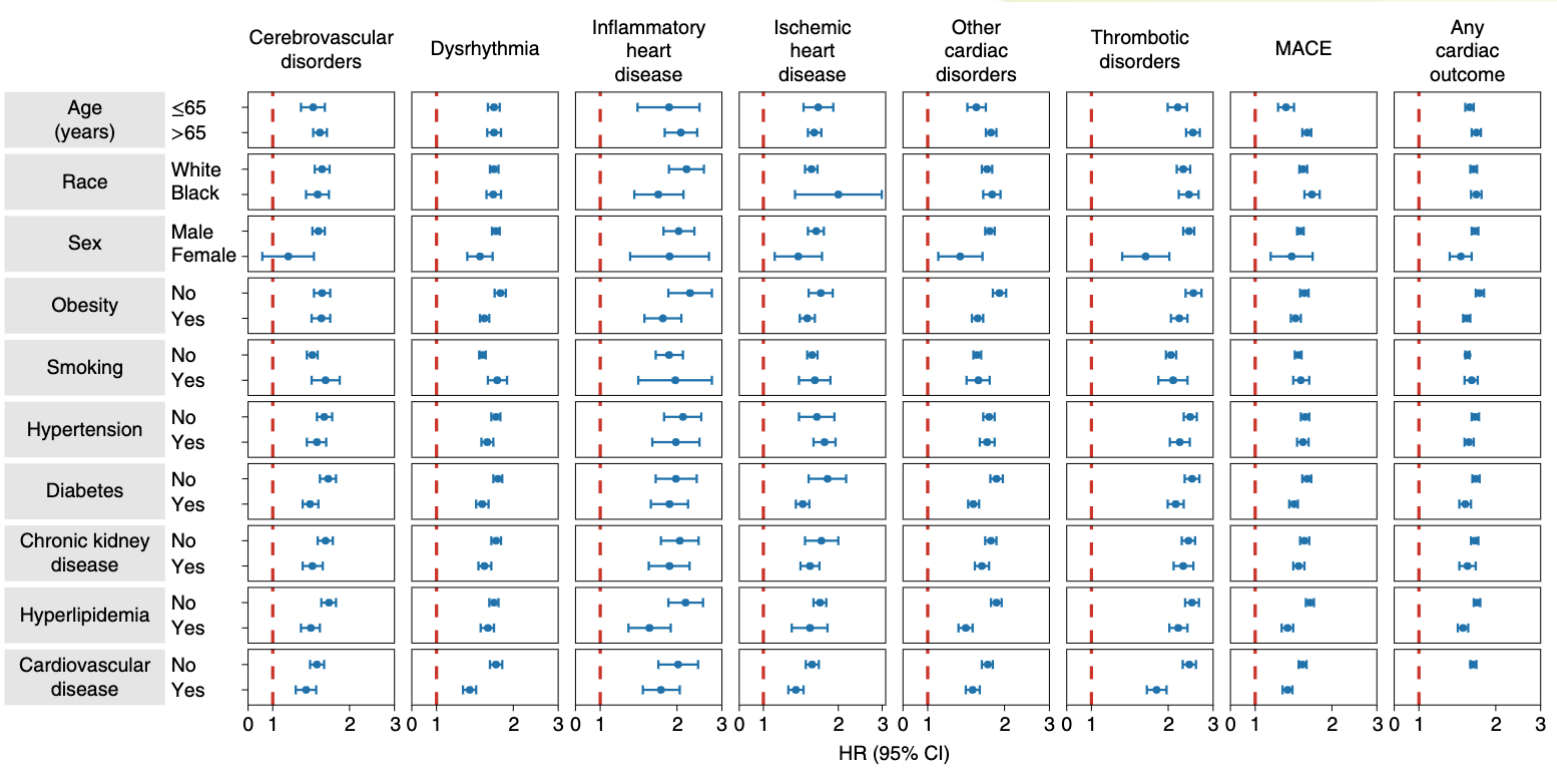
Table of Contents

OPEN

Long-term cardiovascular outcomes of COVID-19

Yan Xie [1,2,3], Evan Xu [1,4], Benjamin Bowe [1,2] and Ziyad Al-Aly [1,2,5,6,7] ✉



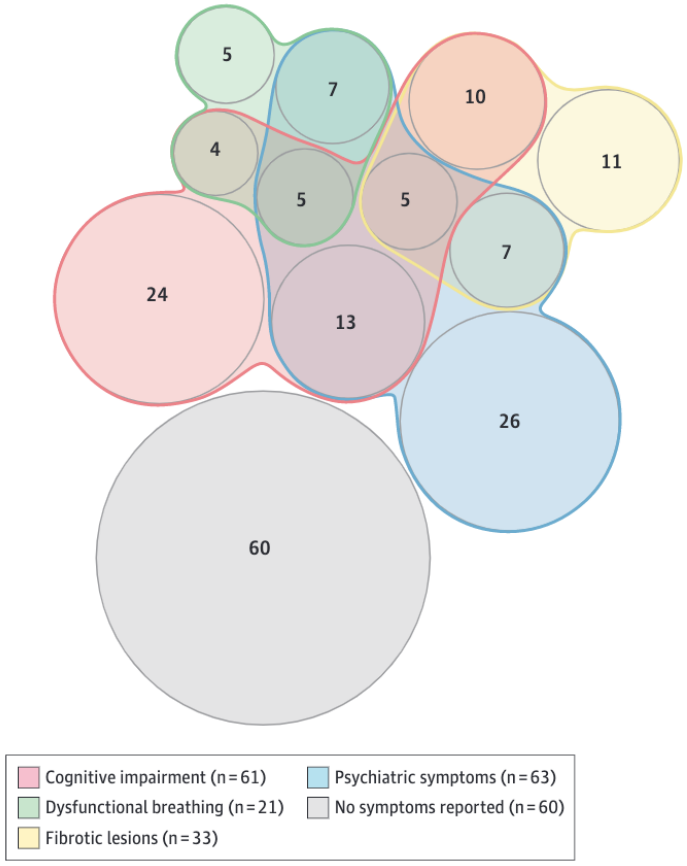


Nature medicine, 2021

JAMA | Original Investigation

Four-Month Clinical Status of a Cohort of Patients After Hospitalization for COVID-19

The Writing Committee for the COMEBAC Study Group



Symptoms	All patients	Nonintubated	Intubated
Dyspnea	78 (16.3)	53 (13.1)	25 (34.2)
Cough	21/420 (5)	16/358 (4.5)	5/62 (8.1)
Chest discomfort	34/418 (8.1)	25/356 (7)	9/62 (14.5)
Fatigue	134/431 (31.1)	110/368 (29.9)	24/63 (38.1)
Anorexia	34/436 (7.8)	25/370 (6.7)	9/66 (13.6)
Memory difficulties	73/416 (17.5)	63/354 (17.8)	10/62 (16.2)
Mental slowness	42/415 (10.1)	38/353 (10.8)	4/62 (6.4)
Concentration problems	41/412 (10.0)	35/351 (10.0)	6/61 (9.8)

JAMA, 2021

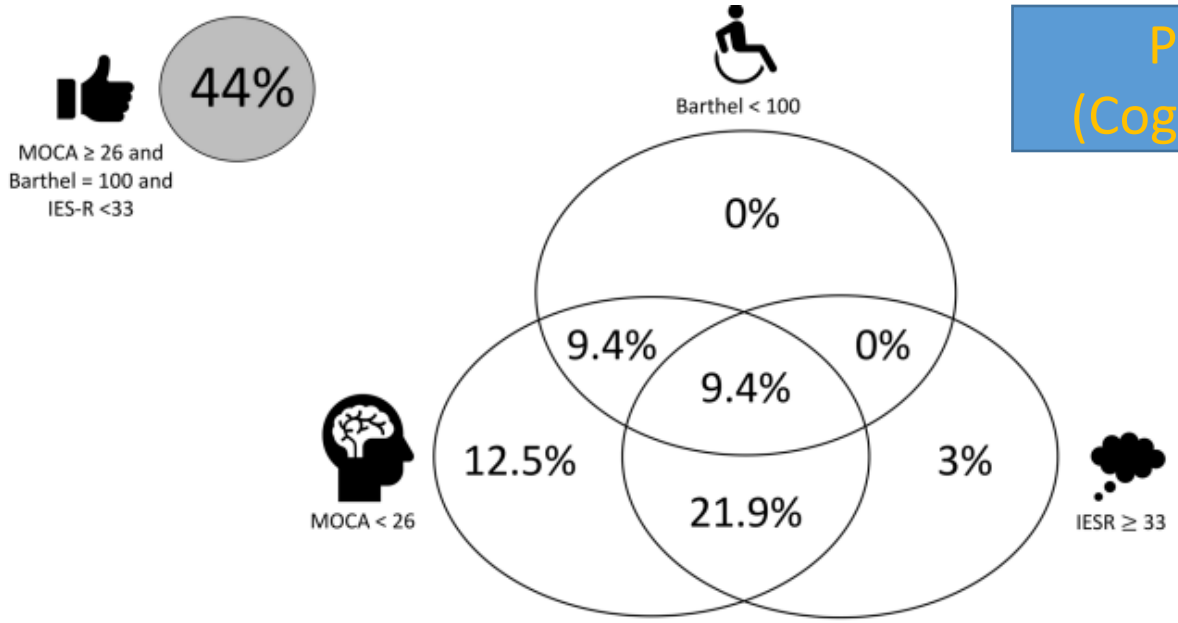
THE CATHOLIC UNIVERSITY
CATHOLIC MEDIC

RESEARCH Open Access

Post-intensive care syndrome after a critical COVID-19: cohort study from a Belgian follow-up clinic

Anne-Françoise Rousseau[1*], Pauline Minguet[1], Camille Colson[1], Isabelle Kellens[1], Sourour Chaabane[1], Pierre Delanaye[2,4], Etienne Cavalier[3], J. Geoffrey Chase[5], Bernard Lambermont[1] and Benoit Misset[1]

- Single center prospective, Belgium, n = 32
- Proportions of patients experiencing PICS
- Effect of rehab in COVID-19 ICU patients



PICS: 56%
(Cognitive: 53%)

Ann. Intensive Care, 2021

Variables	Rehab (n = 17)	No rehab (n = 15)	P value
MV duration, days	24 (18 – 32)	16 (11 – 26)	0.004
ICU LOS, days	39 (23 – 43)	16 (11 – 26)	0.011
MoCA (cognitive)	26 (23 – 28)	27 (22 – 28)	NS
IES-R (mental)	6 (4 – 24)	9 (3 – 34)	NS
EQ-5D score	7 (6 – 9.5)	6 (5.7 – 7.2)	NS
Barthel Index	100 (75 – 100)	100 (100 –100)	0.03
Handgrip strength	21 (14 – 27)	32 (28 - 42)	0.005

Ann. Intensive Care, 2021

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Clinical Outcomes Among Patients With 1-Year Survival Following Intensive Care Unit Treatment for COVID-19

Hidde Heesakkers, MD; Johannes G. van der Hoeven, MD, PhD; Stijn Corsten, MD; Inge Janssen, MD; Esther Ewalds, MD; Koen S. Simons, MD, PhD; Brigitte Westerhof, MD; Thijs C. D. Rettig, MD, PhD; Crétien Jacobs, MD; Susanne van Santen, MD, PhD; Arjen J. C. Slooter, MD, PhD; Margaretha C. E. van der Woude, MD, PhD; Mark van den Boogaard, RN, PhD; Marieke Zegers, PhD

- Multicenter prospective, Dutch, n = 246 / 452,

- Proportions of patients experiencing PICS

Domain	1 Domain	2 Domains	All 3 Domains
Physical	107 / 245 (43.5)	35 / 246 (14.2) + Mental	26/246 (10.5)
Mental	1 / 244 (0.4)		
Cognitive		15 / 246 (5.9) + Physical	

JAMA, 2022

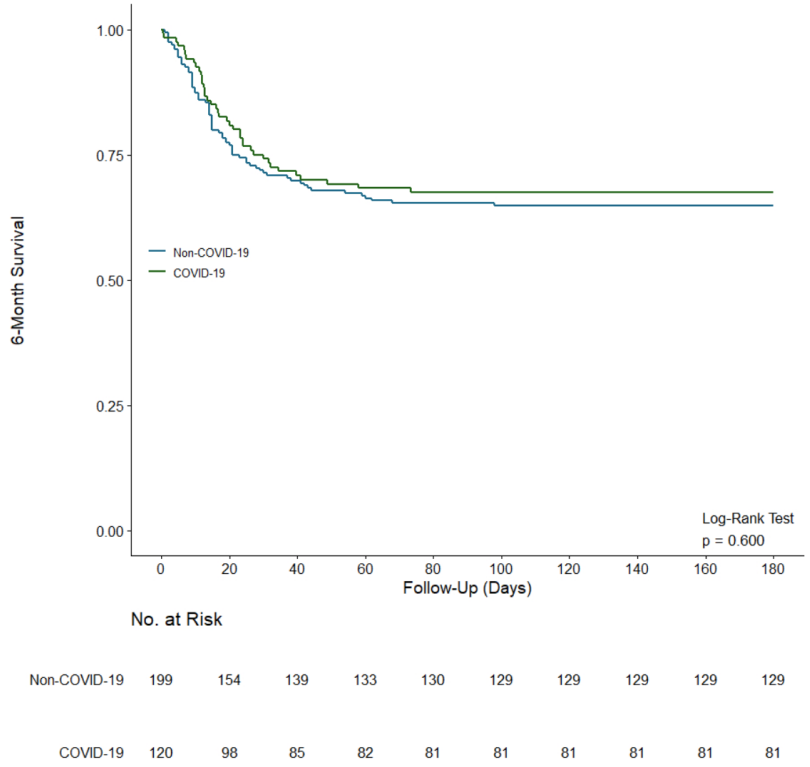
- New physical problems

New physical problems	Percentage
Weakened condition	38.9
Joint stiffness	26.3
Joint pain	25.5
Muscle weakness	24.8
Myalgia	21.3
Dyspnea	20.8
Numb sensation in limbs	20.6
Lung disease	18.5
Neuropathic pain	17.4
Voice problems	11.9
Dizziness	11.5

JAMA, 2022

Comparison of 6-Month Outcomes of COVID-19 vs Non-COVID-19 Survivors of Critical Illness

- COVID-19 (n = 120, SPRINT-SARI) vs. non-COVID-19 (n = 199, PREDICT)
- Mechanically ventilated patients for acute respiratory failure



AJRCCM, 2022

Functional outcomes	COVID-19	Non-COVID-19	P value
EQ-5D-5L	0.8 (0.7 – 0.9)	0.7 (0.5 – 0.9)	0.140
EuroQol-visual analogue scale	70 (60 – 85)	70 (50 – 80)	0.511
New disability	19/54 (35.2)	29/80 (36.2)	0.653
IADL	8 (7 – 8)	8 (6 – 8)	0.275
HADS anxiety	2 (0 - 6)	4 (1 – 9)	0.302
HADS depression	2 (1– 5)	3 (1 – 7)	0.917
PTSD	9/44 (20.5)	7/49 (14.3)	0.802
Cognitive dysfunction	14/34 (41.2)	13/44 (29.5)	0.430

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

- Rehabs in COVID-19 ICU

Early rehabilitation with dedicated use of belt-type electrical muscle stimulation for severe COVID-19 patients

Kensuke Nakamura*, Hidehiko Nakano, Hiromu Naraba, Masaki Mochizuki and Hideki Hashimoto

Critical Care, 2020

Rehabilitation Levels in Patients with COVID-19 Admitted to Intensive Care Requiring Invasive Ventilation

An Observational Study

David McWilliams[1], Jonathan Weblin[1], James Hodson[2], Tonny Veenith[3], Tony Whitehouse[3], and Catherine Snelson[3]; on behalf of the Queen Elizabeth Hospital Birmingham COVID-19 Research Team

- Single center, prospective, n = 110/177
- COVID-19 Patients who required MV
- First mobilize: sitting on the edge of the bed

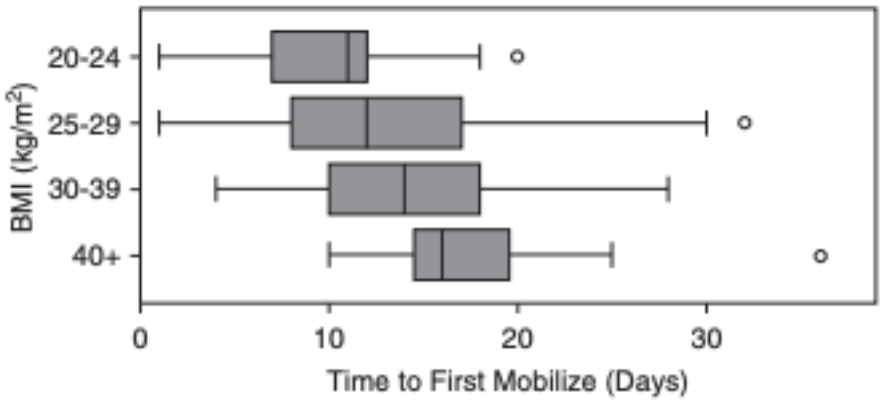
ICU therapy	
Mechanical ventilation	110 (100%)
Duration of vent, day	19 ± 10
Tracheostomy	85 (77)
Prone position	74 (67)
Neuromuscular blockade	99 (90)

ICU outcomes	
ICU acquired weakness	110 (100%)
Delirium	76 (69%)
Mobilized in ICU	110 (100%)
Time to first mobilize, day	14 ± 7
ICU LOS, day	22 ± 11

Annals of ATS , 2021

- **Factors associated with initiate rehab**

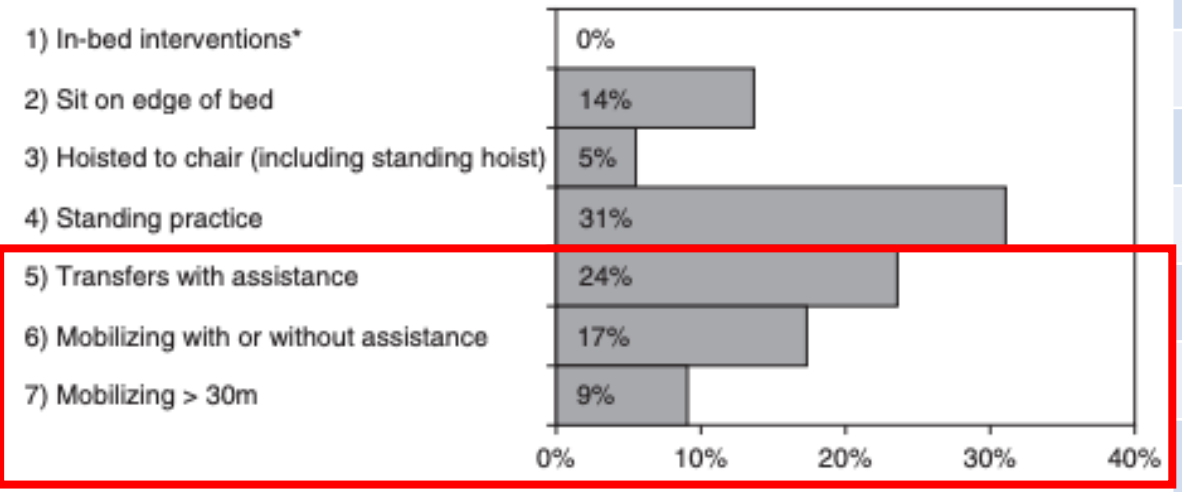
Factor	Days to first mobilize	P value
BMI, kg/m^2		< 0.001
20 - 24	10 ± 5	
25 - 29	13 ± 7	
30 - 39	14 ± 6	
40 +	18 ± 6	
Age		0.094
APACHE II		0.108
Clinical frailty score		0.317



Annals of ATS , 2021

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

- **Factors associated with physical outcome**

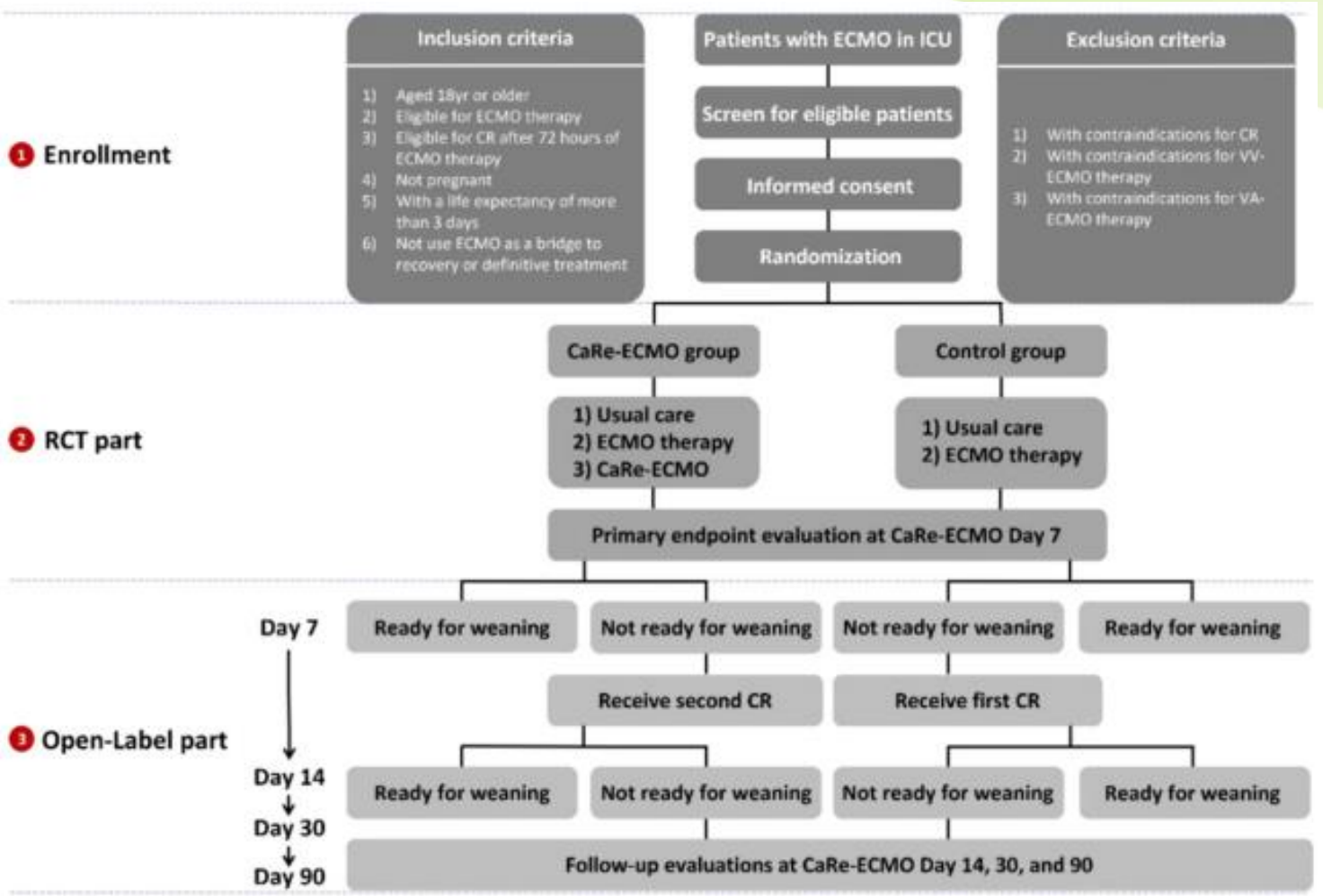


	MMS 5+ at ICU discharge	P value
Clinical frailty score		0.033
1	14 (61)	
2	18 (56)	
3	17 (49)	
Cardiovascular dz	6 (30)	
No	53 (53)	0.019
Yes	2 (20)	
APACHE II		0.420
BMI		0.262

Annals of ATS , 2021

THE CATHOLIC UI
CATHOLIC

Can Cardiopulmonary Rehabilitation Facilitate Weaning of Extracorporeal Membrane Oxygenation (CaRe-ECMO)? Study Protocol for a Prospective Multidisciplinary Randomized Controlled Trial



Frontiers in Cardiovascular Medicine, 2022

THE CATHOLIC UNIVERSITY OF KOREA
CATHOLIC MEDICAL CENTER

Thank you for your attention!