REDFLAGS:
Pas de souci, mobilisons:

MOBILISATION EN SITUATIONS EXTREMES

Xavier Wittebole
Critical care Department

Cliniques universitaires
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UCL BRUXELLES

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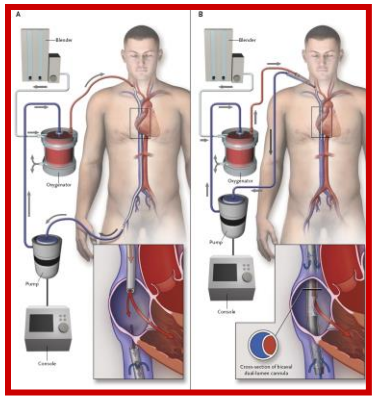

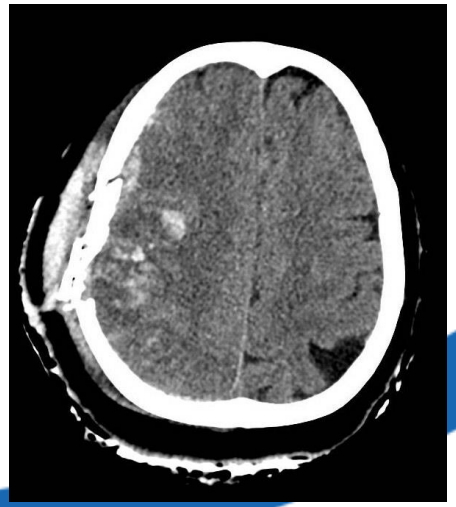

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Je n'ai aucun conflit d'intérêts à déclarer.

INTRODUCTION

People enduring a prolonged stay in the ICU on MV are at high risk of long-term physical, psychological, and cognitive disabilities.

Decreasing these risks through rehabilitation activities, including mobilization to prevent rapid muscle wasting, have been endorsed in many international ICU guidelines as part of the ABCDEF bundle.

However, there are many remaining questions such as optimal mobilization frequency, intensity, type, and time, and it is unclear if specific patient groups have different needs.

On top of this, in the TEAM trial, the intervention (increased early mobilization) was associated with increased adverse events.

Early Active Mobilization during Mechanical Ventilation in the ICU

The TEAM Study Investigators and the ANZICS Clinical Trials Group*

Adverse events — no. (%)¶¶				
Patients with ≥1 adverse event potentially due to mobilization — no. (%)	34 (9.2)	15 (4.1)	2.55 (1.33–4.89)§	0.005
Adverse events per patient — no. (%)				0.02
0	337 (90.8)	355 (95.9)		
1	19 (5.1)	11 (3.0)		
2	4 (1.1)	2 (0.5)		
≥3	11 (3.0)	2 (0.5)		
Type of adverse events — no. (%)‖‖				
Altered blood pressure	13 (3.5)	8 (2.2)		0.27
Cardiac arrhythmia	13 (3.5)	4 (1.1)		0.03
Oxygen desaturation	8 (2.2)	1 (0.3)		0.02
Pain or agitation	4 (1.1)	1 (0.3)		0.37
Removal of invasive line	2 (0.5)	2 (0.5)		1.00
Gastrointestinal	2 (0.5)	1 (0.3)		1.00
Tachypnea	3 (0.8)	0		0.25
Altered neurologic state	1 (0.3)	1 (0.3)		1.00
Other	4 (1.1)	0		0.12

Hodgson C et al. N Engl J Med.2022;387: 1747-58.

Early Active Mobilization during Mechanical Ventilation in the ICU

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Table S15. Serious Adverse Events*

	Early Mobilization (n=371)	Usual Care (n=370)	P value
Fall to the floor	0 (0)	0 (0)	1.0
Cardiac arrest	0 (0)	0 (0)	1.0
Arrhythmia, no. (%) †	5 (1.3)	0 (0)	0.06
Desaturation, no. (%) ‡	1 (0.3)	1 (0.3)	1.0
Unplanned extubation	0 (0)	0 (0)	1.0
Line removal requiring urgent replacement, no. (%)	0 (0)	0 (0)	1.0
Other, no. (%)§	1 (0.3)	0 (0)	1.0

Adverse events — no. (%)¶¶			
Patients with ≥1 adverse event potentially due to mobilization	34 (9.2)	15 (4.1)	2.55 (1.33–4.89)‖ 0.005
Tachypnea	3 (0.8)	0	0.25
Altered neurologic state	1 (0.3)	1 (0.3)	1.00
Other	4 (1.1)	0	0.12

Hodgson C et al. N Engl J Med.2022;387: 1747-58.

Exclusion criteria

1. Dependent for activities of daily living in the month prior to current ICU admission (gait aids are acceptable).
2. Documented cognitive impairment.
3. Proven or suspected acute primary brain pathology (e.g. traumatic brain injury, stroke, hypoxic brain injury).
4. Proven or suspected spinal cord injury or other neuromuscular disease that will result in permanent or prolonged weakness (not including ICU acquired weakness).
5. Has rest in bed orders and/or has bilateral non-weight bearing orders for the lower limbs.
6. Life expectancy less than 180 days due to a chronic or underlying medical condition.
7. Death is deemed inevitable as a result of the current illness and either the patient or treating clinical or substitute decision maker are not committed to full active treatment.
8. Unable to communicate in the official local language.
9. This is not the first ICU admission in the index hospital admission.
10. Fulfilled all inclusion criteria and none of the exclusion criteria ≥72 hours.

Hodgson C et al. N Engl J Med.2022;387: 1747-58.

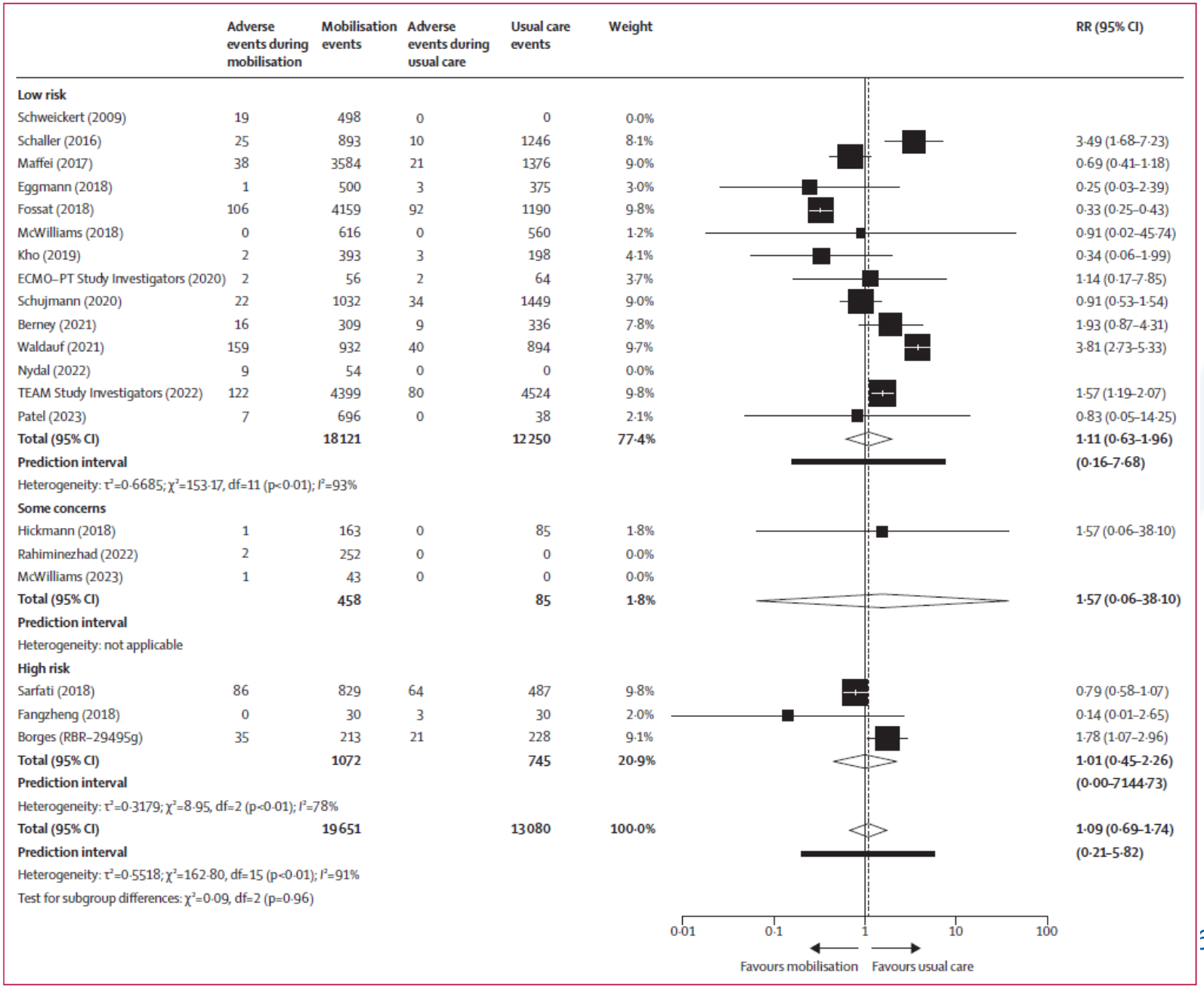
Association of active mobilisation variables with adverse events and mortality in patients requiring mechanical ventilation in the intensive care unit: a systematic review and meta-analysis

- Systematic review with frequentist and Bayesian analyses
- RCT active mobilization in the critically ill (on MV) compared with either
  - no mobilization
  - mobilization commencing later,
  - mobilization at a lower frequency or intensity.

- Primary outcome: number of adverse events that occurred during the implementation of mobilization,
- Secundary outcome: effect of mobilization on mortality.

- After title and abstract screening: 14 440 studies
  Review of 466 full texts,
  67 trials with 7004 participants / 59 trials contributing to the MA.

Paton M et al. Lancet Respir Med. 2024;12: 386–98.



	Adverse events during mobilisation	Mobilisation events	Adverse events during usual care	Usual care events	Weight	RR (95% CI)
Low risk						
Schweickert (2009)	19	498	0	0	0·0%	
Schaller (2016)	25	893	10	1246	8·1%	3·49 (1·68–7·23)
Maffei (2017)	38	3584	21	1376	9·0%	0·69 (0·41–1·18)
Eggmann (2018)	1	500	3	375	3·0%	0·25 (0·03–2·39)
Fossat (2018)	106	4159	92	1190	9·8%	0·33 (0·25–0·43)
McWilliams (2018)	0	616	0	560	1·2%	0·91 (0·02–45·74)
Kho (2019)	2	393	3	198	4·1%	0·34 (0·06–1·99)
ECMO–PT Study Investigators (2020)	2	56	2	64	3·7%	1·14 (0·17–7·85)
Schujmann (2020)	22	1032	34	1449	9·0%	0·91 (0·53–1·54)
Berney (2021)	16	309	9	336	7·8%	1·93 (0·87–4·31)
Waldauf (2021)	159	932	40	894	9·7%	3·81 (2·73–5·33)
Nydal (2022)	9	54	0	0	0·0%	
TEAM Study Investigators (2022)	122	4399	80	4524	9·8%	1·57 (1·19–2·07)
Patel (2023)	7	696	0	38	2·1%	0·83 (0·05–14·25)
Total (95% CI)		**18121**		**12250**	**77·4%**	**1·11 (0·63–1·96)**
Prediction interval						**(0·16–7·68)**
Heterogeneity: τ^2=0·6685; χ^2=153·17, df=11 (p<0·01); I^2=93%						
Some concerns						
Hickmann (2018)	1	163	0	85	1·8%	1·57 (0·06–38·10)
Rahiminezhad (2022)	2	252	0	0	0·0%	
McWilliams (2023)	1	43	0	0	0·0%	
Total (95% CI)		**458**		**85**	**1·8%**	**1·57 (0·06–38·10)**
Prediction interval						
Heterogeneity: not applicable						
High risk						
Sarfati (2018)	86	829	64	487	9·8%	0·79 (0·58–1·07)
Fangzheng (2018)	0	30	3	30	2·0%	0·14 (0·01–2·65)
Borges (RBR–29495g)	35	213	21	228	9·1%	1·78 (1·07–2·96)
Total (95% CI)		**1072**		**745**	**20·9%**	**1·01 (0·45–2·26)**
Prediction interval						**(0·00–7144·73)**
Heterogeneity: τ^2=0·3179; χ^2=8·95, df=2 (p<0·01); I^2=78%						
Total (95% CI)		**19651**		**13080**	**100·0%**	**1·09 (0·69–1·74)**
Prediction interval						**(0·21–5·82)**
Heterogeneity: τ^2=0·5518; χ^2=162·80, df=15 (p<0·01); I^2=91%						
Test for subgroup differences: χ^2=0·09, df=2 (p=0·96)						

6–98.

Association of active mobilisation variables with adverse events and mortality in patients requiring mechanical ventilation in the intensive care unit: a systematic review and meta-analysis

In conclusion, our systematic review with frequentist and Bayesian analysis of existing data in a heterogeneous population of critically ill adults showed **no overall effect of mobilisation on the occurrence of adverse events or mortality**.
With mobilisation leading to a **less than 3% incidence of adverse events**, with all bar one event reported as transient or resolving with cessation of the intervention or minor medical attention, **our review provides clinicians with reassurance about the safety of providing this treatment**.

Paton M et al. Lancet Respir Med 2024;12: 386–98.

INTRODUCTION

These results look great…

But

In those studies, many ICU patients were nor enrolled!!!

INTRODUCTION

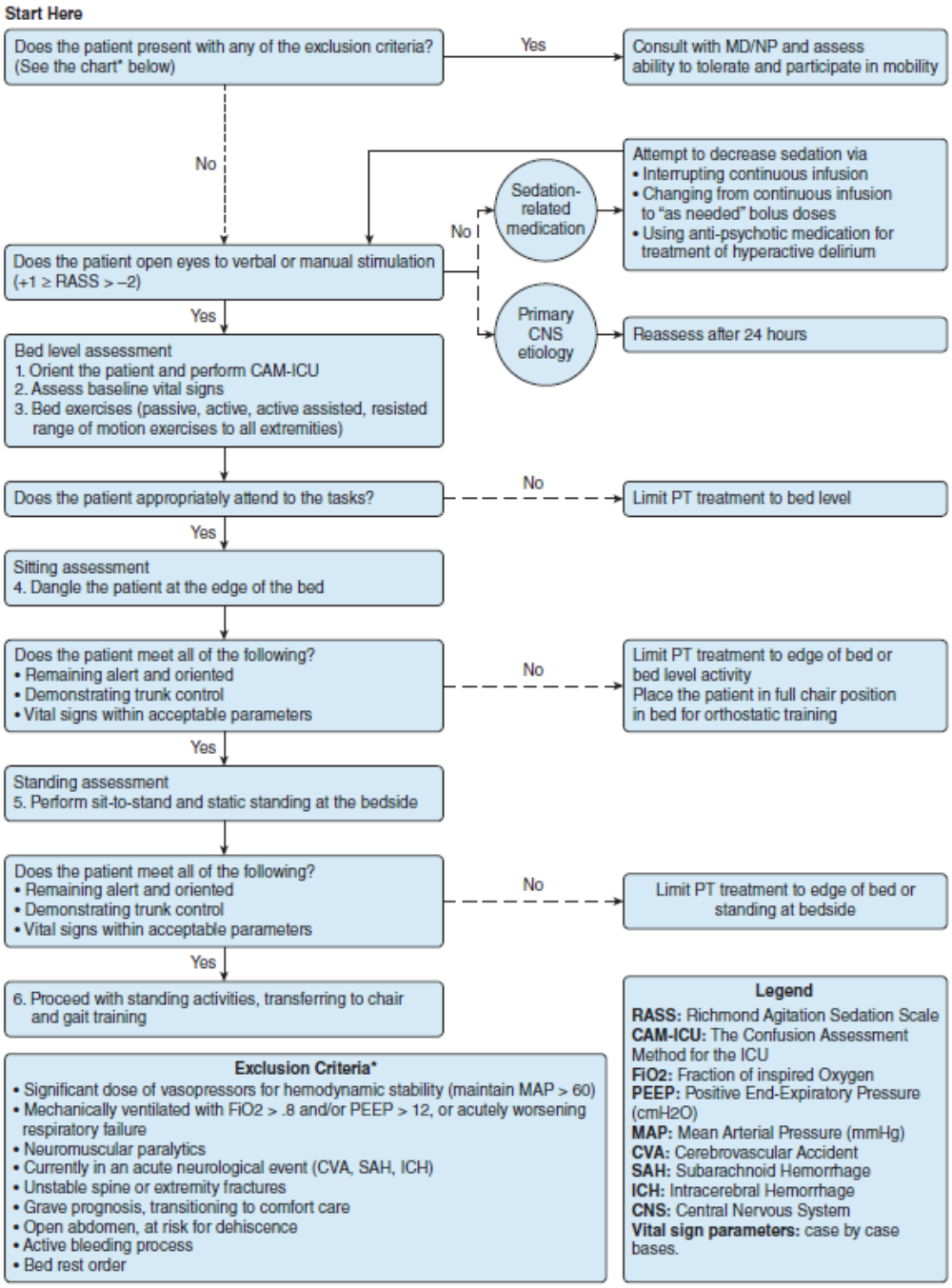
These results look great…

But

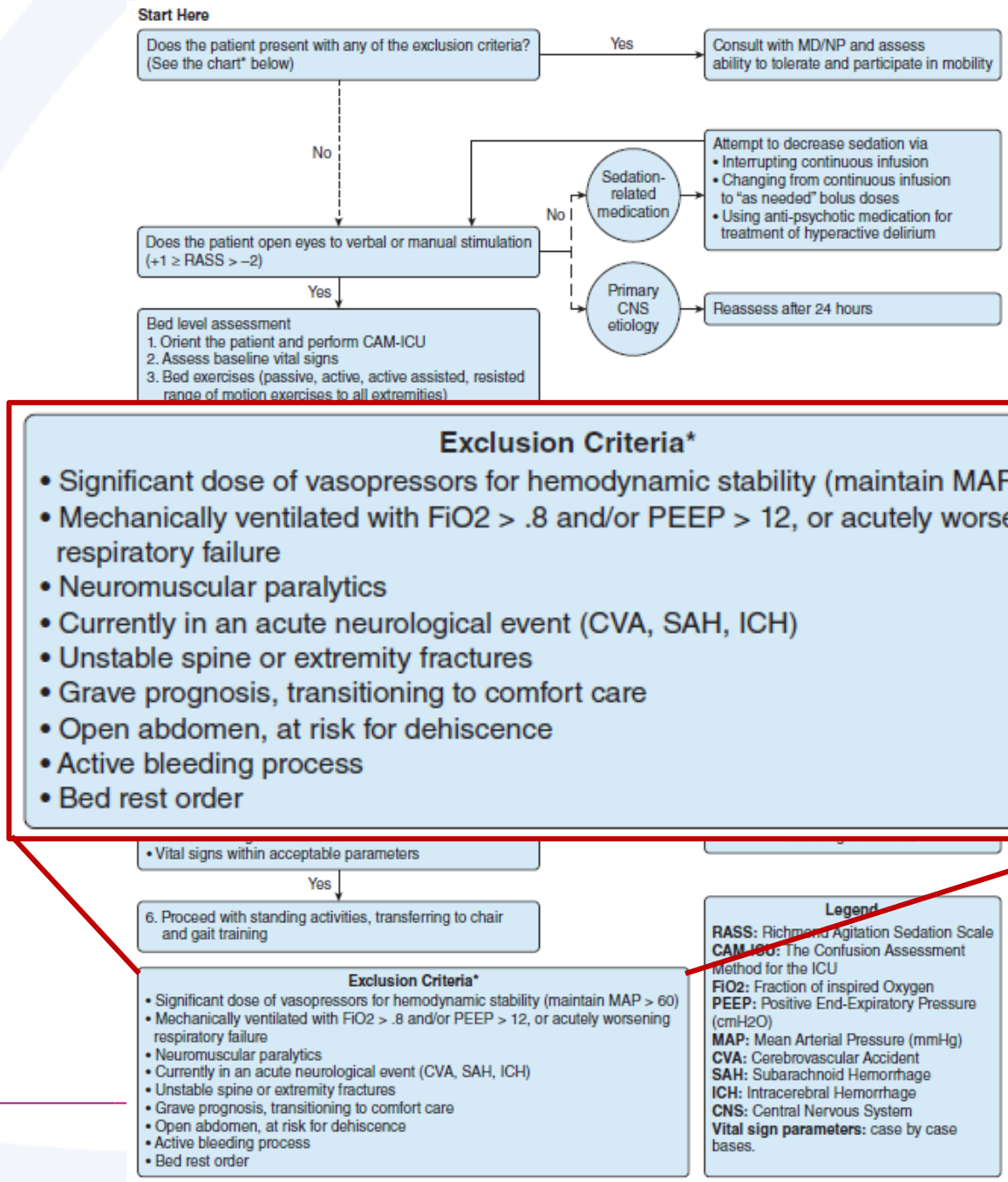
In those studies, many ICU patients were nor enrolled!!!

The question is:

What can we do with the « extreme situations »?



Rawal D et al. Chest.2024; 2(1):100038



Rawal D et al. Chest.2024; 2(1):100038

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Respiratory parameters		
Endotracheal or tracheostomy tube		
Spo_2, %		
≤ 90		
> 90		
Fio_2		
≤ 0.6		
> 0.6		
Respiratory rate, breaths/min		
> 30		
≤ 30		
PEEP, cm H_2O		
≤ 10		
> 10		
Prone positioning		

Red = significant risk of an adverse event.
Yellow = potential risk of adverse event, but benefits of EM may outweigh the risk.
Green = low risk of an adverse event.

Rawal D et al. Chest.2024; 2(1):100038

M.V.?

Early Active Mobilization during Mechanical Ventilation in the ICU

The TEAM Study Investigators and the ANZICS Clinical Trials Group*

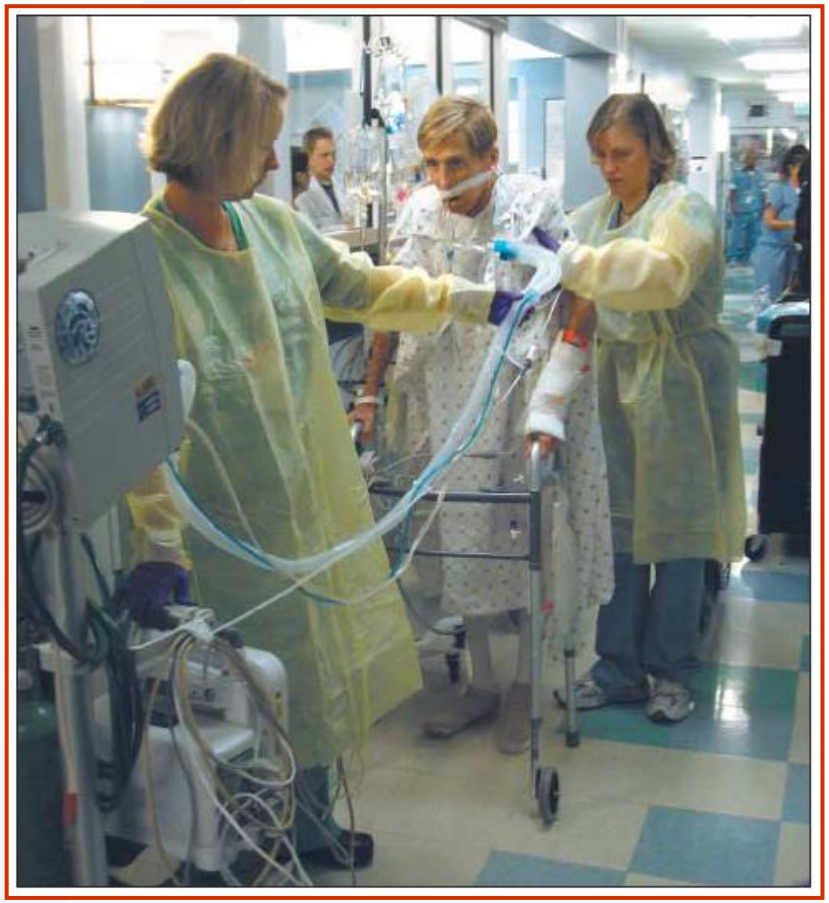
Hodgson C et al. N Engl J Med.2022;387: 1747-58.

M.V. ?

Bayesian subgroup analysis identified a **higher probability of AE** occurring

- with longer durations of mobilization versus shorter durations of mobilization (67·05%; RR 1·12 [95% CI 0·60–1·97]; 18 237 events, 11 studies vs 21·56%; 0·64 [0·20–1·91]; 3391 events, five studies),
- in surgical cohorts versus medical cohorts (77·82%; 1·27 [0·64–2·59]; 8856 events, four studies vs 9·45%; 0·47 [0·14–1·49]; 8173 events, five studies),
- when mobilisation was commenced later rather than earlier in the admission (17·62%; 0·76 [0·35–1·58]; 2672 events, four studies vs 10·95%; 0·69 [0·37–1·58]; 27 920 events, 15 studies),
- ***in patients who were extubated when mobilisation commenced versus those mechanically ventilated*** (88·42%; 1·72 [0·58–4·93]; 441 events, one study vs 71·43%; 1·16 [0·64–2·05]; 23 272 events, 12 studies];

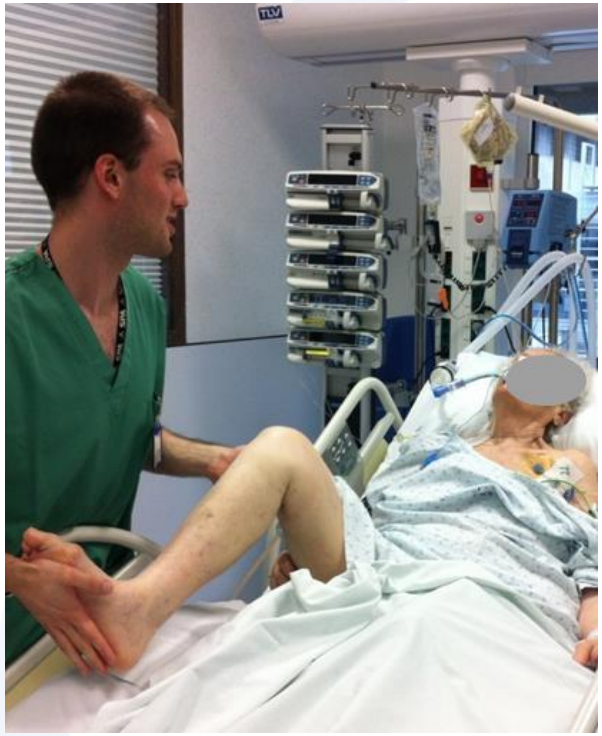
Paton M et al. Lancet Respir Med 2024;12: 386–98.

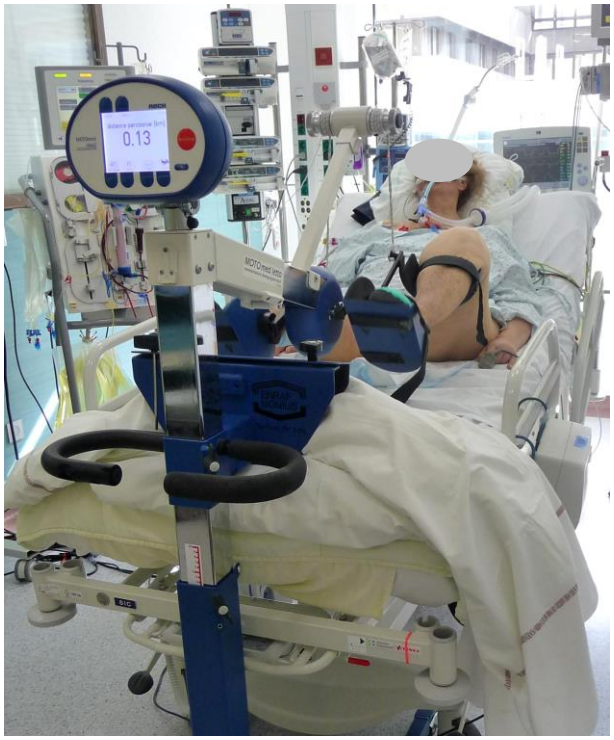


Mobilizing Patients in the Intensive Care Unit

Improving Neuromuscular Weakness and Physical Function

Needham. JAMA.2008;300:1685-90.

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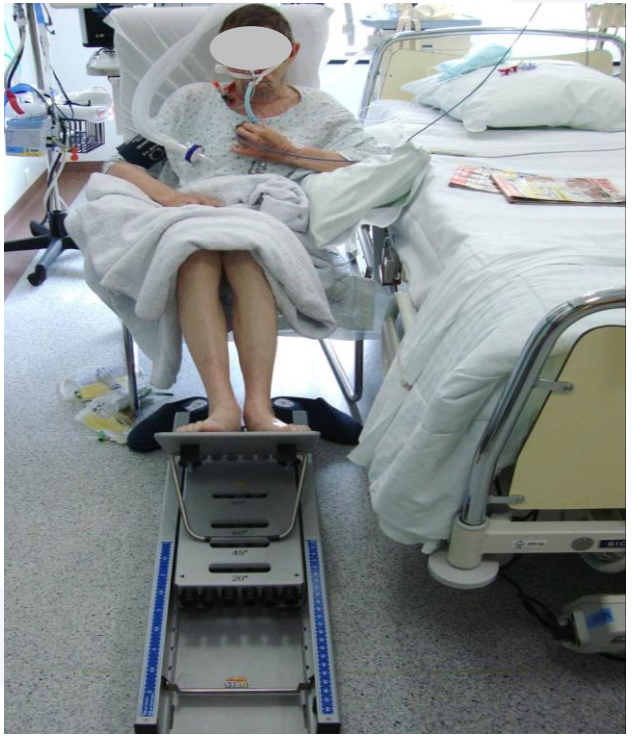

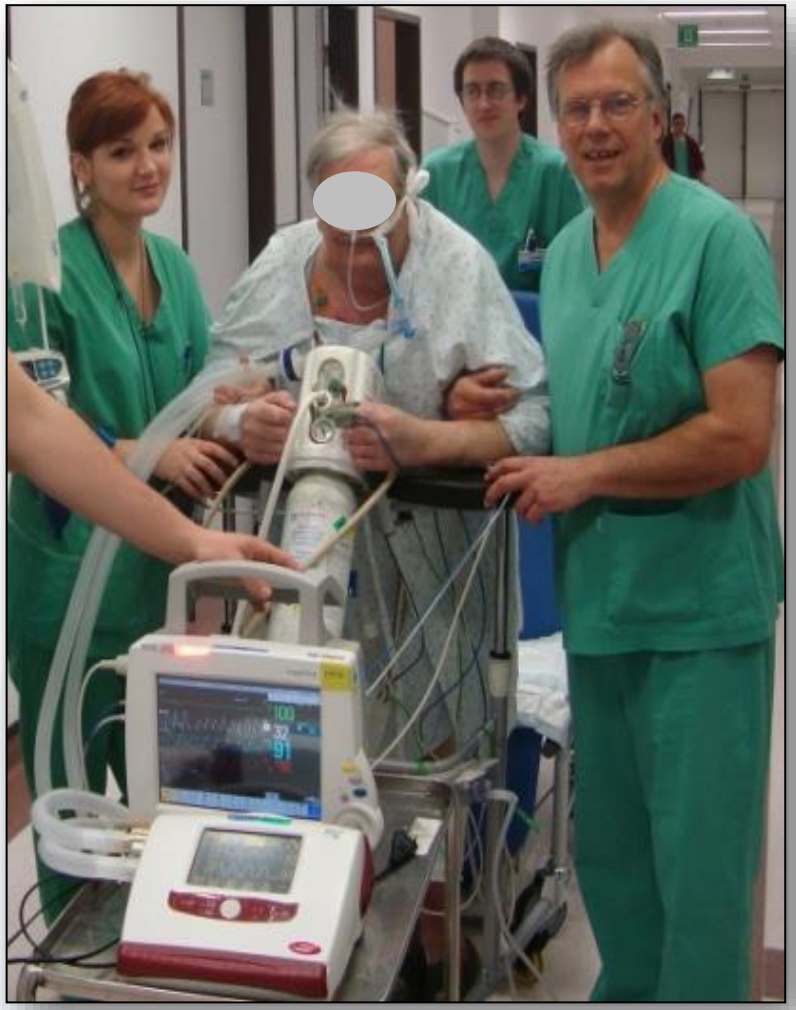

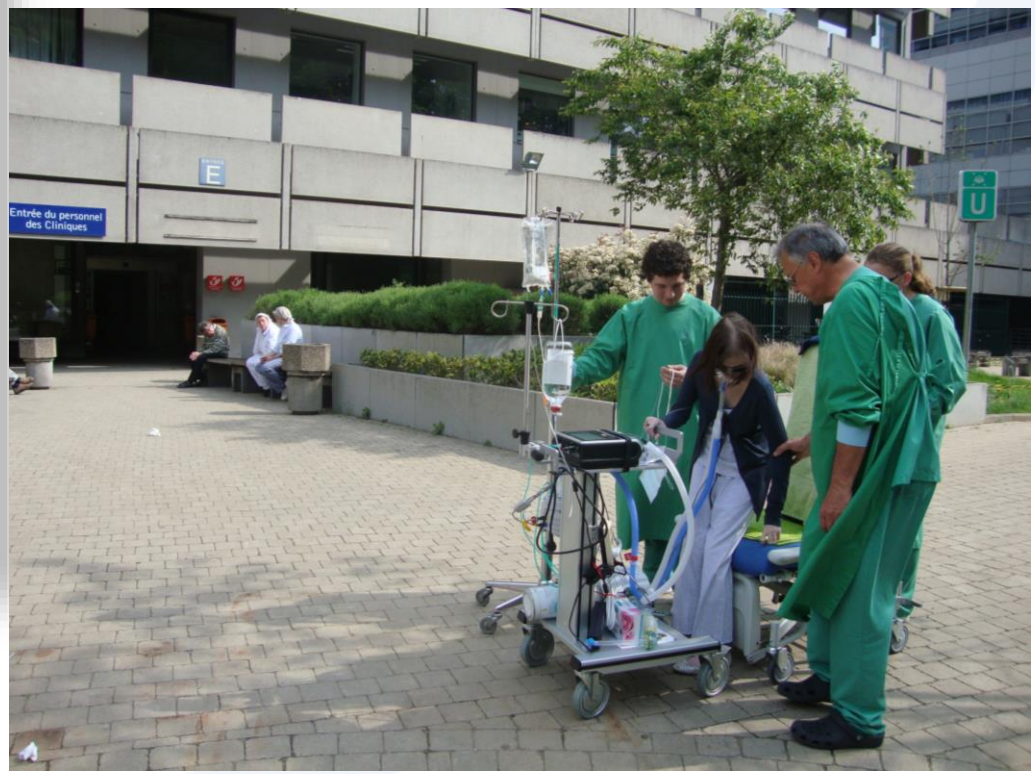
Entrée du personnel
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PRONE ?

Physical rehabilitation while awake, intubated and proned for COVID-19-associated severe acute respiratory distress syndrome

Seth B et al. BMJ Case Rep.2024; 17:e251772.

Physical rehabilitation while awake, intubated and proned for COVID-19-associated severe acute respiratory distress syndrome

Mechanical ventilation day	1	2	3	4	5	6
Plateau pressure (cmH_2O)*	25	24	24	22	27	30
ABG ($pH/PCO_2/PaO_2$) Or VBG* (pH/PCO_2)	7.25/55/65	7.30/47/86	7.37/44*	7.36/49*	7.36/49*	7.45/40/72
PaO_2/FiO_2	65	108	117†	136†	136†	180
FiO_2	100%	80%	70%	60%	60%	40%
Pain score‡	0	0	0	0	0	0
Sedation status (RASS score)§	+1	0	0	0	−1	0
CAM-ICU	Positive	Negative	Negative	Negative	Negative	Negative
Physical therapy treatment session	None	None	TherEx	TherEx, stretching	TherEx with RB	TherEx with RB, rolling
Occupational therapy treatment session	None	None	TherEx, iPad	ADL	TherEx	ADL, positioning

TherEx: Therapeutic Exercises - RB : resistance band

Seth B et al. BMJ Case Rep.2024; 17:e251772.

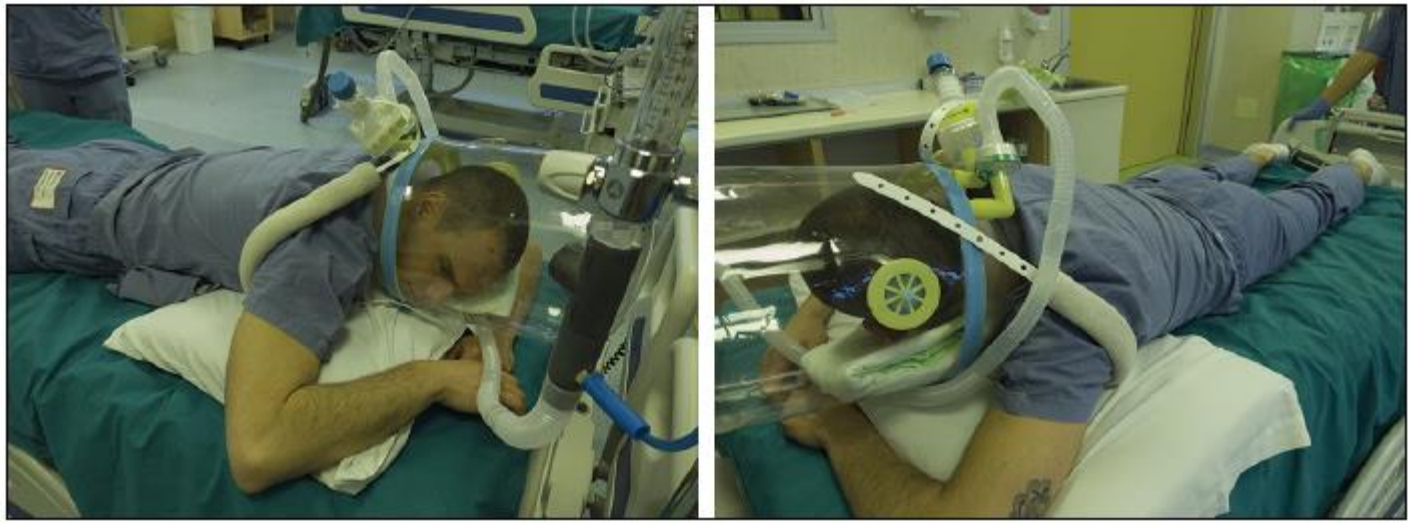
Physical rehabilitation while awake, intubated and proned for COVID-19-associated severe acute respiratory distress syndrome

- Severe hypoxaemia / lung protective MV / Prone P / Low level of sedation

- Modified physical rehabilitation interventions by PT and OT.
  - Upper and lower extremity exercises, with and without an exercise resistance band, were conducted, and included hip extension, abduction, hamstring curls and scapular stabilisation exercises.
  - Patient education on repositioning for prevention of pressure sores, assist with patient comfort and prevent potential for shoulder subluxation while in a prone position.
  - Self-care activities, such as brushing hair and hygiene, which included washing hair with a shower cap and face washing, were performed with OT while in a prone position.
  - Both PT and OT assisted with non-pharmacological, multicomponent delirium prevention interventions, such as reorientation, having lights on and blinds open during the day, early mobilisation and cognitive stimulation.

Seth B et al. BMJ Case Rep.2024; 17:e251772.

Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study



Interpretation Prone positioning was feasible and effective in rapidly ameliorating blood oxygenation in awake patients with COVID-19-related pneumonia requiring oxygen supplementation. The effect was maintained after resupination in half of the patients. Further studies are warranted to ascertain the potential benefit of this technique in improving final respiratory and global outcomes.

Coppo A et al. Lancet Respir Med.2020; 8:765-74.

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Respiratory parameters		
Endotracheal or tracheostomy tube		
Spo_2, %		
≤ 90		
> 90		
Fio_2		
≤ 0.6		
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Respiratory rate, breaths/min		
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≤ 30		
PEEP, cm H_2O		
≤ 10		
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Prone positioning		

!

Red = significant risk of an adverse event.
Yellow = potential risk of adverse event, but benefits of EM may outweigh the risk.
Green = low risk of an adverse event.

Adapted from Rawal D et al. Chest.2024; 2(1):100038

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Cardiovascular parameters		
Hypertensive emergency on treatment		
MAP		
More than lower limit of target on no support or low support		
Less than target range despite support or causing symptoms		
More than target on high level support		
Severe pulmonary hypertension		
Bradycardia		
Requiring treatment or awaiting pacemaker placement		
Stable rhythm with a pacemaker		
Pacemaker with a dependent rhythm		
Tachyarrhythmia		
Any with ventricular rate < 120 beats/min		
Stable with ventricular rate > 150 beats/min		
Cardiac ischemia (chest pain or EKG changes)		

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Rawal D et al. Chest.2024; 2(1):100038

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Rawal D et al. Chest.2024; 2(1):100038

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Devices		
Femoral IABP		
ECMO		
Ventricular assist device		
Pulmonary artery catheter or another cardiac monitoring device		
Venous and arterial femoral catheters		
Femoral sheaths		
Continuous renal replacement therapy		

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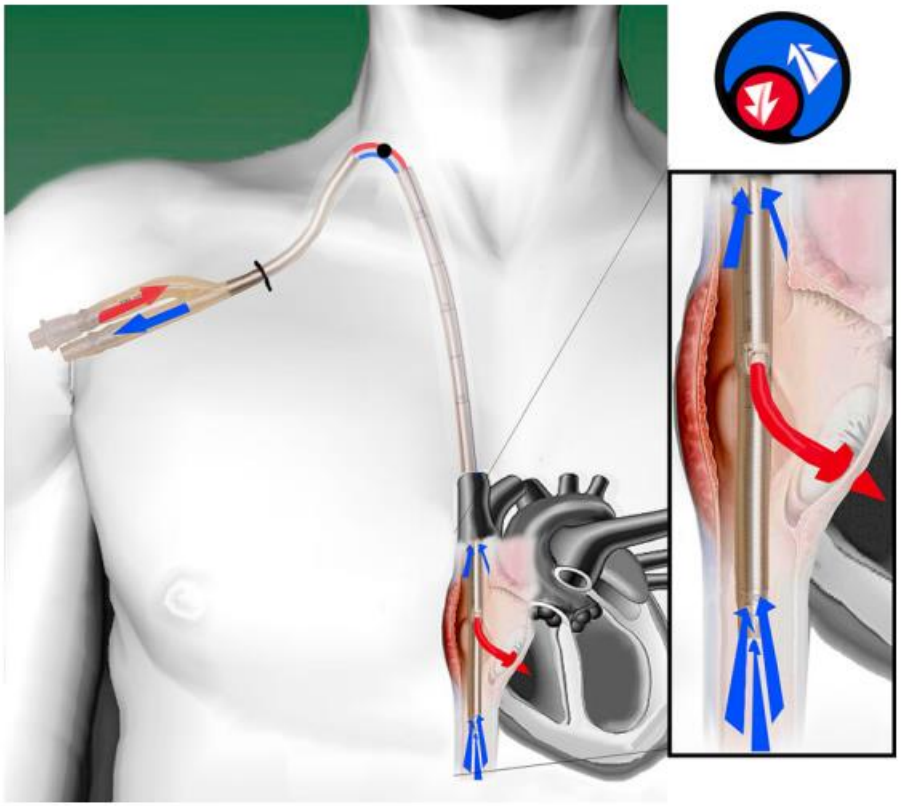
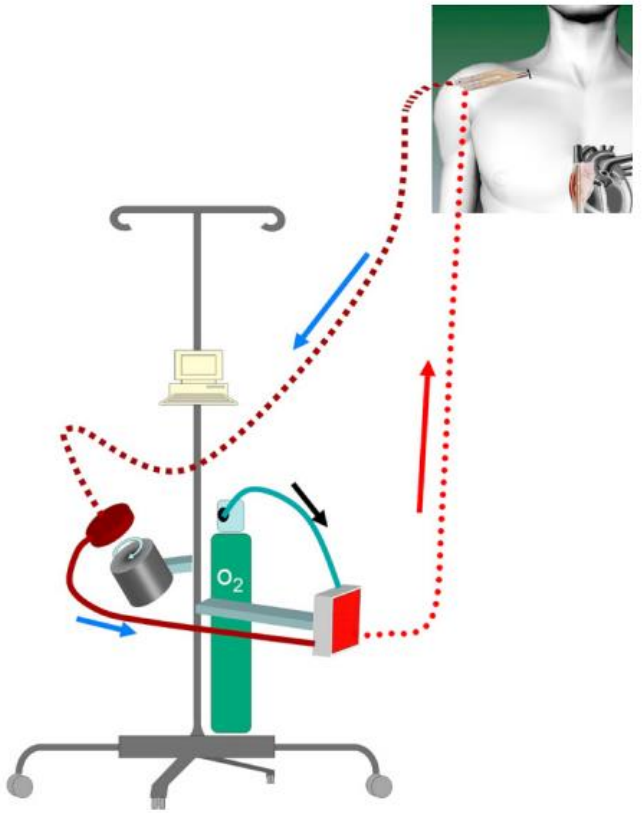
Rawal D et al. Chest.2024; 2(1):100038

ECMO ?

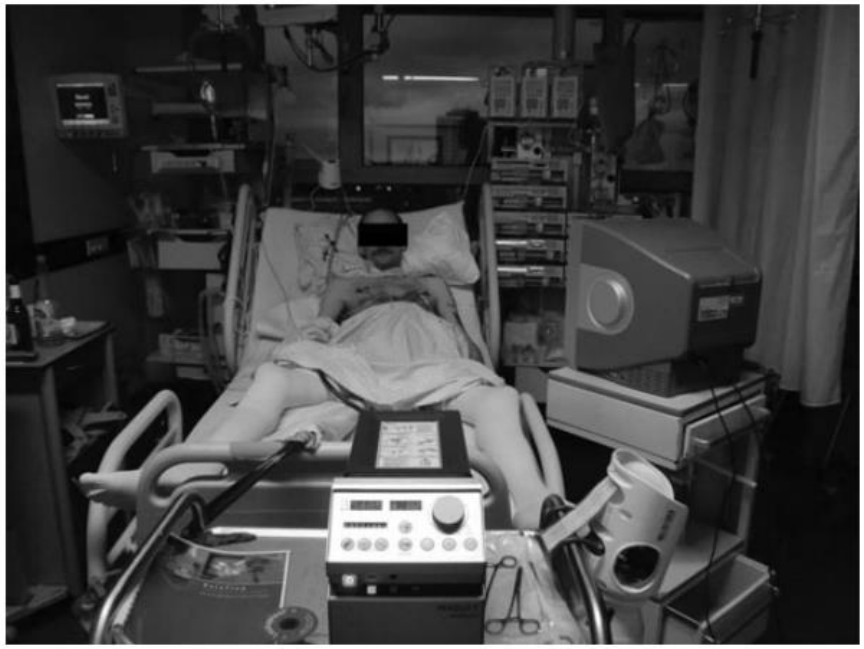




Garcia JP et al. J Thorac Cardiovasc Surg.2010; 139(6):e137.

Extracorporeal Membrane Oxygenation in Nonintubated Patients as Bridge to Lung Transplantation

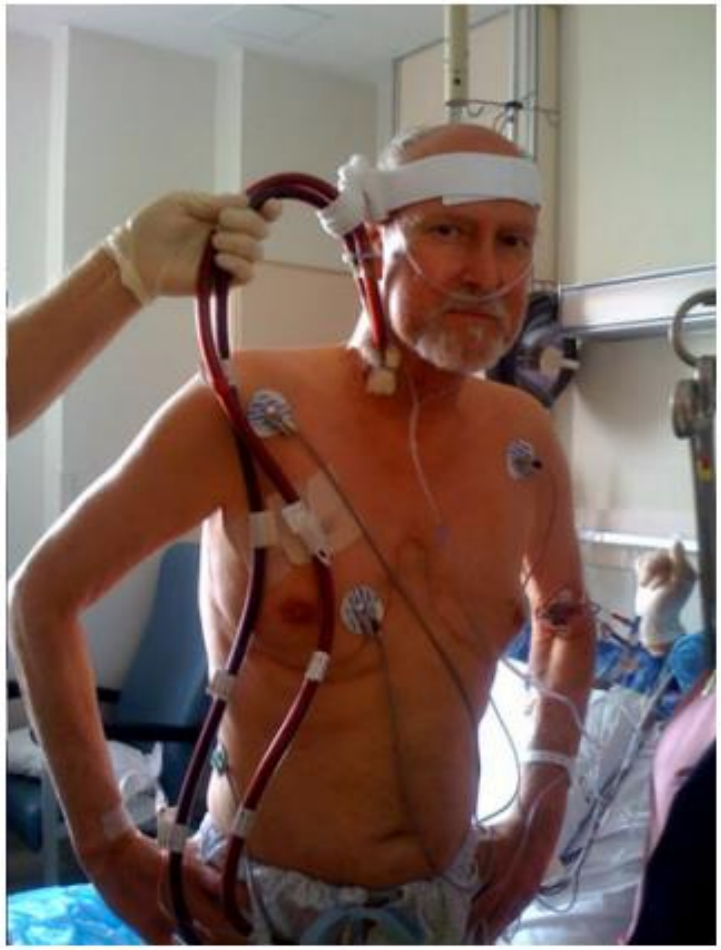
Pat	Age	Gender	Diagnosis	Days on ECMO	Type of Tx	Outcome
1	29	Female	CTEPH	35	BLTx	Discharged, alive, follow-up 14 months after Tx
2	53	Male	PAH, LF, SSc	11	BLTx	Deceased after Tx
3	41	Male	PH, LF due to sarcoidosis	18	BLTx	Discharged, alive, follow-up 6 months after Tx
4	54	Female	IPF	35	BLTx	Discharged, alive, follow-up 4 months after Tx
5	55	Female	IPAH	8	-	Deceased prior to Tx



These data have all the limitations of small case series but they may be viewed as a **proof-of-concept study** demonstrating the feasibility of using ECMO support in non-intubated patients.

Olsson KM et al. Am J Transpl.2010; 10:2173-8.

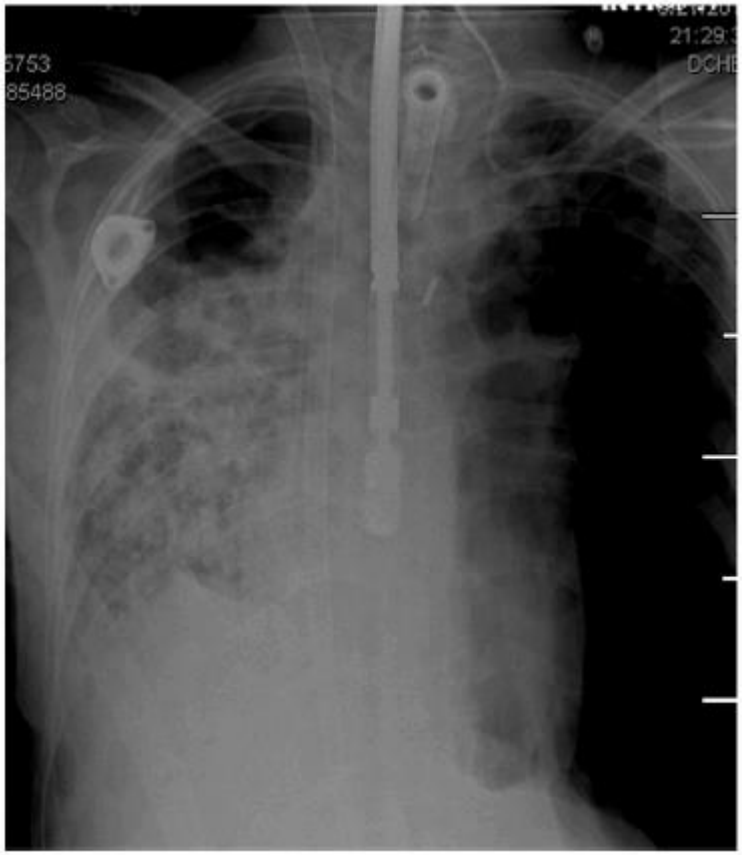
"*The management of ECMO patients has been transformed in recent times as a direct result of the* ***improvement in circuitry****; for example, one of the advantages of the novel, single-lumen ECMO cannulas is the ease of patient positioning.* ***Patients can sit up or out of bed****. In more experienced centres, patients awaiting lung transplantation* ***can be extubated and encouraged to ambulate on ECMO*** *(Fig. 6) [57,58]. This may help* ***prevent deconditioning and improve long-term outcome*** *[59]. The realization that patients can be bridged to transplant awake and ambulatory* ***for months*** *is beginning to influence care of acute lung failure patients.The ECMO centre at Karolinska Institute, Stockholm, has emphasized for years that awake, spontaneous breathing leads to better results in acute disease in children and adults, although this strategy has not been subjected to controlled investigation.* ***In addition to the benefits of spontaneous breathing, awake management may avoid many potential complications of intensive care such as excessive sedation, dependent oedema and pressure sores.***"

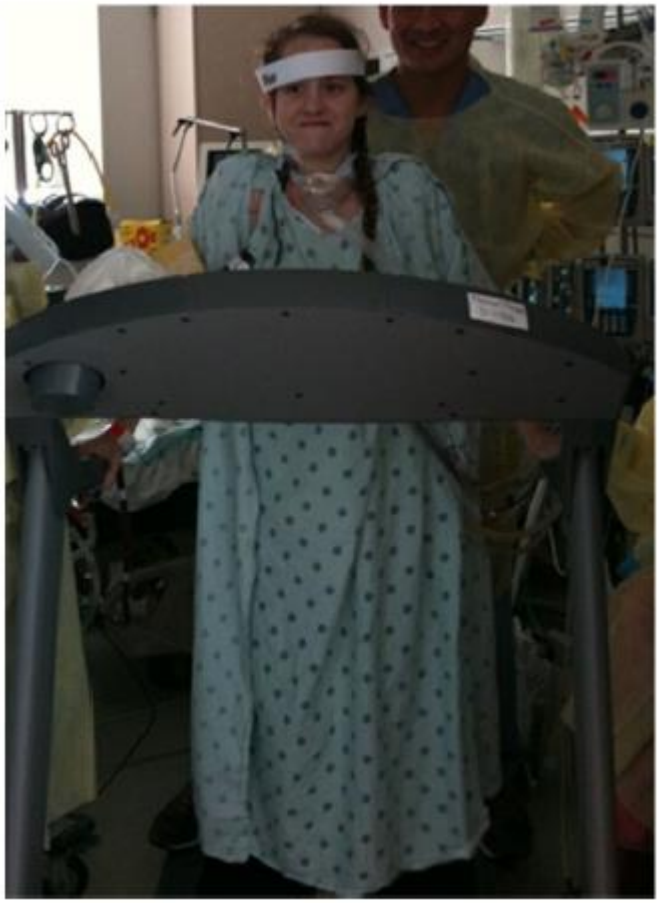


Picture from C. Hoopes, MD.

MacLaren et al. Intensive Care Med.2012. 38:210–220.

Ambulatory venovenous extracorporeal respiratory support as a bridge for cystic fibrosis patients to emergent lung transplantation☆

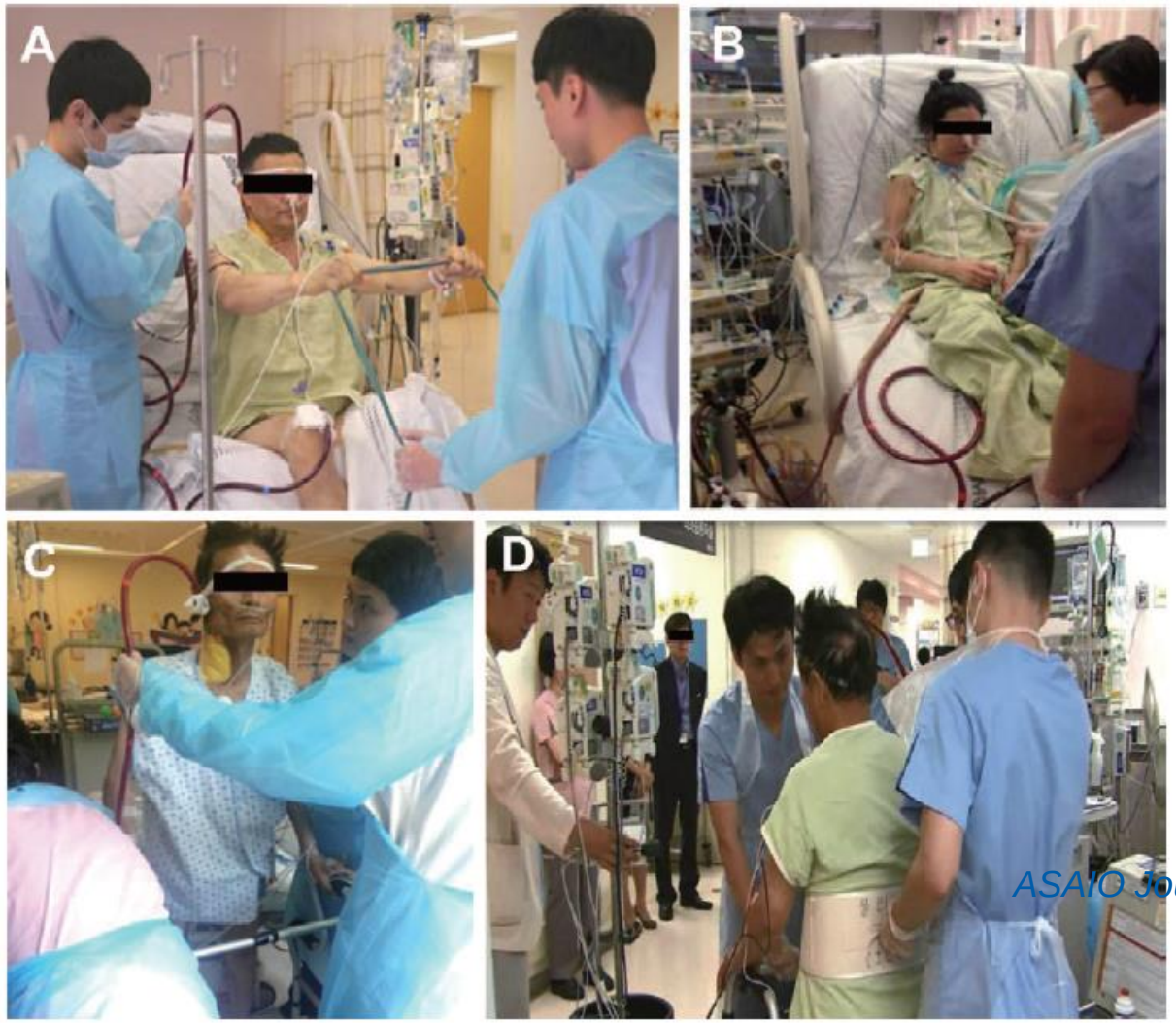




Hayes D et al. J Cyst Fibros.2012; 11:40-5.

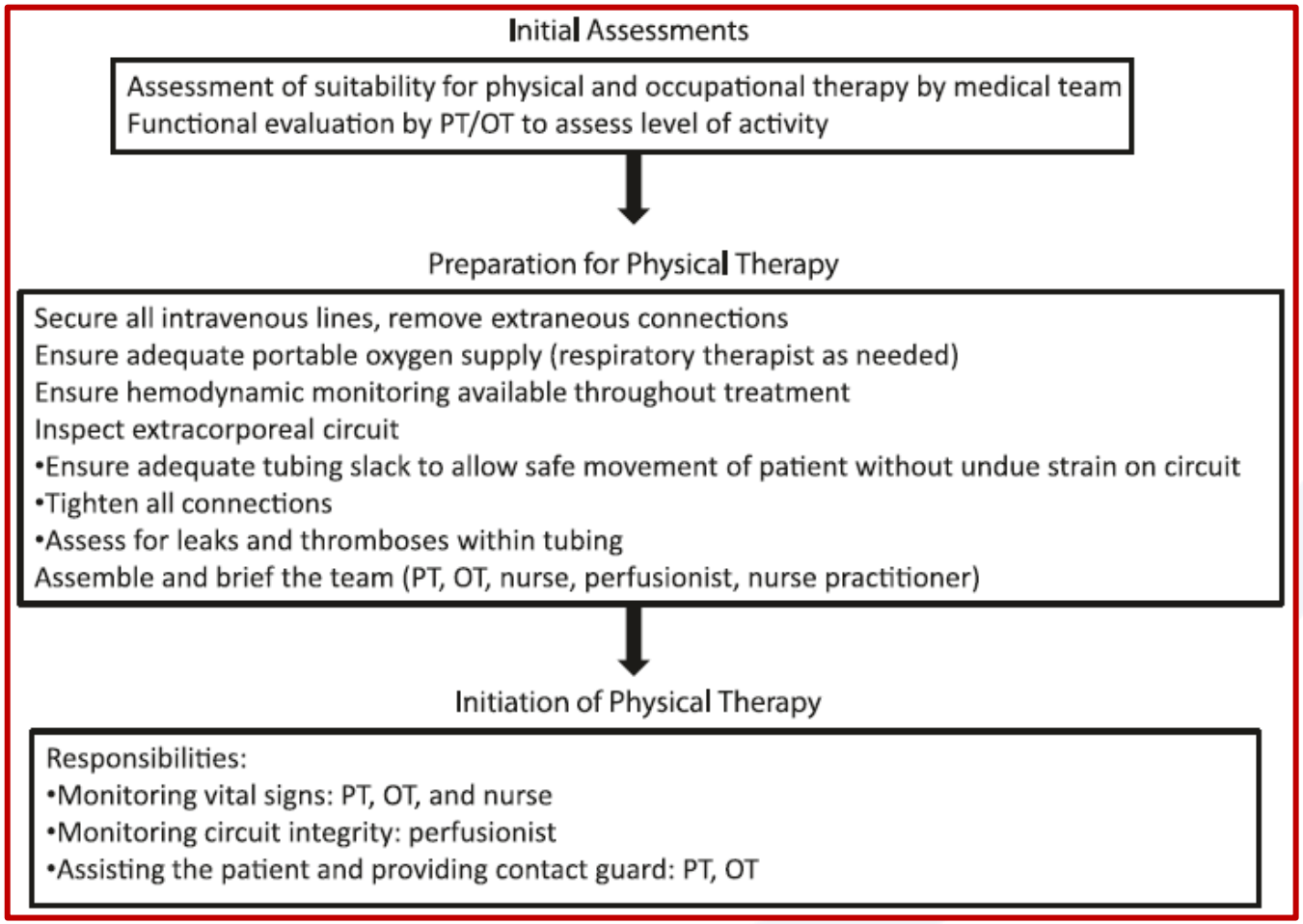
Feasibility and Safety of Early Physical Therapy and Active Mobilization for Patients on Extracorporeal Membrane Oxygenation

Youngjun Ko,* Yang Hyun Cho,† Yun Hee Park,‡ Hyun Lee,§¶ Gee Young Suh,§¶ Jeong Hoon Yang,¶‖ Chi-Min Park,¶# Kyeongman Jeon,§¶ and Chi Ryang Chung¶



Ko Y et al.
ASAIO Journal 2015; 61:564–568

Early mobilization of patients receiving extracorporeal membrane oxygenation: a retrospective cohort study



Abrams D et al. Crit Care.2014; 18:R38.

Early mobilization of patients receiving extracorporeal membrane oxygenation: a retrospective cohort study

Initial Assessments

Assessment of suitability for physical and occupational therapy by medical team

Funct

Secure all int

Ensure adequ

Ensure hemo

Inspect extra

•Ensure adeq

•Tighten all c

•Assess for le

Assemble an

on circuit

Responsibili

•Monitoring

•Monitoring

•Assisting the patient and providing contact guard: PT, OT

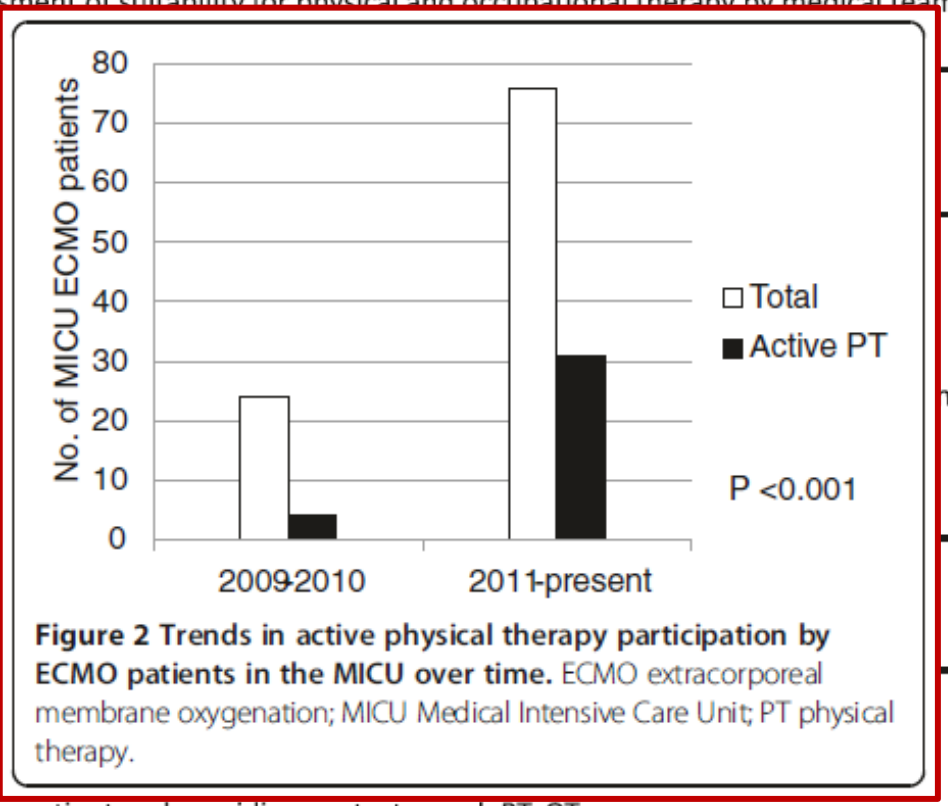


Figure 2 Trends in active physical therapy participation by ECMO patients in the MICU over time. ECMO extracorporeal membrane oxygenation; MICU Medical Intensive Care Unit; PT physical therapy.

Abrams D et al. Crit Care.2014; 18:R38.

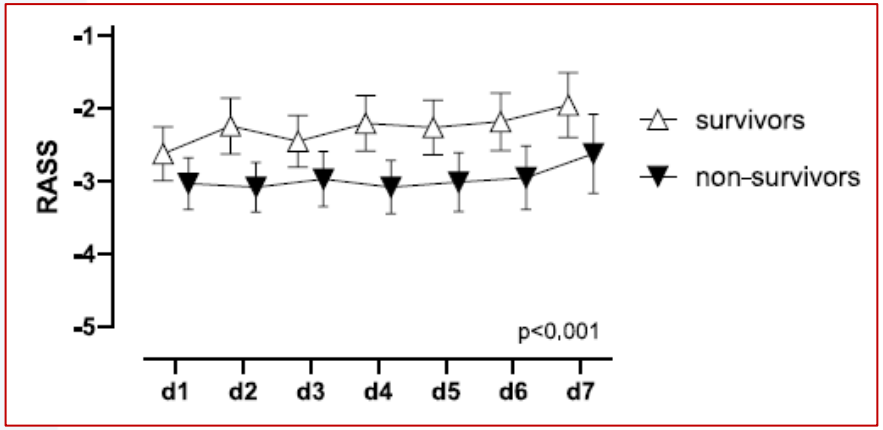
Early mobilization of patients receiving extracorporeal membrane oxygenation: a retrospective cohort study

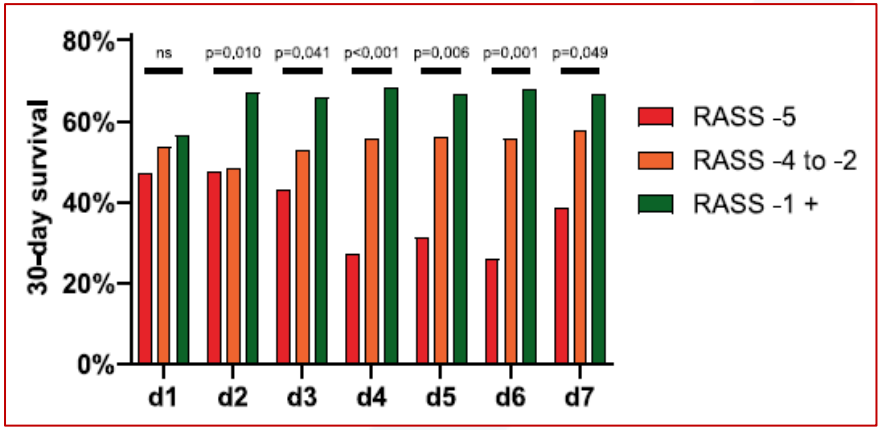
	Total (n = 35)	BTT (n = 19)	BTR (n = 16)
Maximum PT score (median, IQR)	8 (2 to 8)	8 (6 to 8)	2 (2 to 8)
No. of PT sessions per patient (median, IQR)	5 (1 to 13)	13 (8 to 15)	1.5 (1 to 3.25)
No. of PT sessions/patient/week (median, IQR)	2.8 (0.5 to 7.8)	4.5 (1.4 to 7.8)	1.3 (0.5 to 6.4)
Time from initiation of ECMO to first PT session (days, median, IQR)	2 (1 to 4.5)	2 (1 to 2)	4 (1.75 to 5.75)
No. of ambulatory patients (n, %)	18 (51)	12 (63)	6 (38)
Maximum distance ambulated (ft, median, IQR)	175 (37.5 to 285)	170 (55 to 525)	195 (60 to 398)
Survival to transplantation (n, %)	NA	10 (53)	NA
Survival to discharge (n, %)	23 (66)	9 (90)[a]	14 (88)
Disposition of survivors (n, %)			
Home	13 (57)	4 (44)	9 (64)
Acute rehabilitation	8 (35)	4 (44)	4 (29)
Subacute rehabilitation	2 (9)	1 (11)	1 (7)

Abrams D et al. Crit Care.2014; 18:R38.

Awake venovenous extracorporeal membrane oxygenation and survival

Retrospective study – 343 patients – 179 survivors
More cirrhosis, tumor, immunosuppression, lung fibrosis in the NS





Rottman FA et al. Front Med (Lausanne). 2024 24;11:1394698.

Rehabilitation for adult patients undergoing extracorporeal membrane oxygenation

Abstract

Background and purpose: Current information on the latest rehabilitative practices is limited, with previous reviews only covering data up to October 2021, and some considering only patients on awake ECMO or with COVID-19. This review aims to present a concise overview of the latest findings on rehabilitation and highlight emerging trends for patients undergoing ECMO support.

Methods: This integrative review was conducted by searching the National Library of Medicine – PubMed database. Two different search strings "extracorporeal membrane oxygenation" AND "rehabilitation" and "extracorporeal membrane oxygenation" AND "physiotherapy" were used to search the published literature. Articles that did not describe rehabilitation techniques, editorials, conference proceedings, letters to editor, reviews and research protocols were excluded. Studies conducted on pediatric populations were also excluded. The search process was completed in December 2023.

Results: Thirteen articles were included in the final analysis. Eight hundred and thirty-nine patients aged between 27 and 63 years were included; 428 were men (51%). In 31% of the included studies, patients had COVID-19; nevertheless, rehabilitative activities did not differ from non-COVID-19 patients. In most studies, rehabilitation commenced within the first 48–96 h and consisted of progressive exercise and out-of-bed activities such as sitting, standing and walking.

Conclusion: Current practice focuses on rehabilitative protocols that incorporate exercise routines with progressive intensity, greater emphasis on out-of-bed activities, and a multidisciplinary approach to patient mobilization.

Polastri M et al. Perfusion.2024; 39(S1):S115-S126

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Devices		
Femoral IABP		
ECMO		
Ventricular assist device		
Pulmonary artery catheter or another cardiac monitoring device		
Venous and arterial femoral catheters		
Femoral sheaths		
Continuous renal replacement therapy		

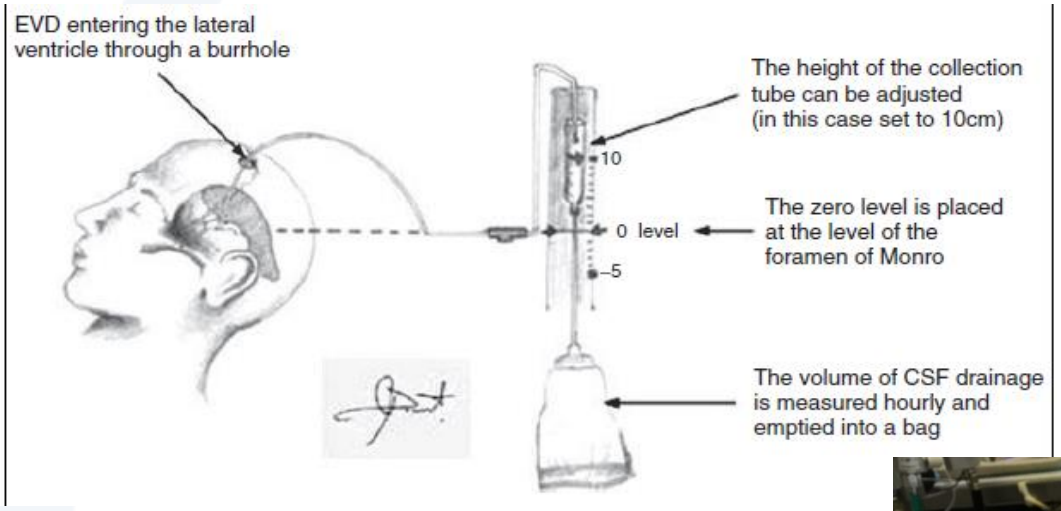
!

E.V.D. ???

Red = significant risk of an adverse event.
Yellow = potential risk of adverse event, but benefits of EM may outweigh the risk.
Green = low risk of an adverse event.

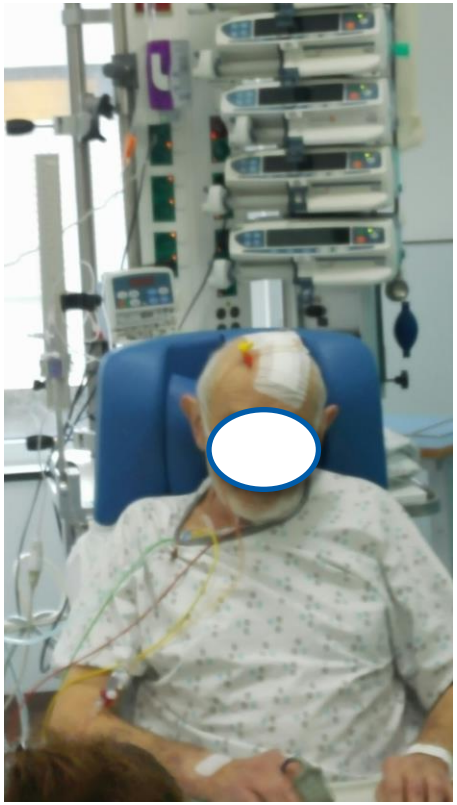
Rawal D et al. Chest.2024; 2(1):100038

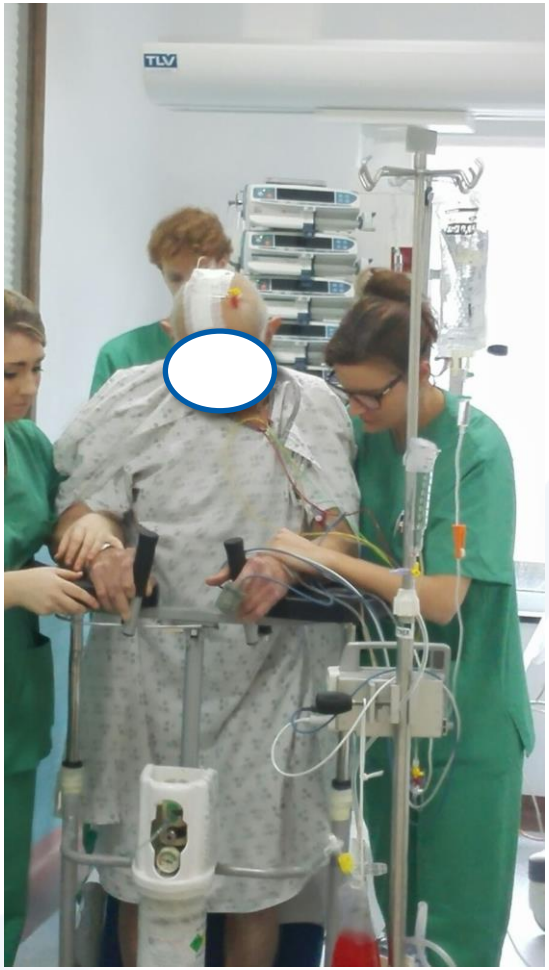
E.V.D. ?


EVD entering the lateral ventricle through a burrhole
The height of the collection tube can be adjusted (in this case set to 10cm)
10
0 level
The zero level is placed at the level of the foramen of Monro
–5
The volume of CSF drainage is measured hourly and emptied into a bag

E.V.D. ?

E.V.D. ?





E.V.D. ?

Specific surveillance:

- Hemodynamic
- Neurologic

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Adapted from Rawal D et al. Chest.2024; 2(1):100038

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Neurologic parameters		
Level of consciousness, RASS score		
−1 to +1		
−2 to +2		
< −2		
> +2		
Active management of elevated ICP		
Uncontrollable seizures		
Spinal precautions		

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Rawal D et al. Chest.2024; 2(1):100038

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> +2		
Active mana		
Uncontrolla		
Spinal preca		

RASS score

Richmond Agitation & Sedation Scale				CAM-ICU
Score	Description			
+4	Combative	Violent, immediate danger to staff		RASS ≥ -2 Proceed to CAM-ICU assessment
+3	Very agitated	Pulls at or removes tubes, aggressive		
+2	Agitated	Frequent non-purposeful movements, fights ventilator		
+1	Restless	Anxious, apprehensive but movements not aggressive or vigorous		
0	Alert & calm			
-1	Drowsy	Not fully alert, sustained awakening to voice (eye opening & contact >10 secs)	Voice	
-2	Light sedation	Briefly awakens to voice (eye opening & contact < 10 secs)		
-3	Moderate sedation	Movement or eye-opening to voice (no eye contact)		RASS < -2 STOP Recheck later
-4	Deep sedation	No response to voice, but movement or eye opening to physical stimulation	Touch	
-5	Un-rousable	No response to voice or physical stimulation		

Rec
Yell
Gre

Rawal B et al. Chest.2024; 2(1):100038

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
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T.B.I. ?

Assessing the impact of early progressive mobilization on moderate-to-severe traumatic brain injury: a randomized controlled trial

Yen HC et al. Critical Care.2024; 28:172.

Assessing the impact of early progressive mobilization on moderate-to-severe traumatic brain injury: a randomized controlled trial

RCT – 65 patients
EPM (Early Progressive Mobilization) vs EPUP (Early Progressive Uprise Mobilization)
Primary outcome: the Perme ICU Mobility Score (0-32)

Similar GCS (9) – ISS: 24 vs 29
ICP: 51% vs 43%
Craniectomy: 10 vs 12

Yen HC et al. Critical Care.2024; 28:172.

Assessing the impact of early progressive mobilization on moderate-to-severe traumatic brain injury: a randomized controlled trial

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Primary o

Similar G
ICP: 51%
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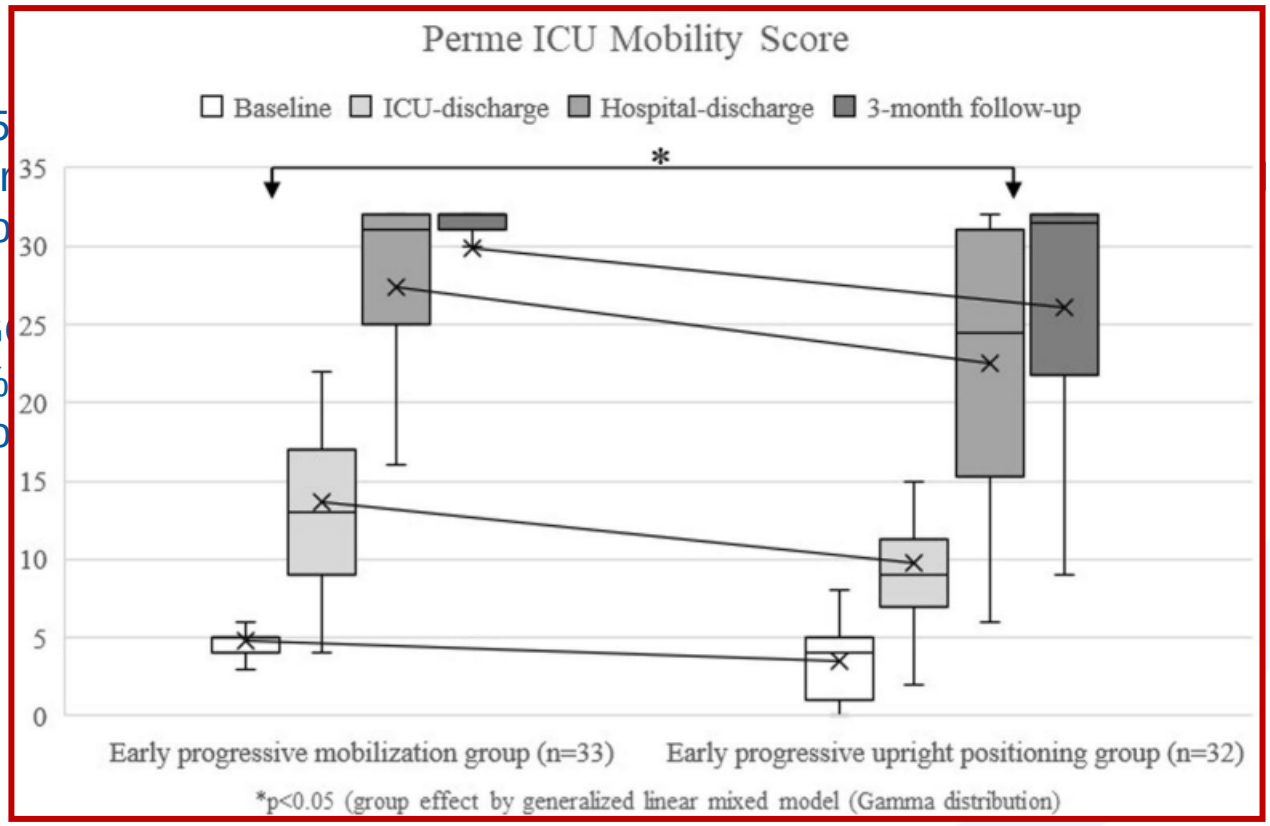
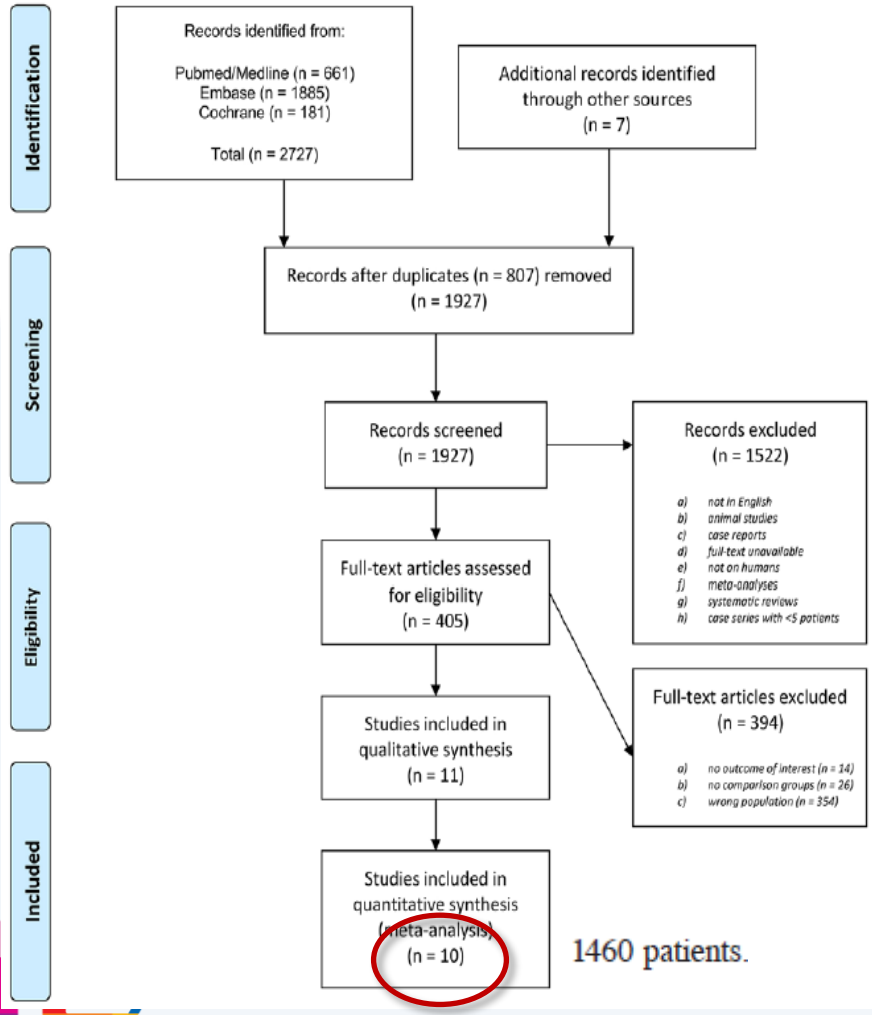


Time to first rehabilitation intervention (days), mean ± SD	2.05 ± 1.02	2.03 ± 0.88	0.927[a]
Time to first out-of-bed mobilization (days), mean ± SD	4.31 ± 1.25	12.98 ± 6.19	< 0.001[a]*

Yen HC et al. Critical Care.2024; 28:172.

Early versus delayed mobilization after aneurysmal subarachnoid hemorrhage: a systematic review and meta-analysis of efficacy and safety



- Early (within 7 days) vs late mobilization

- lack of high-quality studies,
- varying protocols,
- statistical heterogeneity,

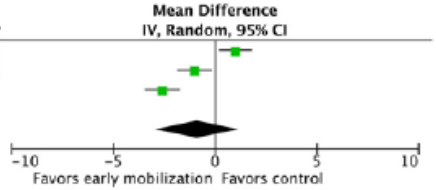
The level of evidence for recommendations regarding EM in patients with aSAH remains low.

Morello A et al. Neurosurg Focus.2023; 55(6):E11.

mRS at Discharge

Study or Subgroup	Early Mobilization Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year
Foudhaili et al. 2023 [27]	2	1.48	31	1	2.22	57	33.5%	1.00 [0.22, 1.78]	2023
Yokobatake et al. 2022 [24]	3	2.22	56	4	2.22	55	33.3%	-1.00 [-1.83, -0.17]	2022
Okamura et al. 2021 [23]	1.5	1.4	13	4.1	0.8	22	33.2%	-2.60 [-3.43, -1.77]	2021
Total (95% CI)			100			134	100.0%	-0.86 [-2.93, 1.20]	

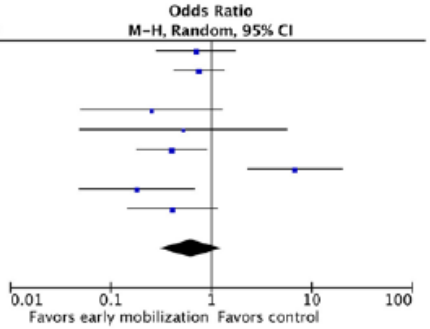
Heterogeneity: $Tau^2 = 3.16$; $Chi^2 = 38.85$, df = 2 ($P < 0.00001$); $I^2 = 95\%$
Test for overall effect: Z = 0.82 (P = 0.41)



Clinical Vasospasm

Study or Subgroup	Early Mobilization Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Foudhaili et al. 2023 [27]	11	31	25	57	14.5%	0.70 [0.29, 1.74]	2023
Takara et al. 2022 [26]	22	228	35	282	16.9%	0.75 [0.43, 1.33]	2022
Yang et al. 2022 [25]	0	34	0	34		Not estimable	2022
Yokobatake et al. 2022 [24]	2	56	7	55	9.4%	0.25 [0.05, 1.28]	2022
Okamura et al. 2021 [23]	1	13	3	22	6.0%	0.53 [0.05, 5.68]	2021
Karic et al. 2017 [22]	12	84	21	72	15.3%	0.40 [0.18, 0.90]	2017
Milovanovic et al. 2017 [21]	25	34	9	31	13.1%	6.79 [2.29, 20.14]	2016
Riordan et al. 2015 [19]	3	22	27	58	11.3%	0.18 [0.05, 0.68]	2015
Shimamura et al. 2014 [17]	8	25	23	43	13.5%	0.41 [0.15, 1.15]	2014
Total (95% CI)		527		654	100.0%	0.63 [0.31, 1.26]	
Total events	84		150				

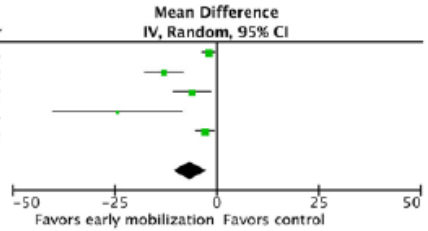
Heterogeneity: $Tau^2 = 0.67$; $Chi^2 = 25.21$, df = 7 ($P = 0.0007$); $I^2 = 72\%$
Test for overall effect: Z = 1.31 (P = 0.19)



Length of Stay (days)

Study or Subgroup	Early Mobilization Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year
Foudhaili et al. 2023 [27]	13	3.7	31	15	3.33	57	27.2%	-2.00 [-3.56, -0.44]	2023
Yokobatake et al. 2022 [24]	26	2.96	56	39	17.78	55	20.5%	-13.00 [-17.76, -8.24]	2022
Yang et al. 2022 [25]	19.8	8.1	34	25.9	11	34	20.9%	-6.10 [-10.69, -1.51]	2022
Okamura et al. 2021 [23]	25.7	3.7	13	50.1	37.5	22	5.4%	-24.40 [-40.20, -8.60]	2021
Olkowski et al. 2015 [18]	12.8	5.7	55	15.7	5.6	38	26.0%	-2.90 [-5.23, -0.57]	2015
Total (95% CI)			189			206	100.0%	-6.56 [-10.64, -2.47]	

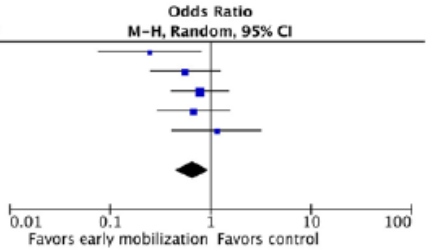
Heterogeneity: $Tau^2 = 15.33$; $Chi^2 = 26.98$, df = 4 ($P < 0.0001$); $I^2 = 85\%$
Test for overall effect: Z = 3.14 (P = 0.002)



Radiological Vasospasm

Study or Subgroup	Early Mobilization Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Yang et al. 2022 [25]	5	34	14	34	10.8%	0.25 [0.08, 0.79]	2022
Yokobatake et al. 2022 [24]	16	56	23	55	22.6%	0.56 [0.25, 1.23]	2022
Karic et al. 2017 [22]	50	84	47	72	31.9%	0.78 [0.41, 1.50]	2017
Olkowski et al. 2015 [18]	25	55	21	38	20.6%	0.67 [0.29, 1.55]	2015
Riordan et al. 2015 [19]	14	22	35	58	14.1%	1.15 [0.42, 3.18]	2015
Total (95% CI)		251		257	100.0%	0.65 [0.44, 0.97]	
Total events	110		140				

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 4.32$, df = 4 ($P = 0.36$); $I^2 = 7\%$
Test for overall effect: Z = 2.11 (P = 0.03)



Morello A et al. Neurosurg Focus.2023; 55(6):E11.

Early versus delayed mobilization after aneurysmal subarachnoid hemorrhage: a systematic review and meta-analysis of efficacy and safety

- No difference in neurological outcome and clinical vasospasm
- Decrease in radiological vasospasm and HLOS
- Trend towards decreased use of permanent CSF shunting and LD (but no effect on EVD devices used and hydrocephalus)
- No effect on 30-day mortality, rates of pneumonia and DVT

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*"The currently available data indicated that mobilization within the first 5 days after aneurysm repair was **feasible and safe** without significant excessive adverse events, that neurological outcome with EM was almost certainly not worse than with prolonged immobilization, and that there was likely at least some reduction in length of hospital stay."*

Morello A et al. Neurosurg Focus.2023; 55(6):E11.

Association Between Early Mobilization and Functional Outcomes in Patients with Aneurysmal Subarachnoid Hemorrhage: A Multicenter Retrospective Propensity Score-Matched Study

Table 2 Primary and secondary outcomes after propensity score matching

	Early mobilization group ($n = 122$)	Delayed mobilization group ($n = 122$)	*P* value	Risk difference (95% CI)
Primary outcome				
Favorable outcome (mRS score 0–2), *n* (%)	99 (81.1)	64 (52.5)	< 0.001	28.7 (17.4 to 39.9)
Secondary outcome				
Discharge to home, *n* (%)	95 (77.9)	55 (45.1)	< 0.001	32.8 (21.3 to 44.3)
Walking independence at discharge, *n* (%)	102 (83.6)	69 (56.6)	< 0.001	27.0 (16.1 to 38.0)
Length of hospital stay (days), median (IQR)	27.0 (21.0–35.0)	37.5 (27.3–52.0)	< 0.001	
Lower limb paralysis, *n* (%)	24 (19.7)	48 (39.3)	0.001	− 19.7 (− 30.8 to − 8.5)
Higher brain dysfunction, *n* (%)	47 (38.5)	67 (54.9)	0.015	− 16.4 (− 28.7 to − 4.0)
Complication, *n* (%)				
Symptomatic cerebral vasospasm	5 (4.1)	27 (22.1)	< 0.001	− 18.0 (− 26.2 to − 9.9)
Secondary hydrocephalus with shunt surgery	12 (9.8)	20 (16.4)	0.184	− 6.6 (− 15.0 to 1.9)
Deep venous thrombosis	2 (1.6)	4 (3.3)	0.684	− 1.6 (− 5.5 to 2.2)
Pneumonia	4 (3.3)	19 (15.6)	0.002	− 12.3 (− 19.5 to − 5.1)
Heart failure	1 (0.8)	9 (7.4)	0.019	− 6.6 (− 11.5 to − 1.7)
Symptomatic epilepsy	1 (0.8)	3 (2.5)	0.622	− 1.6 (− 4.8 to 1.5)
Meningitis	0 (0.0)	8 (6.6)	0.007	− 6.6 (− 10.9 to − 2.2)
Urinary tract infection	1 (0.8)	3 (2.5)	0.622	− 1.6 (− 4.8 to 1.5)

Takara H et al. Neurocrit Care.2024.

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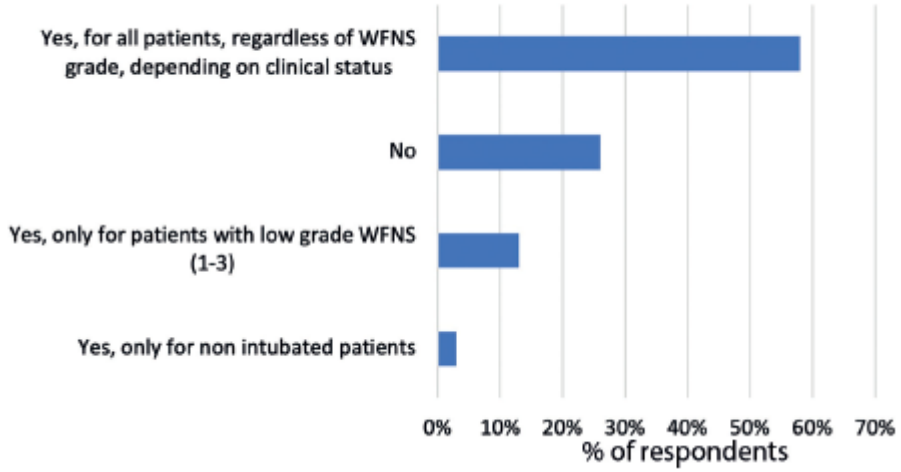
11 DAYS vs 17 DAYS

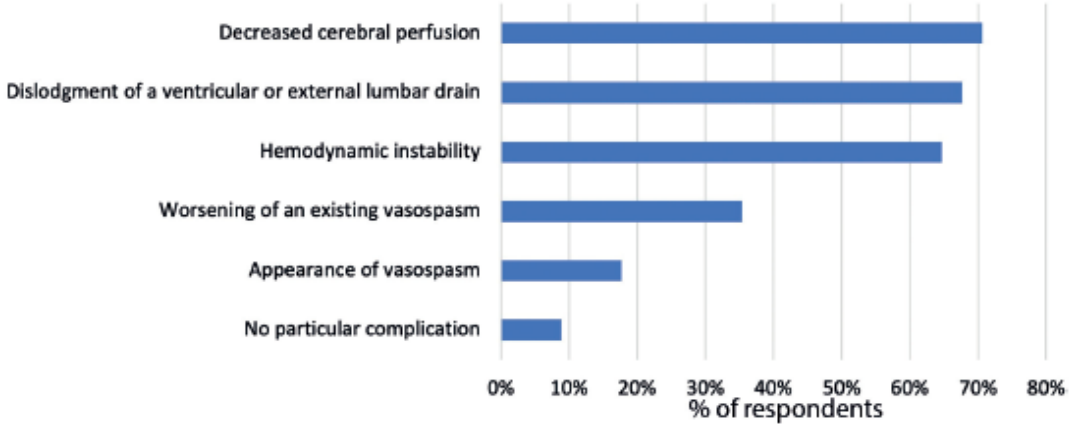
Takara H et al. Neurocrit Care.2024.

EARLY MOBILIZATION OF PATIENTS WITH SUBARACHNOID HAEMORRHAGE: A NATIONAL SURVEY OF FRENCH INTENSIVE CARE UNITS

Is sitting out of bed allowed within the first 5 days of securing the aneurysm ?



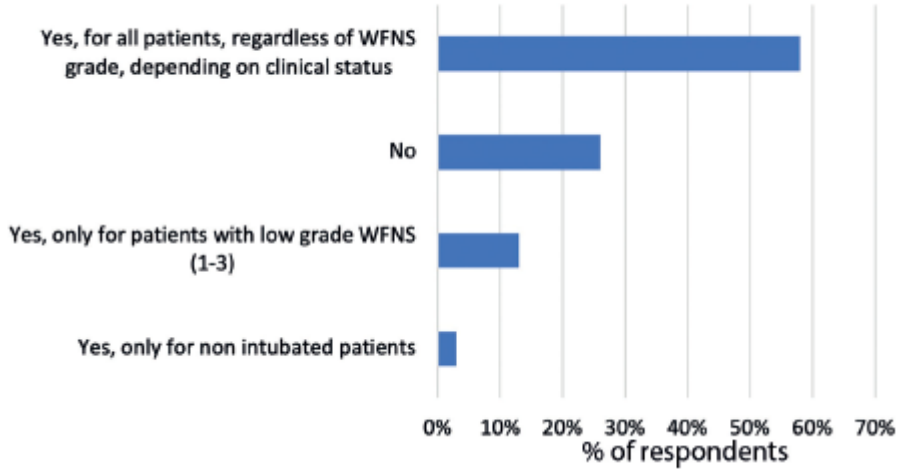
What complications do you think could be associated with the standing of patients admitted for SAH?



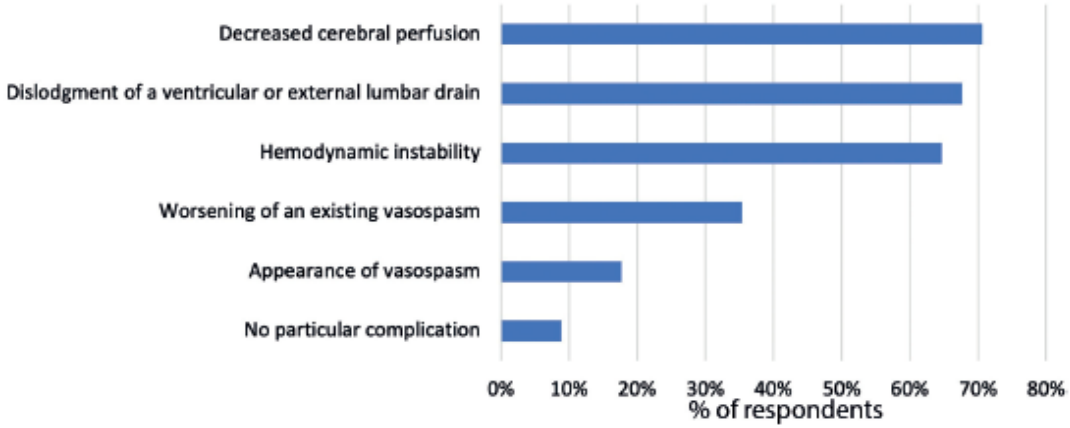
Foudhaili R et al. J Rehabil Med. 2024; 56: jrm17734

EARLY MOBILIZATION OF PATIENTS WITH SUBARACHNOID HAEMORRHAGE: A NATIONAL SURVEY OF FRENCH INTENSIVE CARE UNITS

Is sitting out of bed allowed within the first 5 days of securing the aneurysm ?



What complications do you think could be associated with the standing of patients admitted for SAH?

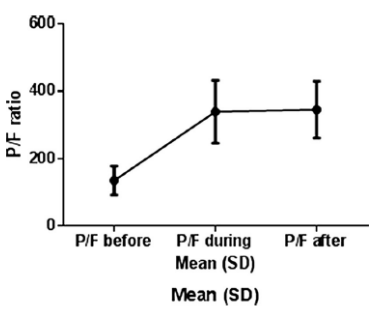


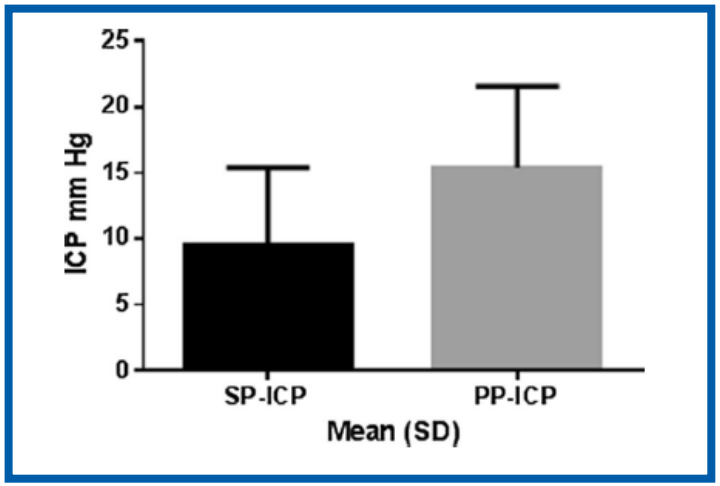
Conclusion: **Mobilization of patients with subarachnoid haemorrhage is heterogeneous among French neuro-intensive care units and several barriers preclude improvement of mobilization practices. Interventional studies assessing mobilization practices, as well as education and training of staff, are crucial to ensure the proper management of patients with subarachnoid haemorrhage and to improve outcomes.**

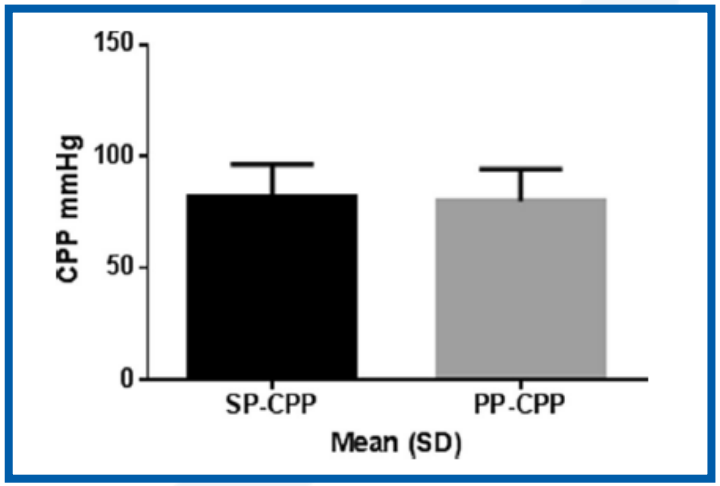
Foudhaili R et al. J Rehabil Med. 2024; 56: jrm17734

PRONE and ICP

Does Prone Positioning Increase Intracranial Pressure? A Retrospective Analysis of Patients with Acute Brain Injury and Acute Respiratory Failure







29 patients – 119 episodes of PP – Mean duration of PP: 2,5days
More ICP > 20 and more CPP < 70 durin PP

Roth C et al. Neurocrit Care.2014; 21:186–191

PRONE and ICP

Invasive Mechanical Ventilation in Traumatic Brain Injured Patients with Acute Respiratory Failure

Ventilatory Parameters and Strategies	Recommended Ventilatory Targets in Patients with TBI [2, 15]	Recommended Ventilatory Targets in Patients with ARDS [26]
Tidal volume	6-9 ml/kg IBW (strong recommendation)	4-8 ml/kg IBW (strong recommendation)
PEEP	Reasonable to set PEEP level monitoring ICP in order to avoid significant ICP increase due to PEEP	Higher rather than lower levels of PEEP are suggested in patients with moderate or severe ARDS (conditional recommendation)
Plateau Pressure	Plateau pressure <30 cm H_2O (strong recommendation)	Plateau pressure <30 cm H_2O (strong recommendation)
PaO_2	Normoxia: PaO_2 ranges from 80 to 120 mm Hg (strong recommendation)	PaO_2 55-88 mmHg accepted
$PaCO_2$	Normocapnia: $PaCO_2$ ranges from 35 to 45 mm Hg (strong recommendation)	Permissive hypercapnia accepted
Prone positioning	Reasonable to attempt in case of severe hypoxemia with strict neuromonitoring	Recommended when PaO_2/FiO_2 ratio <150 for more than 12 hours (strong recommendation)
Recruitment maneuvers	Reasonable to attempt in case of severe hypoxemia with strict neuromonitoring	RMs are suggested in patients with severe ARDS (conditional recommendation)
ECMO	Only in specific cases, such as rescue therapy when conventional treatment fails	Might be used as rescue therapy (additional evidence is necessary to make a definitive recommendation for or against the use of ECMO)

Racca F et al. Rev Recent Clin Trials. 2023;18(1):3-11.

Early Mobilization in the ICU

Variable	Exercise in Bed	Exercise Outside Bed
Other considerations		
Unstable major fractures		
Pelvic		
Spinal		
Lower limb long bone		
Large open surgical wounds		
Chest		
Abdomen		
Known uncontrolled active bleeding		

Red = significant risk of an adverse event.
Yellow = potential risk of adverse event, but benefits of EM may outweigh the risk.
Green = low risk of an adverse event.

Rawal D et al. Chest.2024; 2(1):100038

Assessing the safety of physical rehabilitation in critically ill patients: a Delphi study

Did an adverse event occur during or immediately after the mobilisation treatment (as per the definitions below)?		**Yes*: ☐**		**No: ☐**	
***If YES please: a) specify adverse event on questionnaire below; b) give a classification at the end:**					
Unsafe change in physiological observations where (one or more of the following occurred): • it **stopped** the mobilisation treatment • it did not resolve with **rest** • it caused **symptoms** (e.g. syncope (fainting) due to cardiovascular deterioration) and/or **haemodynamic instability** • it requires a new **treatment** or a substantial increase in existing treatment (e.g. unplanned increase in ventilator support) • it went above/below a pre-specified patient-specific **target range** for an adverse event					
Bradycardia	☐	Hypotension	☐	Tachypnoea	☐
Tachycardia	☐	Hypertension	☐	Bradypnoea	☐
Arterial oxygen desaturation, or arterial blood gases with hypoxia and/or hypercapnia					☐
Airway					
Any unplanned displacement, disruption or dysfunctioning of endotracheal tube or tracheostomy. If yes:					☐
• Airway was removed completely	☐	• Reintubation was required			☐
Cardiovascular					
Myocardial infarction/ischaemia	☐	Embolisation of a thrombosis (dislodging a blood clot)			☐
Any new arrhythmia (ignore arrhythmias that are not clinically concerning). If yes:					☐
• arrhythmia associated with symptoms and/or haemodynamic instability					☐
• arrhythmia does not resolve with rest	☐	• arrhythmia requires treatment			☐
Neurological					
Seizure	☐	Stroke	☐	Any other neurological deterioration	☐
If any of the above occurred, please specify if:					
• Neurological deterioration was persistent					☐
• Neurological deterioration requires imaging /treatment					☐
Any indwelling devices, lines, tubes or drains:					
• were disrupted or dysfunctioning	☐	• were removed completely			☐
Please specify which tubes, drains, lines (e.g. if attached to organ support):					
Falls and injuries					
Any fall (which also includes if fall was averted/ lessened by intervention of staff). If yes:					☐
• The fall caused physical injury	☐	• The fall caused psychological injury			☐
		• The fall required treatment			☐
Please specify the extent of the fall (e.g. fall to chair or the floor):					
Any injuries to patient e.g. changes to skin integrity, disruption to wounds/ dressings/surgical incisions. If yes:					☐
• Injury not recovered by 24 hours	☐	• Injury delays other treatment plan			☐
Staff injured related to patient mobilisation					☐
Other					
Death	☐	Cardiac and/or respiratory arrest			☐
Requires acute surgery as a result of mobilisation					☐
Any other patient deterioration thought to be related to mobilisation. If yes:					☐
• Mobilisation had to be stopped early due to an unsafe event					☐
• Adverse events that did not resolve with rest					☐
• Mobilisation leads to starting new organ support modalities					☐
Please specify:					
Adverse event classification					
a) Adverse event that stopped mobilisation					☐
b) Adverse event that did not cause mobilisation to stop, but lead to further consequences					☐
c) Adverse event with serious consequences (increased length of stay, surgery, death)					☐
NB if > 1 adverse event occurred, please specify classification (a, b or c) for each one below:					

Do you want to mobilise a patient out of bed receiving vasoactive drugs?

Principles

1. Assess risk using a stepwise approach: only progress mobilisation if vital signs remain stable.
2. Specific doses of vasoactive drugs to indicate when risk changes cannot be specified - dose should be taken within the context of individual patient risk factors.
3. The heart rate and blood pressure for different levels of risk will vary according to specific patient characteristics.
4. This tool is not designed for brain injured patients with specific haemodynamic targets.

Please consider:

Vasoactive drug specific	Cardiovascular	Other indicators
• Dose and recent change in dose • Number and particular types of vasoactive drugs. • Reason for use.	• Recent trends in heart rate and blood pressure. • Heart rhythm. • Signs of inadequate perfusion.	• Disease specific factors • Premorbid functional status • Degree of cooperativeness of patient

STOP: mobilisation is CONTRAINDICATED (IF YES, TURN OVER FOR MORE DETAILS)

• *Failure* to achieve satisfactory cardiovascular stability on any dose of vasoactive drugs?	• Pulmonary embolus? • Aortic dissection?	Other things to consider. Severe respiratory failure? Active cooling? Active bleeding? Unstable fractures or spinal injuries?

TALK TO THE LEAD/SENIOR CLINICIAN BEFORE MOBILISATION: Caution because mobilisation has become HIGHER risk (IF YES, TURN OVER FOR MORE DETAILS)

Vasoactive drug specific	Cardiovascular	Examples of other things to consider
• Two or more vasoactive drugs? • Medium dose of vasoactive drugs or above? • Any recent increase in dose? • Unsecure central venous access? • Vasoactive drugs used for patient pathology rather than counteracting other treatments such as an epidural?	• Cardiovascular instability? • Recent onset arrhythmia? • Hypovolaemia/inadequate perfusion? • Impaired cardiac output? • Percutaneous cardiopulmonary support (e.g. pacing)? • Myocardial ischemia/infarction?	• Staff inexperience? • Patient's first mobilisation treatment on a vasopressor? Previous adverse events during mobilization? • Acidosis? • Severe dyspnoea? Higher ventilation support? • Autonomic dysregulation? • Active organ ischemia? • ECMO / Intra-aortic balloon pump? • Inadequate analgesia? If mobilization has been specifically limited post-surgery (e.g. open abdomen) or because of injuries? • Reduced conscious level? There may be other things in your environment that will add to risk.

Guidance tool to aid risk assessment for mobilising patients out of bed receiving vasoactive drugs

Definitions:

- Mobilising out of bed: away from the support of the bed i.e. sitting on the edge of bed, moving from sitting to standing, transferring to a chair, marching on the spot and walking.
- Vasoactive drugs: Continuous infusions primarily used to support cardiac function e.g. to maintain cardiac output, organ perfusion and blood pressure, e.g. noradrenaline, adrenaline, dobutamine.
- For use with general ICU patients. This tool is not designed for brain injured patients with specific haemodynamic targets.

Overriding principles:

1. Risk should be assessed using a stepwise approach, with progression of mobilisation occurring if vital signs remain stable.
2. Specific cut off doses of vasoactive drugs for different levels of risk cannot be specified, since there are multiple issues that must be considered at the same time. The doses given here are guidance, are not absolute and dose should be taken in the context of individual patient risk factors.
3. Target ranges for heart and blood pressure for different levels of risk vary according to specific patient characteristics.

Types of indicators of risk to consider:

Vasoactive drug specific	Cardiovascular	Other indicators
• Dose and recent change in dose • Number and particular types of vasoactive drugs. • Reason for use.	• Recent trends in heart rate and blood pressure. • Heart rhythm. • Signs of inadequate perfusion (e.g. lactate, central venous oxygen saturation).	• Disease specific factors • Premorbid functional status • Degree of cooperativeness of patient

Indicators that mobilisation is CONTRAINDICATED

Vasoactive drug specific	Cardiovascular	Other indicators
• (Possible guidance dose, in the region of adrenaline/ epinephrine dose > 0.5 mcg/kg/min** required to maintain cardiovascular stability - *see principle 2 above.*)	• Failure to achieve satisfactory cardiovascular stability on any dose of vasoactive drugs • Submassive or massive pulmonary embolus. • Untreated acute aortic dissection	• Severe respiratory failure e.g. requiring deep sedation +/- paralysis and lung protective ventilation • Active cooling • Active bleeding • Unstable fractures or spinal injuries

Indicators that a patient has become HIGHER risk (More caution required, for instance by consulting with a lead/senior clinician or gaining specific sign off before mobilising.)

Vasoactive drug specific	Cardiovascular	Other indicators
• Two or more vasoactive drugs. • Medium dose of vasoactive drugs or above. (possible guidance doses, in the region of noradrenaline/norepinephrine or adrenaline/epinephrine dose > 0.2, dobutamine dose > 10 mcg/kg/min** - *see principle 2 above*) • Any recent increase in dose or dose needs to be increased during mobilisation. • Unsecure central venous access with possibility of occluding/disconnecting line during mobilisation. • Vasoactive drugs used for patient pathology (e.g. septic shock) rather than counteracting other treatments (e.g. epidural).	• Cardiovascular instability: o Difficulty in achieving targets (e.g. blood pressure below target range despite escalating support), o causing symptomatic changes, o during recent mobilisation/change in posture. • Recent onset arrhythmia with or without haemodynamic instability. • Signs of hypovolaemia/inadequate perfusion • Evidence of impaired cardiac output • Percutaneous cardiopulmonary support (e.g. pacing). • Any recent/current signs of myocardial ischemia/infarction*	These are examples rather than an exclusive list. There may be other specialist considerations in your environment that will add to risk. • Staff inexperience • Any first mobilisation treatment on a vasopressor. • Previous adverse events during mobilisation. • Acidosis • Severe dyspnoea. • Higher ventilation support e.g. high FiO2 and PEEP requirements. • Autonomic dysregulation. • Active organ ischemia that is new or acute (less than 6 hours) • ECMO / intra-aortic balloon pump*. • Inadequate analgesia. • Reduced conscious level. • If mobilisation has been specifically limited post-surgery (e.g. open abdomen) or because of injuries.

Woodbridge HR et al. Critical Care.2024; 28:144.

TAKE HOME MESSAGES

- EARLY MOBILIZATION IS FEASIBLE IN ICU PATIENTS, EVEN IN THE MOST EXTREME PATIENTS
- MONITORING IS PARAMOUNT
- MD, NURSES, PT, OT, …
  TO BE SAFE, WE NEED ENOUGH PEOPLE
- WE HAVE TO REMAIN CAUTIOUS WHEN ANALYZING THE LITTERATURE