Neurocritical Care Update

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Trial of Early Minimally Invasive Removal of Intracerebral Hemorrhage

G. Pradilla, J.J. Ratcliff, A.J. Hall, B.R. Saville, J.W. Allen, G. Paulon, A. McGlothlin, R.J. Lewis, M. Fitzgerald, A.F. Caveney, X.T. Li, M. Bain, J. Gomes, B. Jankowitz, G. Zenonos, B.J. Molyneaux, J. Davies, A. Siddiqui, M.R. Chicoine, S.G. Keyrouz, J.A. Grossberg, M.V. Shah, R. Singh, B.N. Bohnstedt, M. Frankel, D.W. Wright, and D.L. Barrow, for the ENRICH trial investigators*

Surgical management of ICH and code ICH has come of age

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cognitive Motor Dissociation in Disorders of Consciousness

Y.G. Bodien, J. Allanson, P. Cardone, A. Bonhomme, J. Carmona, C. Chatelle, S. Chennu, M. Conte, S. Dehaene, P. Finoia, G. Heinonen, J.E. Hersh, E. Kamau, P.K. Lawrence, V.C. Lupson, A. Meydan, B. Rohaut, W.R. Sanders, J.D. Sitt, A. Soddu, M. Valente, A. Velazquez, H.U. Voss, A. Vrosgou, J. Claassen, B.L. Edlow, J.J. Fins, O. Gosseries, S. Laureys, D. Menon, L. Naccache, A.M. Owen, J. Pickard, E.A. Stamatakis, A. Thibaut, J.D. Victor, J.T. Giacino, E. Bagiella, and N.D. Schiff

CMD more common than we thought

Circulation

Part 11: Post–Cardiac Arrest Care: 2025 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Karen G. Hirsch, MD, Chair; Edilberto Amorim, MD; Patrick J. Coppler, PA-C, MSPAS; Ian R. Drennan, ACP, PhD; Andrea Elliott, MD; Alexandra June Gordon, MD; Jacob C. Jentzer, MD, MS; Nicholas J. Johnson, MD; Ari Moskowitz, MD, MPH; Bryn E. Mumma, MD, MAS; Alexander M. Presciutti, PhD, MS; Amber J. Rodriguez, PhD; Albert F. Yen, MD; Jon C. Rittenberger, MD, MS, Vice Chair

ABSTRACT: Cardiac arrest is common and deadly, affecting up to 700 000 people in the United States annually. Advanced cardiac life support measures are commonly employed to improve outcomes. This 2025 guideline on adult post–cardiac arrest care from the American Heart Association summarizes the most recent published evidence for and recommendations on several important areas of post–cardiac arrest management. Based on structured evidence reviews, guidelines are provided for initial blood pressure, oxygen, ventilation, and glucose goals. Evidence evaluating the routine use of antibiotics after return of spontaneous circulation is reviewed. The update also reviews diagnostic testing modalities, temperature control goals and duration, and the use of percutaneous coronary intervention and mechanical circulatory support in the patient resuscitated from cardiac arrest. New data regarding the detection and management of seizures have been incorporated, along with updates regarding the timing and modalities used in neuroprognostication. These guidelines now differentiate prognostication for favorable versus unfavorable outcome. New sections on the utility of advanced neuromonitoring, along with definitions and treatment options for myoclonus, are included to guide the clinician. Expanded recommendations regarding how to optimize survivorship for patients, caregivers, and rescuers are reviewed. Finally, the potential role of organ donation in the patient resuscitated from cardiac arrest is reviewed.

Cardiac arrest care guidelines updated, what has changed

Why This Matters to Neurologists

- Early decisions shape outcomes
- Avoiding premature prognostication
- Neurology plays a central role even outside the ICU

Agenda

- MIS for ICH
- Post cardiac arrest care
- Disorders of Consciousness (DoC)
- Neurorecovery Clinic

No relevant disclosures

Polling Question

Which area feels most uncertain in your practice?

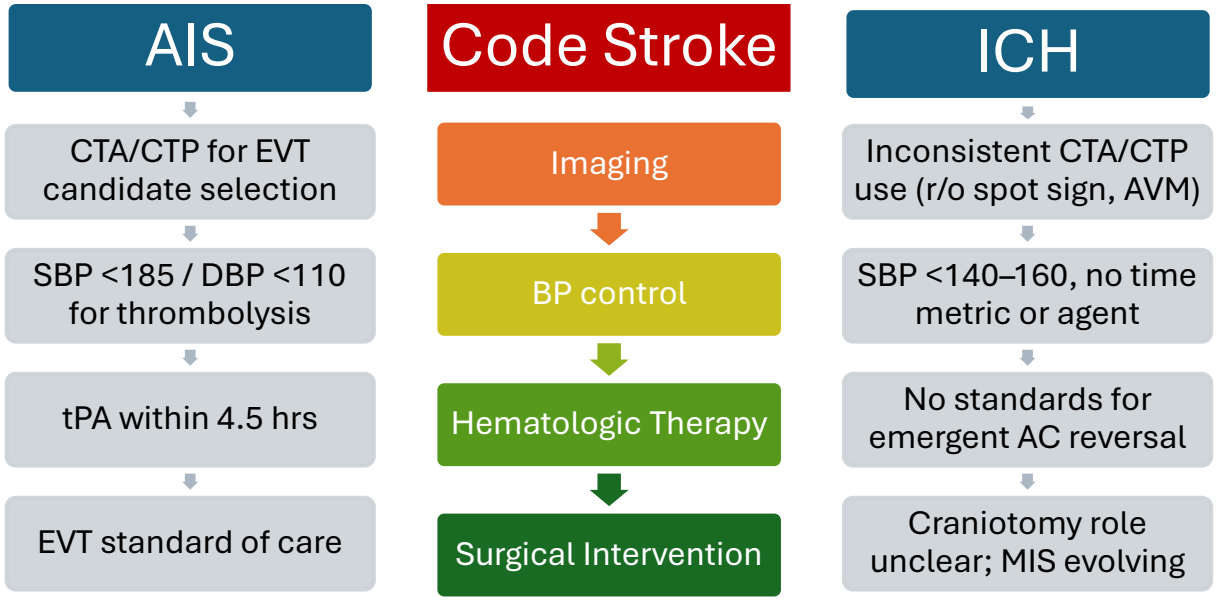
A. ICH surgical decision-making

B. Post–cardiac arrest prognosis

C. Disorders of consciousness

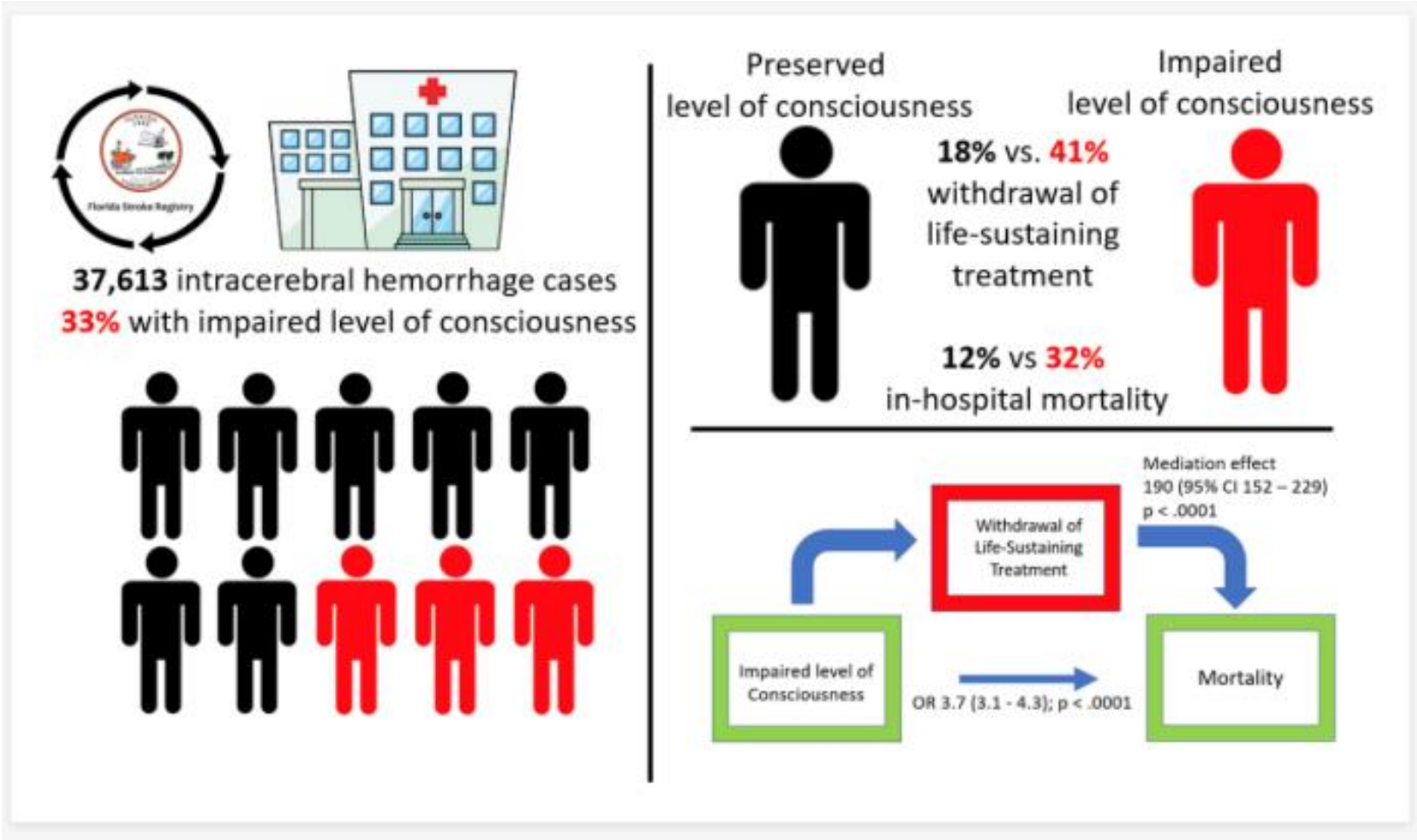
Code ICH: A Call to Action

- High early mortality 30-40%
- Outcome depends on systems of care
- Shift away from therapeutic nihilism



Li, Q, 2024
Ma, L 2204

Pessimism Contributes to Poor Outcome

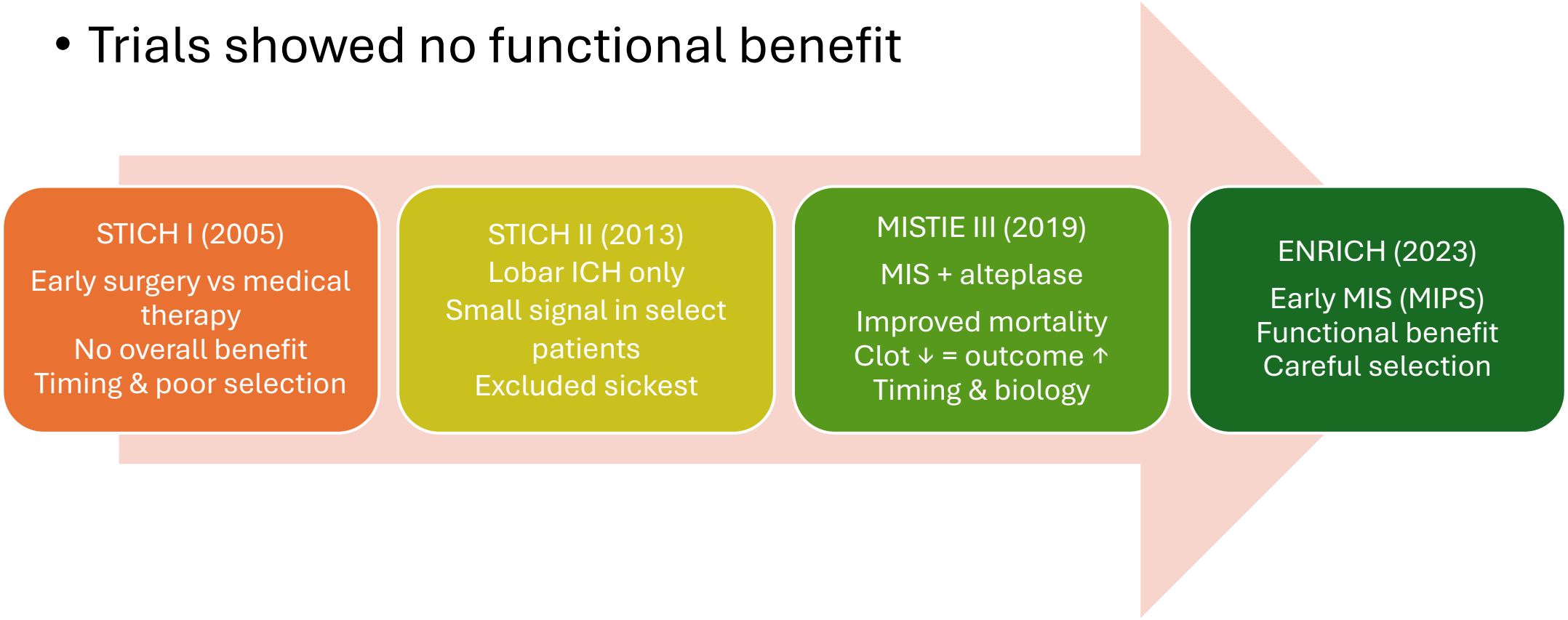


Florida Stroke Registry

Alkhachroum, A, 2019

Why Surgery Failed Historically

- Open craniotomy caused collateral injury
- Trials showed no functional benefit

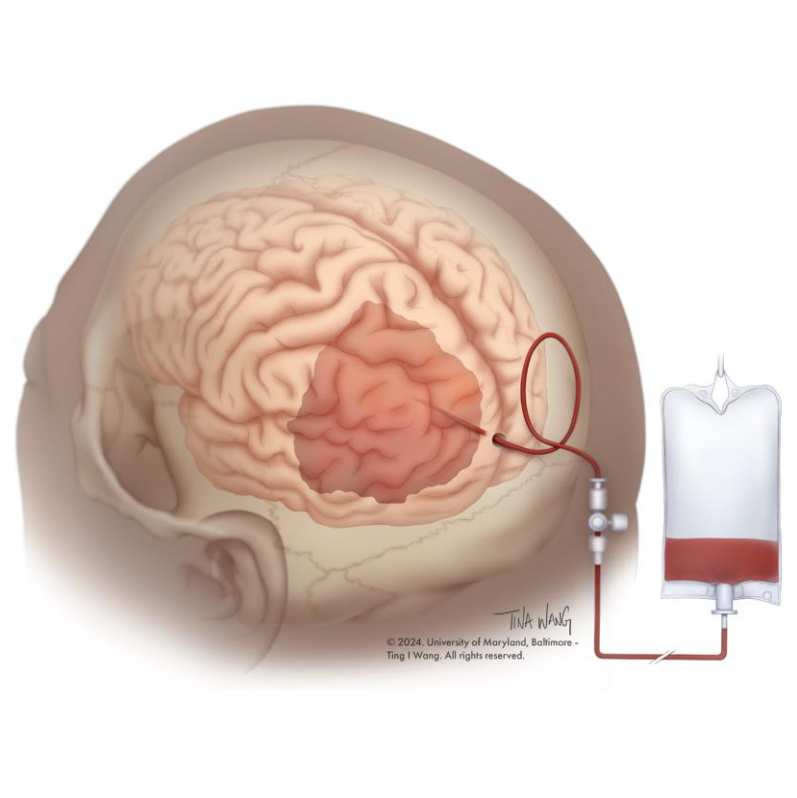


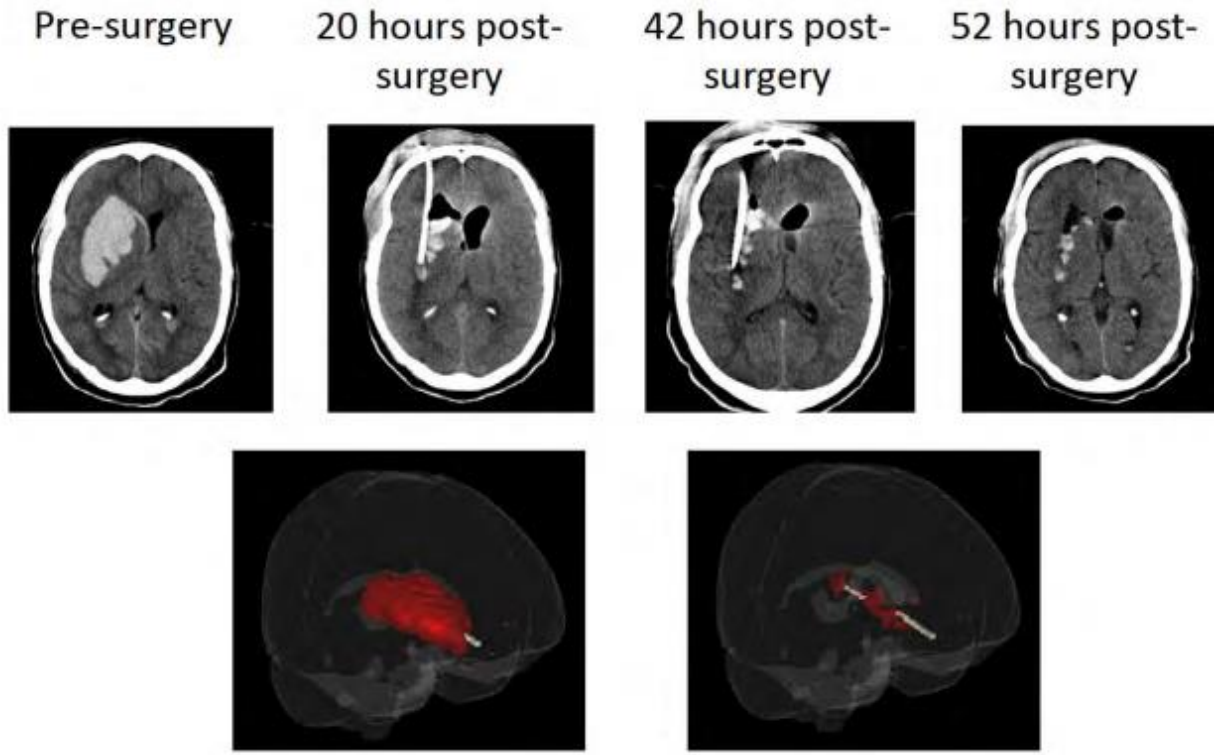
Morris NA; 2024

Minimally Invasive Surgery Comes of Age

MISTIE III

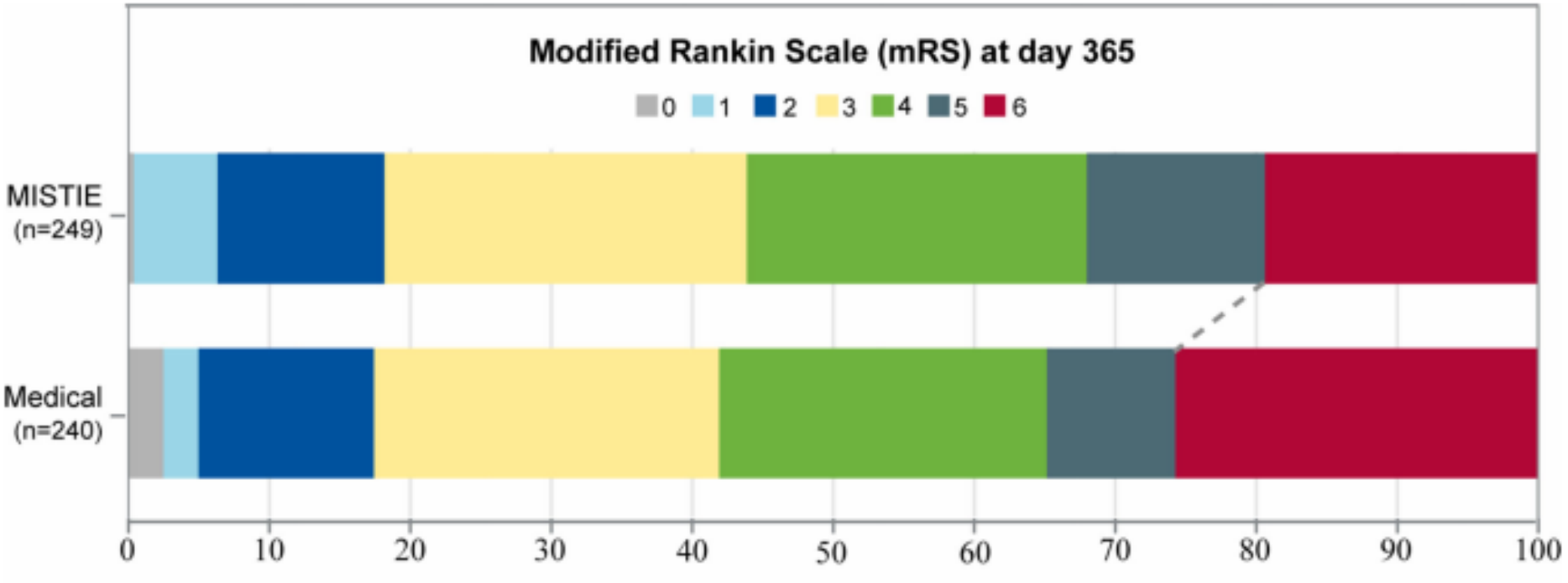
tPA facilitated drainage





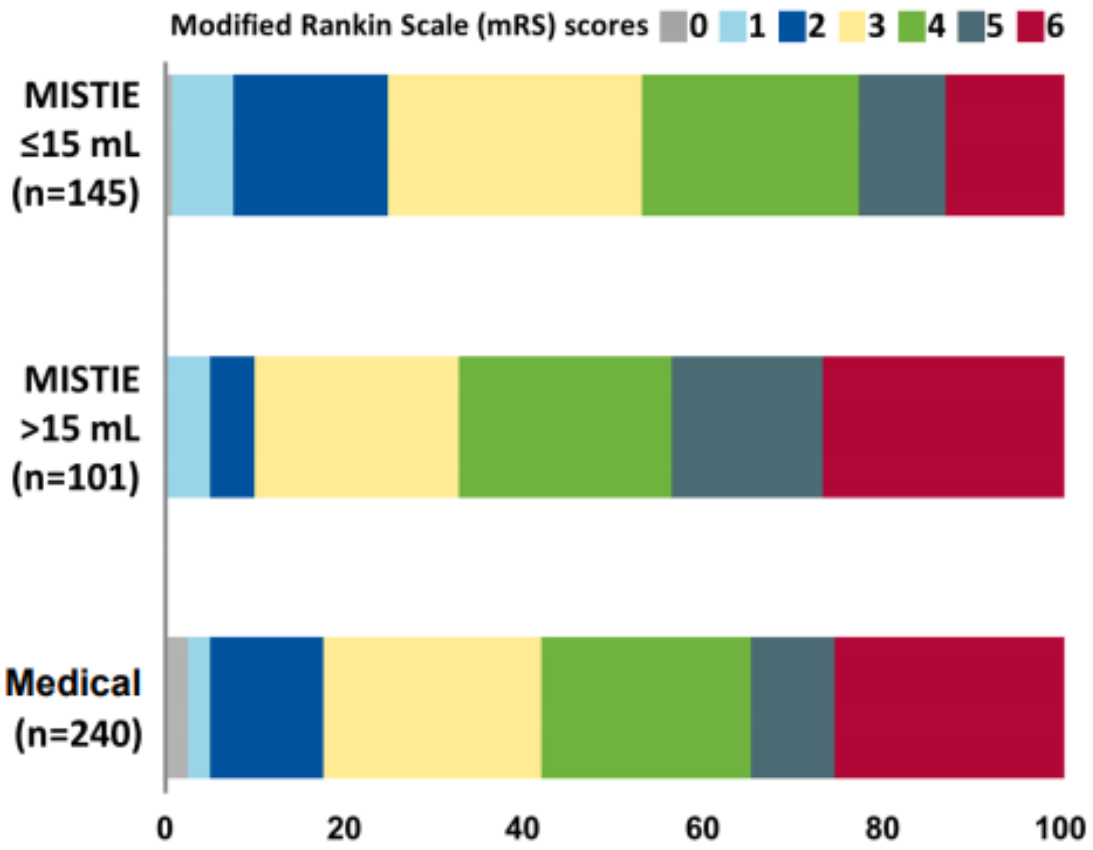
Morris NA; 2024
Hanley D, 2013

MISTIE-III



Hanley DF, 2019

MISTIE-III as-treated analysis



Hanley DF, 2019

ENRICH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RESEARCH SUMMARY

Trial of Early Minimally Invasive Removal of Intracerebral Hemorrhage

Pradilla G et al. DOI: 10.1056/NEJMoa2308440

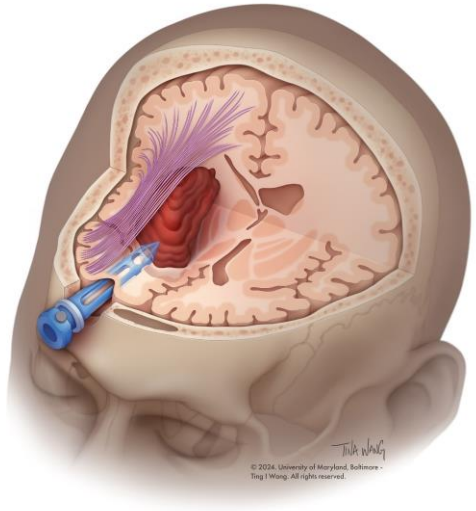
CLINICAL PROBLEM

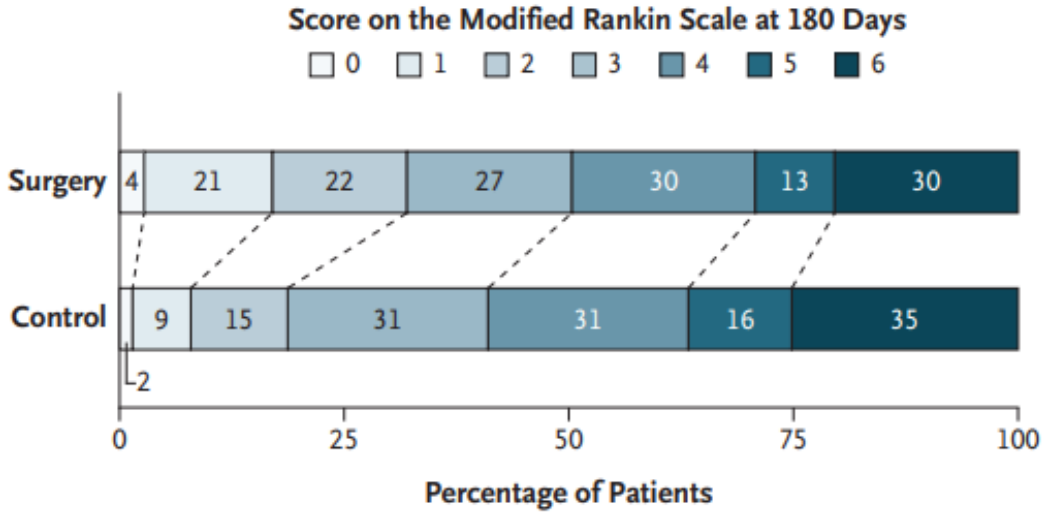
Current treatment guidelines for a spontaneous intracerebral hemorrhage (ICH) support surgical evacuation of the hematoma by means of conventional craniotomy only as lifesaving treatment, because randomized trials have not shown improvement in functional outcomes except in selected subgroups. Whether early minimally invasive surgical removal of the hematoma might improve functional outcomes is unknown.

- 30-80 mL
- GCS 5-14
- Excluded thalamic, infratentorial ICH
- Surgery within 24h

- Adaptive Trial Design
  - Stopped enrolling BG ICH after interim analysis
- Utility-weighted mRS (180 d)
- Achieved target < 15 mL in ~73%
- Median time to surgery 16.75 h

Minimally invasive trans-sulcal para fascicular surgery (MIPS)



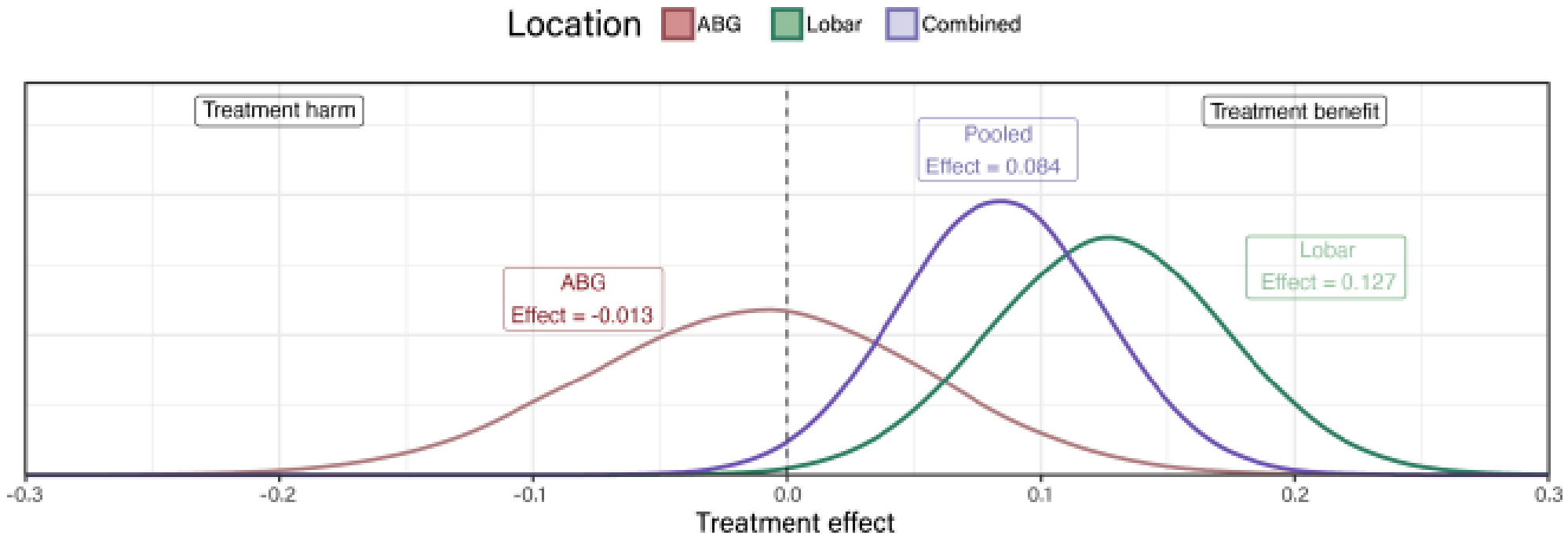


Pradilla, G 2024

ENRICH

50% vs 41% mRS 0-3 at 180d

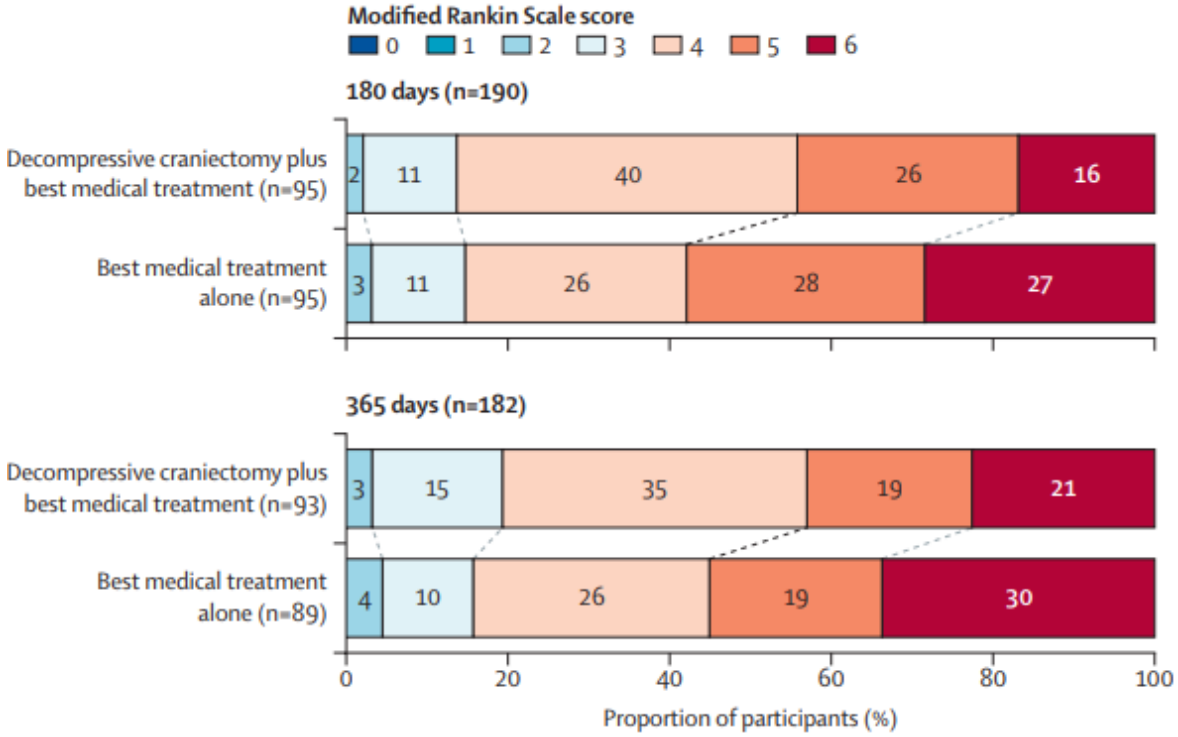
Fewer decompressive craniectomies, decreased ICU length of stay, hospital length of stay and 30-day mortality

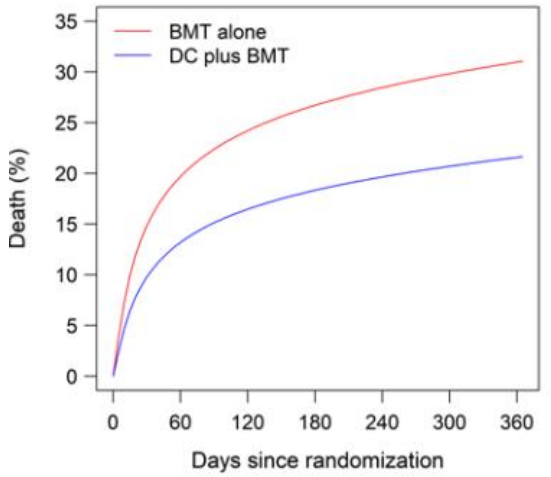


SWITCH

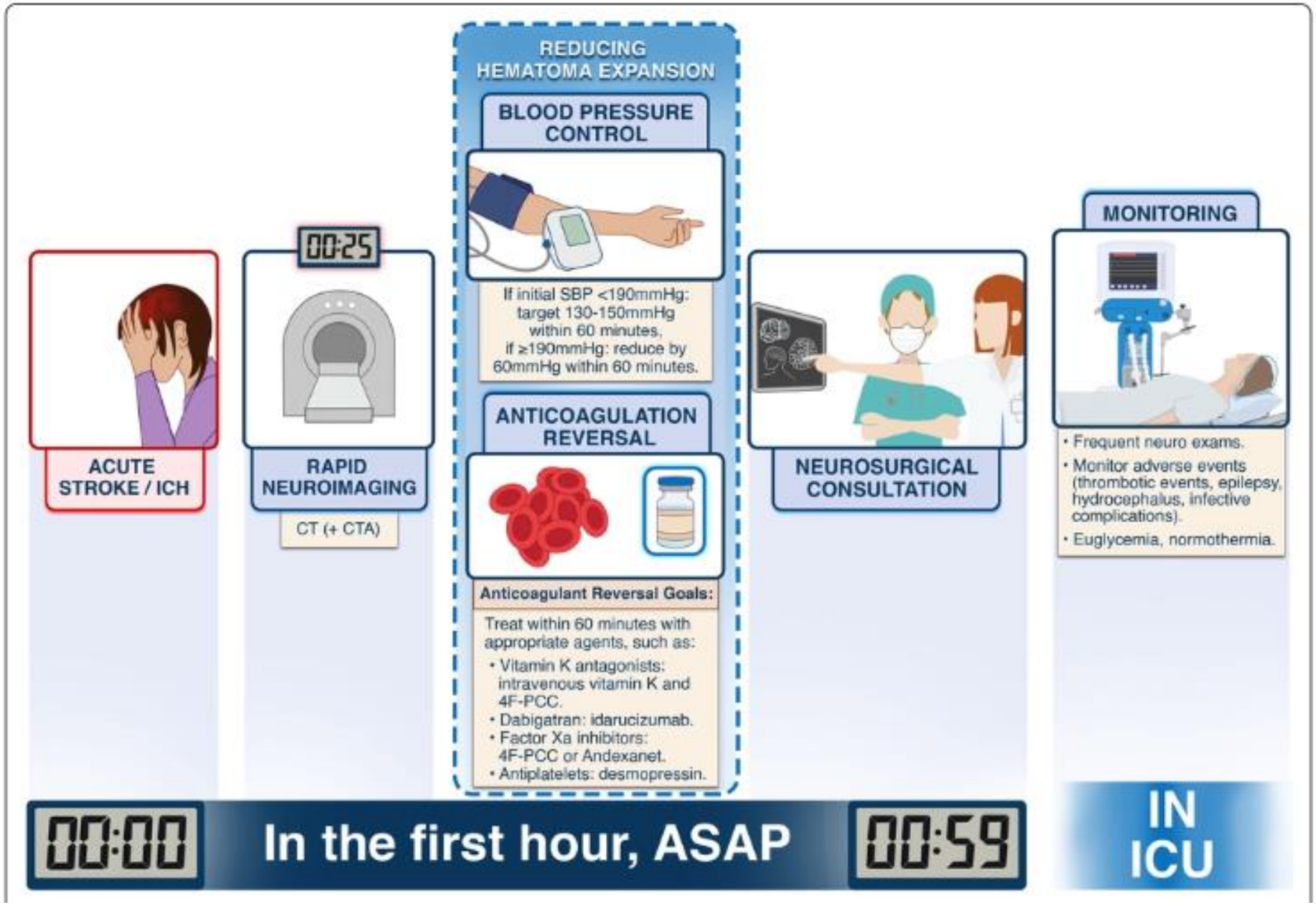
- Decompressive Craniectomy
- Deep, Severe ICH (30-100 mL)
- Surgery within 72 h
- Primary outcome mRS 5-6
- 2/3 planned enrollment (funding)

- 77% would have surgery again





Beck J, 2024



Hemphill, JC, 2024

Post–Cardiac Arrest Care: Beyond TTM → Bundles, Sedation, and Neurorecovery

2025 AHA Guidelines

Hirsch KG et al. 2025

Temperature Management

Recommendations for Temperature Control After Cardiac Arrest in Adults		
COR	**LOE**	**Recommendations**
1	**B-R**	1. A deliberate, protocolized strategy of temperature control is recommended for all adults who are unresponsive to verbal commands after ROSC, irrespective of arrest location or presenting rhythm.
1	**B-R**	2. Maintaining a temperature between 32 °C and 37.5 °C in patients unresponsive to verbal commands after ROSC is recommended for adults.
2a	**B-R**	3. It is reasonable that temperature control be maintained for at least 36 h in adult patients who remain unresponsive to verbal commands after ROSC.
2b	**B-R**	4. The benefit of strategies other than rapid infusion of cold intravenous fluids for prehospital cooling is unclear.
2b	**B-R**	5. It may be reasonable to avoid rapid (faster than 0.5 °C/h) rewarming in adult patients who have spontaneous hypothermia after ROSC or who are warming after hypothermic temperature control.
2b	**B-NR**	6. It is unclear if maintenance of a specific temperature (hypothermia versus normothermia) improves outcomes in subgroups of adult patients with higher illness severity.
3: No Benefit	**B-R**	7. Routine rapid infusion of intravenous fluids for prehospital hypothermic temperature control in adult patients after ROSC is not recommended.

Hirsch KG et al., 2025

Temperature control

- Actively prevent fever by targeting a temperature ≤37.5 °C for patients who remain comatose after ROSC from cardiac arrest.
- Comatose patients with mild hypothermia (32–36 °C) after ROSC should not be actively warmed to achieve normothermia.
- We recommend against the routine use of prehospital cooling with rapid infusion of large volumes of cold intravenous fluid immediately after ROSC.
- Use surface or endovascular temperature control techniques when temperature control is used in comatose patients after ROSC.
- When a cooling device is used, we suggest using a temperature control device that includes a feedback system based on continuous temperature monitoring to maintain the target temperature.
- Prevent active fever for 36 to 72 h in post-cardiac arrest patients who remain comatose.

Nolan JP et al., 2025

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Hypothermia vs. Normothermia after Out-of-Hospital Cardiac Arrest

OPEN-LABEL TRIAL WITH BLINDED OUTCOME ASSESSMENT

1850
Comatose adults after out-of-hospital cardiac arrest

	Hypothermia (target body temperature, 33°C) N=925	Normothermia (target body temperature, ≤37.5°C) N=925
Death from any cause at 6 mo	50%	48%
	RR, 1.04; 95% CI, 0.94 to 1.14; P=0.37	
Modified Rankin scale score ≥4 at 6 mo	55%	55%
	RR, 1.00; 95% CI, 0.92 to 1.09	
Arrhythmia with hemodynamic compromise	24%	17%

Hypothermia did not lead to a lower 6-mo incidence of death than normothermia.

J. Dankiewicz et al. 10.1056/NEJMoa2100591

RESUSCITATION 191 (2023) 109928

Available online at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Review

Temperature control after adult cardiac arrest: An updated systematic review and meta-analysis

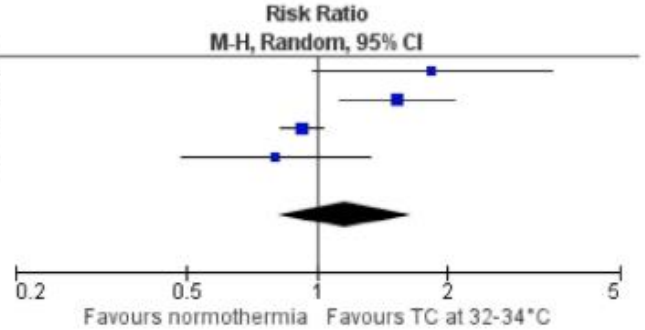
Asger Granfeldt[a,b,*,1], *Mathias J. Holmberg*[a,b,c,1], *Jerry P. Nolan*[d,e], *Jasmeet Soar*[f], *Lars W. Andersen*[a,b,g,h], *for the International Liaison Committee on Resuscitation ILCOR Advanced Life Support Task Force*[†]

Favorable neurological outcome at hospital discharge or 30 days

Study or Subgroup	TC at 32-34°C Events	Total	Normothermia Events	Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Bernard, 2002	21	43	9	34	16.7%	1.84 [0.97, 3.49]	2002
HACA, 2002	64	136	42	137	28.1%	1.54 [1.13, 2.09]	2002
Dankiewicz, 2021	332	899	356	890	34.3%	0.92 [0.82, 1.04]	2021
Wolfrum, 2022	22	120	27	118	20.9%	0.80 [0.48, 1.32]	2022
Total (95% CI)		**1198**		**1179**	**100.0%**	**1.16 [0.81, 1.66]**	
Total events	439		434				

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 13.46$, $df = 3$ ($P = 0.004$); $I^2 = 78\%$

Test for overall effect: $Z = 0.82$ ($P = 0.41$)



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RESEARCH SUMMARY

Duration of Device-Based Fever Prevention after Cardiac Arrest

Hassager C et al. DOI: 10.1056/NEJMoa2212528

CLINICAL PROBLEM

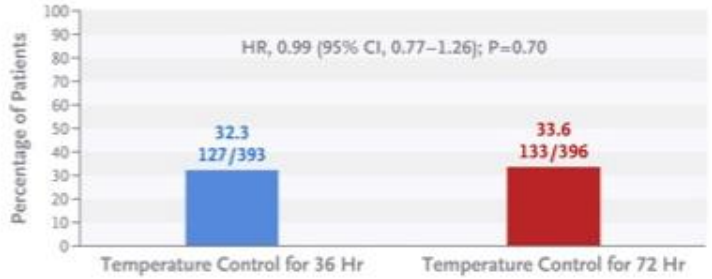
For patients who remain comatose after successful resuscitation from out-of-hospital cardiac arrest, current guidelines recommend active fever prevention for 72 hours. However, randomized trial data to support the duration of fever prevention after the first 24 hours are lacking.

Active Device-Based Fever Prevention Strategies

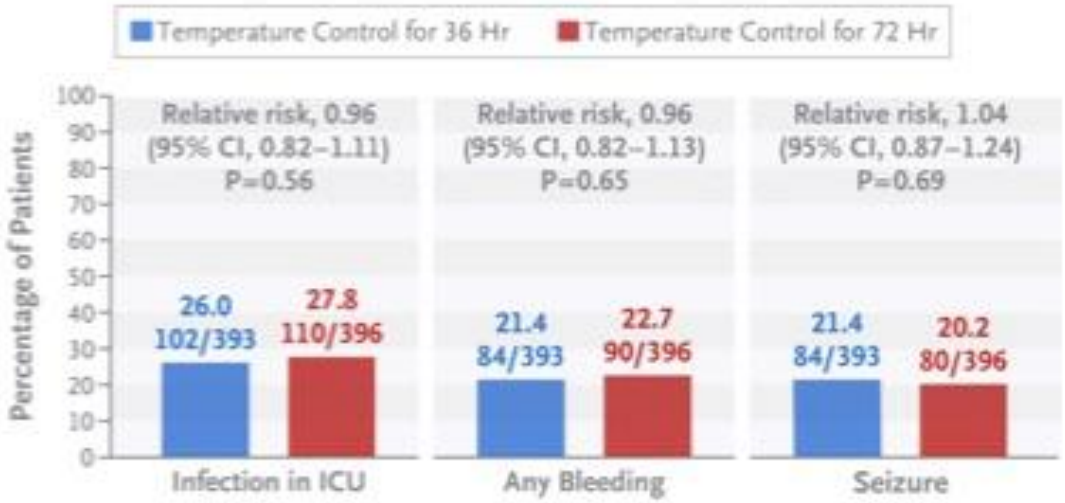
N=393	N=396	Target temperature
24 hr	24 hr	36°C
12 hr	48 hr	37°C
36 hr*	72 hr*	

*Or until return to consciousness

Death from Any Cause or Hospital Discharge with Severe Cerebral Disability or Coma



Adverse Events

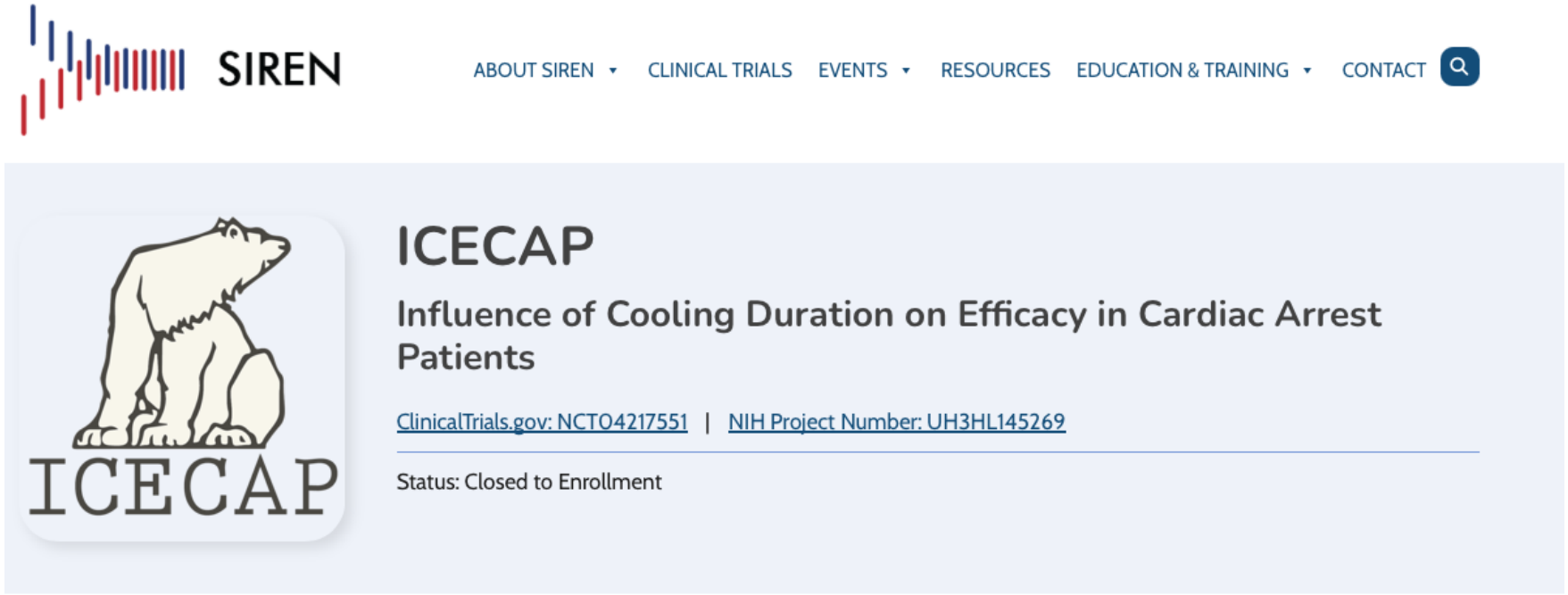


CONCLUSIONS

In comatose patients who were resuscitated after out-of-hospital cardiac arrest, the occurrence of death or severe cerebral disability or coma within 90 days was not significantly different after 36 hours or 72 hours of active device-based fever prevention.

36-72h

Temperature Management Duration



Post-ICECAP

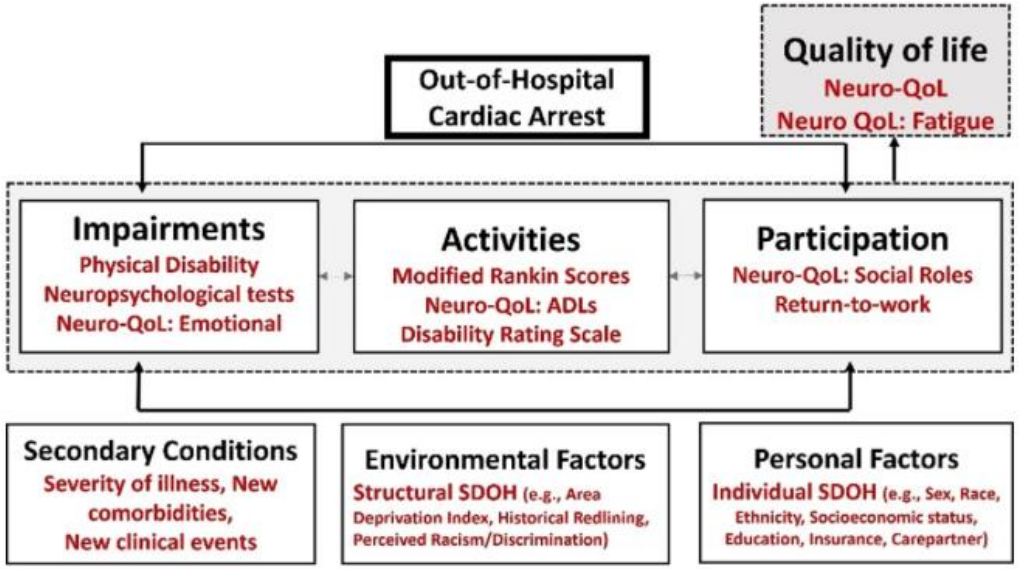
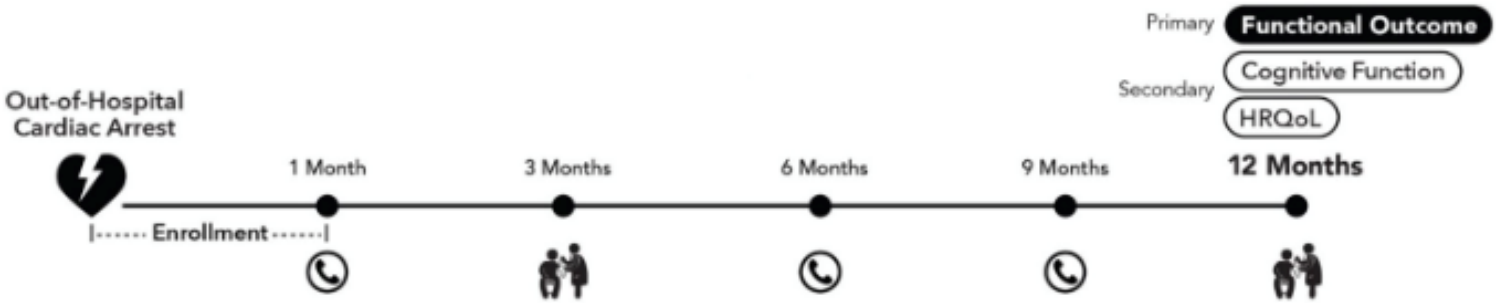


Figure 1. *Proposed OHCA Recovery Framework, an adaptation of the WHO-ICF model,[48] demonstrating 1) the three primary domains of recovery (impairments, activity or functional limitations, and HRQoL/participation restrictions), and 2) the influence of factors related to clinical course and individual and structural components of Social Determinants of Health (SDOH) on functional and cognitive recovery & HRQoL.*



Sachin Agarwal
https://siren.network/trial/post-icecap

Seizure Detection and Management

Recommendations for Diagnosis and Management of Seizure and Other Epileptiform Activity in Adults After Cardiac Arrest		
COR	**LOE**	**Recommendations**
1	**C-LD**	1. We recommend promptly performing and interpreting EEG for the diagnosis of seizures in adult patients who do not follow commands after ROSC.
1	**C-LD**	2. We recommend treatment of clinically apparent seizures in adult patients after ROSC.

Hirsch KG et al., 2025

JAMA Neurology | Original Investigation

Continuous vs Routine Electroencephalogram in Critically Ill Adults With Altered Consciousness and No Recent Seizure
A Multicenter Randomized Clinical Trial

Andrea O. Rossetti, MD; Kaspar Schindler, MD, PhD; Raoul Sutter, MD; Stephan Rüegg, MD; Frédéric Zubler, MD, PhD; Jan Novy, MD, PhD; Mauro Oddo, MD; Loane Warpelin-Decrausaz, PhD; Vincent Alvarez, MD

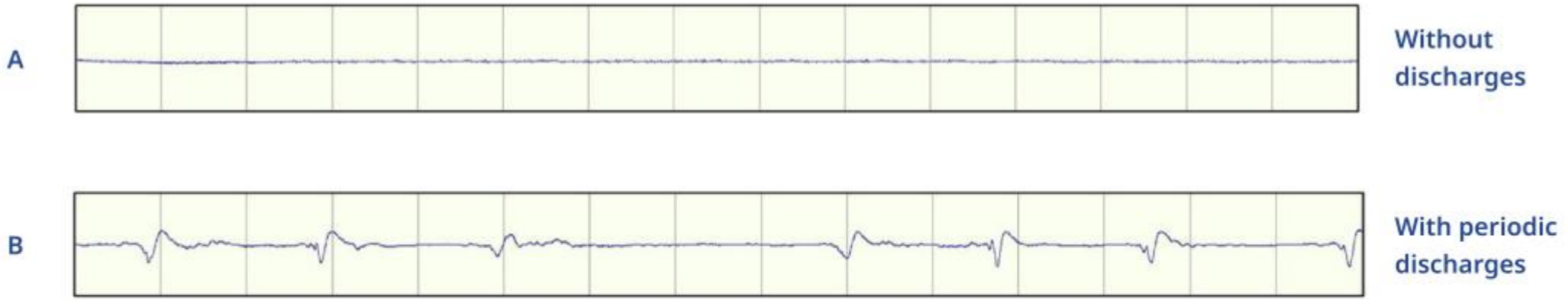
Outcome	rEEG (n = 182), No. (%)	cEEG (n = 182), No. (%)	Crude		Adjusted for CCI, cardiac arrest	
			Relative risk (95% CI)	*P* value	Relative risk (95% CI)	*P* value
Mortality at 6 mo, No. (%)	88 (48.4)	89 (48.9)	1.01 (0.82 to 1.25)	.92	1.02 (0.83 to 1.26)	.85
	Median (range)	Median (range)	Regression coefficient	*P* value	Regression coefficient	*P* value
Δ mRS at 6 mo, survivors	1 (−5 to 4)	1 (−3 to 5)	0.65 (0.13 to 1.16)	.01	0.63 (0.13 to 1.14)	.01
CPC at 6 mo, survivors	2 (1 to 4)	2 (1 to 4)	0.08 (−0.17 to 0.34)	.52	0.08 (−0.18 to 0.33)	.55

Outcome	No. (%)		Relative risk (95% CI)	*P* value
	rEEG (n = 183)	cEEG (n = 185)		
Features of ictal-interictal continuum detected, without seizures/SE	102 (55.7)	128 (69.2)	1.24 (1.06-1.46)	.009
Seizures/SE detected	8 (4.4)	29 (15.7)	3.59 (1.68-7.64)	.001
Changes in antiseizure drug prescription within 60 h following start of EEG intervention[b]	21 (11.5)	39 (21.1)	1.84 (1.12-3.00)	.01

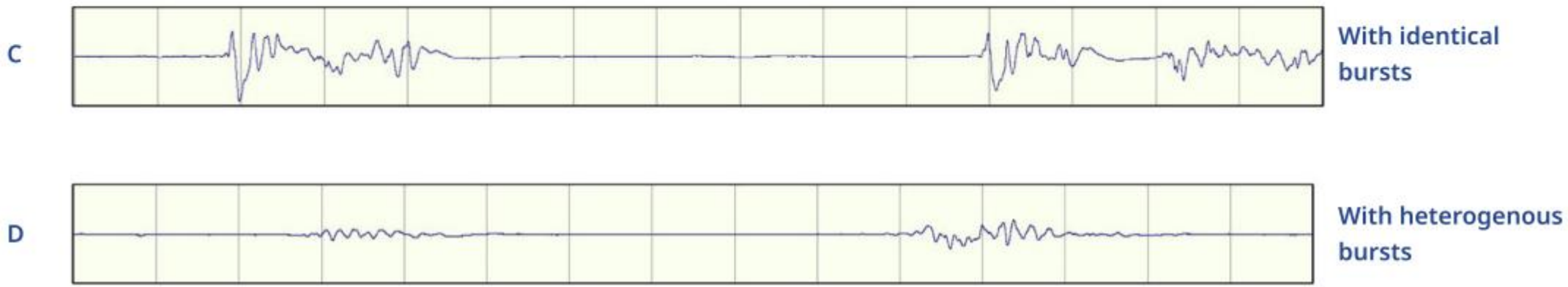
Rossetti et al., 2020

EEG Patterns

Suppression



Burst-suppression



Nolan JP et al., 2025

Seizure Detection and Management

2a	**B-R**	3. Treatment of nonconvulsive seizures (ie, diagnosed by EEG only) is reasonable in adult patients after ROSC.
2a	**C-LD**	4. Monitoring EEG repeatedly or continuously is reasonable for adult patients who do not follow commands after ROSC.
2b	**C-LD**	5. The same antiseizure medications used for treatment of seizures caused by other etiologies may be considered for seizures in adult patients after ROSC.
2b	**C-EO**	6. A therapeutic trial of a nonsedating antiseizure medication may be reasonable in adult patients who do not follow commands after ROSC with EEG patterns on the ictal-interictal continuum.
3: No Benefit	**B-R**	7. Routine seizure prophylaxis in adult patients who do not follow commands after ROSC is not recommended.
3: No Benefit	**C-LD**	2. Treatment to suppress myoclonus without an EEG correlate is not recommended in adult survivors of cardiac arrest.

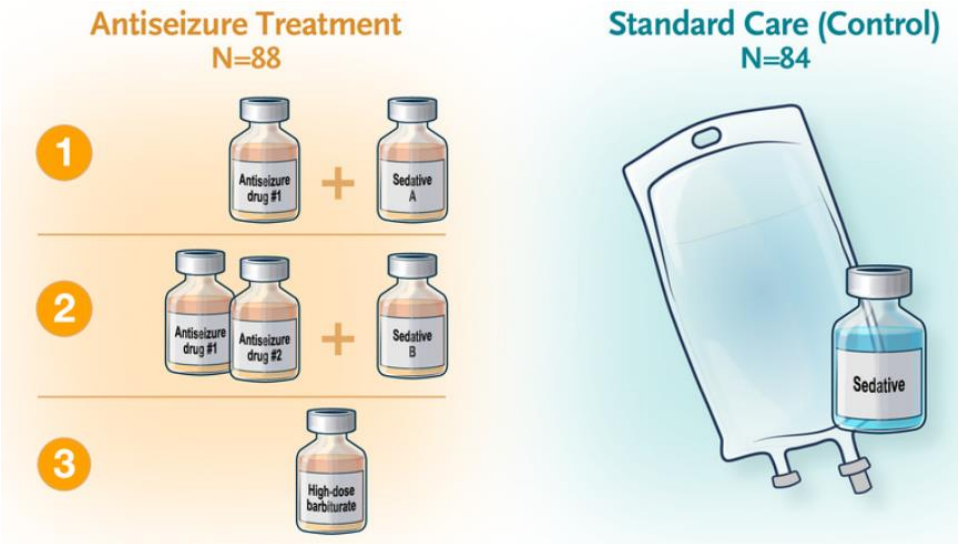
Hirsch KG et al., 2025

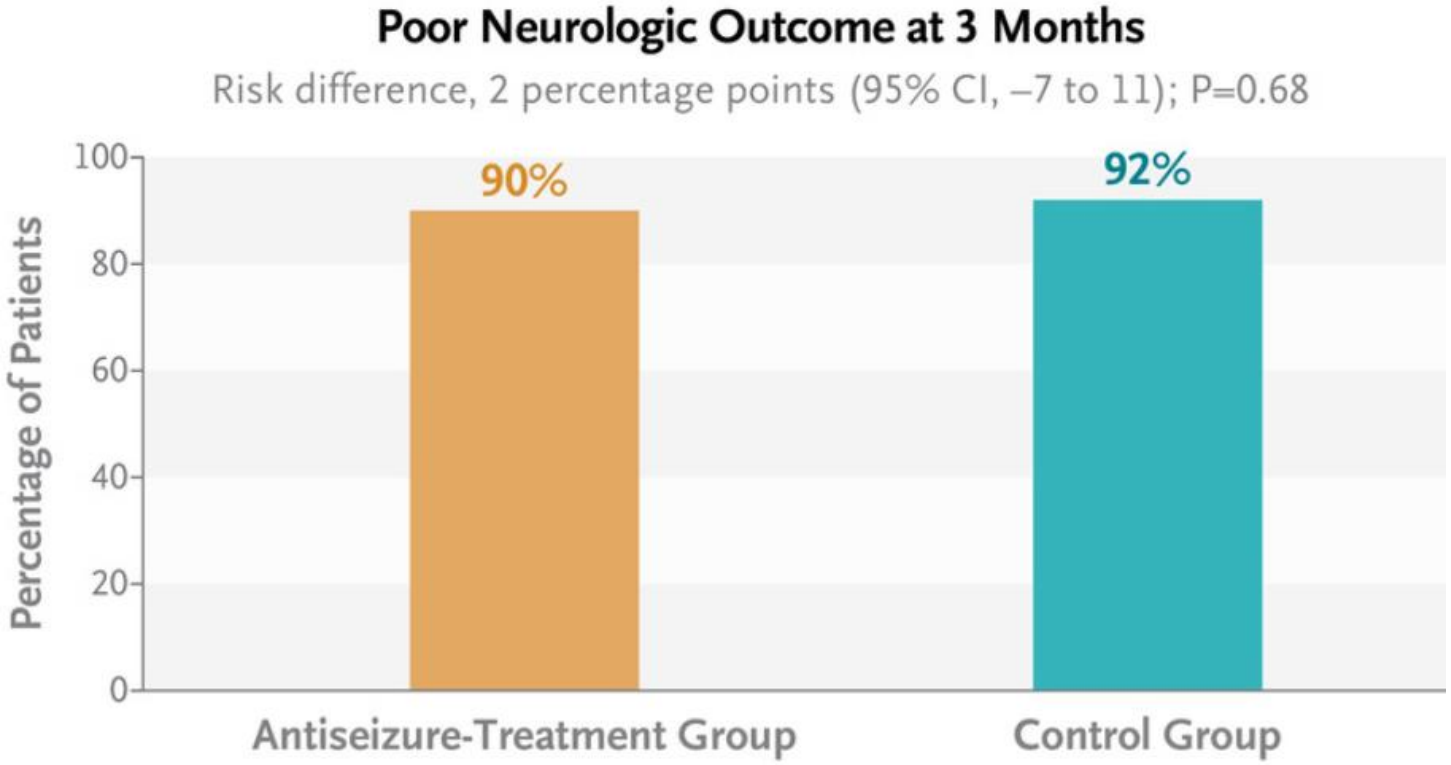
Myoclonus Nomenclature

Terminology	Definition	Note
Status myoclonus Clinical myoclonus without EEG evaluation	Repetitive myoclonic jerks that are diffuse or generalized, focal, or multifocal, occurring once every 10 s for at least 10 min or at least once every min for at least 30 min	Clinical diagnosis that is made without EEG evaluation Status myoclonus cannot be differentiated from myoclonic seizures without an EEG. This term is used only until the myoclonus is further characterized by EEG.
Electroclinical myoclonic seizure/ status epilepticus Cortical myoclonus Myoclonus with EEG correlate	Clinical manifestation of myoclonic jerks with a consistent and unequivocal EEG correlate that is not confounded by muscle artifact on EEG	No definite distinguishable features on clinical exam May require back averaging EEG-EMG for confirmation Distinct electroclinical phenotypes have been identified, which may carry different prognostic implications.
Subcortical myoclonus Myoclonus without EEG correlate	Clinical manifestation of myoclonic jerks without EEG correlate	No definite distinguishable features on clinical exam Ascertaining lack of EEG correlate can be challenging in clinical practice and may be aided by use of neuromuscular blockade.

Hirsch KG et al., 2025

TELSTAR

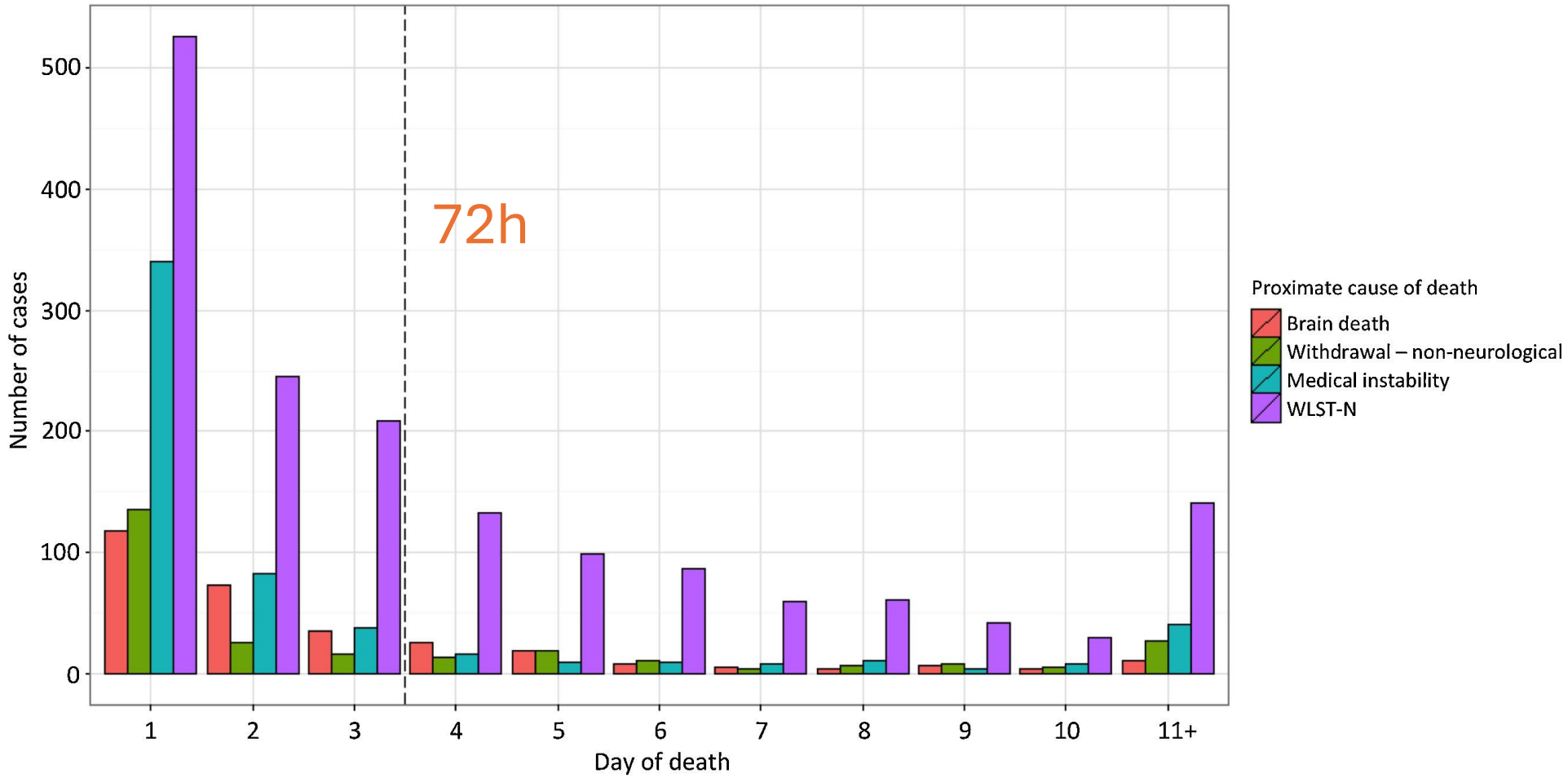




Subgroup	Control	Antiseizure Treatment	Difference (95% CI)
	no. of patients with good outcome/total no. (%)		*percentage points*
Overall	7/83 (8)	9/88 (10)	2 (–7 to 10)
Type of rhythmic and periodic activity			
GPDs, 0.5–2.5 Hz	7/67 (10)	3/68 (4)	–6 (–15 to 3)
Electrographic seizures, ≥2.5 Hz	0/8	2/9 (22)	22 (–5 to 49)
Evolving patterns, 0.5–2.5 Hz	0/3	1/2 (50)	50 (–19 to 119)
Other, 0.5–2.5 Hz	0/5	3/9 (33)	33 (2 to 64)

Ruijter BJ et al., 2022

Prognostic Pessimism in Cardiac Arrest



Elmer et al. Resuscitation 2016

‘Goals of Care’ Family Conferences

Riskiest of all ICU procedures!

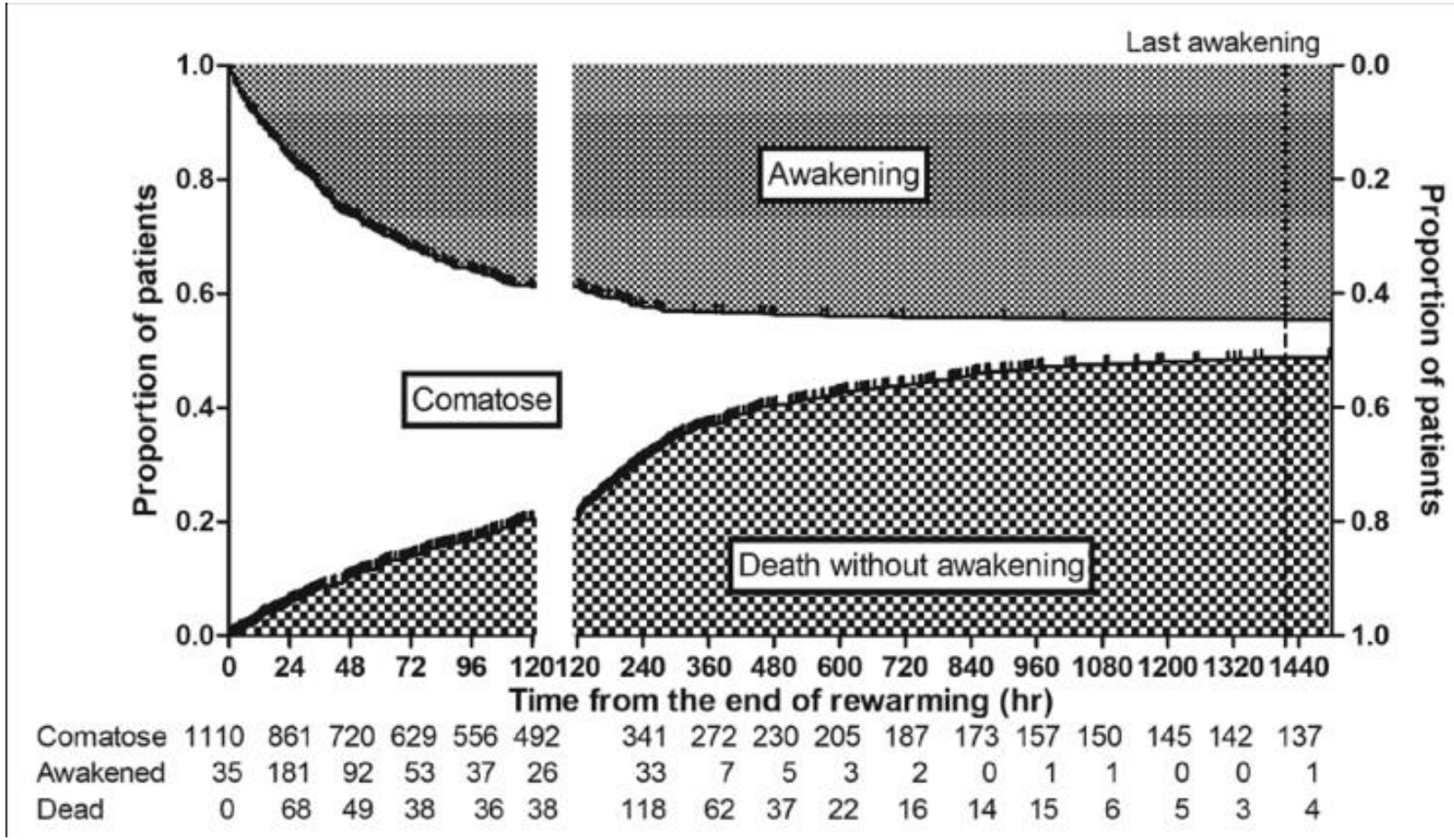
If overly pessimistic: A patient with recovery potential may have withdrawal of life-sustaining therapy in the ICU

If overly optimistic: A patient may end up in an unacceptable vegetative or minimally conscious state

Late Awakening is Common

Good Outcome: 90% for Early Awakening
67% for Late Awakening

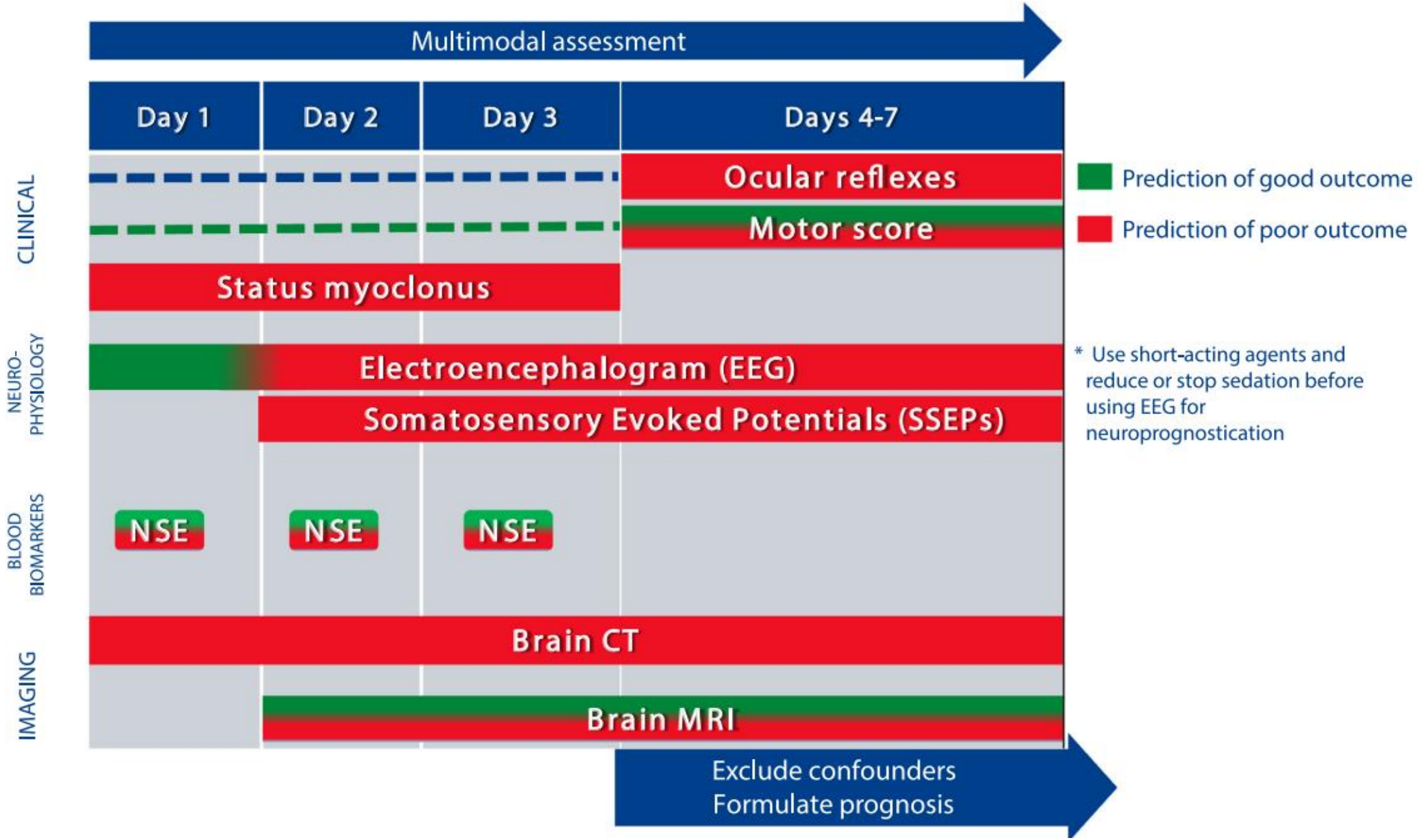
Variables	Adjusted OR (95% CIs)	*p*
Age, yr	0.977 (0.965–0.989)	< 0.001
Witnessed	1.753 (1.170–2.627)	0.006
Shockable rhythm	5.798 (3.860–8.709)	< 0.001
Cardiac etiology	2.283 (1.485–3.511)	< 0.001
Time to return of spontaneous circulation, min	0.942 (0.931–0.953)	< 0.001
Serum lactate level, mg/dL	0.926 (0.895–0.959)	< 0.001
Seizure	0.285 (0.191–0.426)	< 0.001
Sedatives		
Midazolam alone	Reference	
None	0.452 (0.245–0.835)	0.011
Midazolam with dexmedetomidine	5.640 (2.261–14.067)	< 0.001
Triple medication	5.183 (1.497–17.945)	0.009



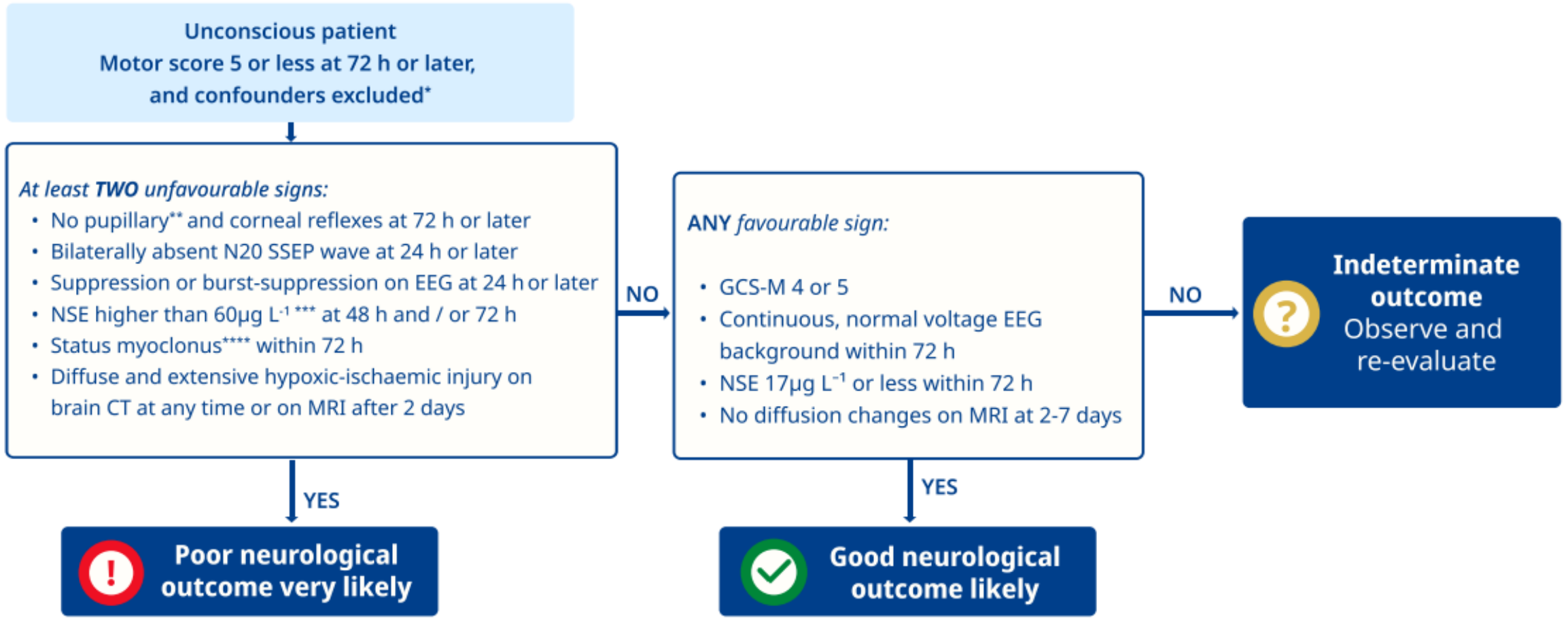
Lee DH et al, 2022

Neuroprognostic modality	Unfavorable outcome more likely	Favorable outcome more likely
Neuroimaging	• Reduced GWR on CT • Extensive areas of reduced ADC on MRI at 2-7 days after cardiac arrest • Extensive areas of restricted diffusion on MRI at 2-7 days after cardiac arrest	• Absence of restricted diffusion on MRI at 2-7 days after cardiac arrest
Neurophysiology	• Bilaterally absent N20 peaks on SSEP at 48 hours or more after cardiac arrest • Burst suppression at ≥72 hours after cardiac arrest in the absence of sedation • Status epilepticus ≥72 hours after cardiac arrest	• Continuous EEG background without discharges within 72 hours after cardiac arrest
Clinical examination	• Bilaterally absent pupillary light reflex at ≥72 hours after cardiac arrest • Bilaterally absent corneal reflexes at ≥72 hours after cardiac arrest • Decreased response on quantitative pupillometry at ≥72 hours after cardiac arrest	• Withdrawal or better motor response
Serum biomarkers	• High NSE within 72 hours after cardiac arrest • High NfL within 72 hours after cardiac arrest	• Normal NSE within 72 hours after cardiac arrest

Hirsch KG et al., 2025

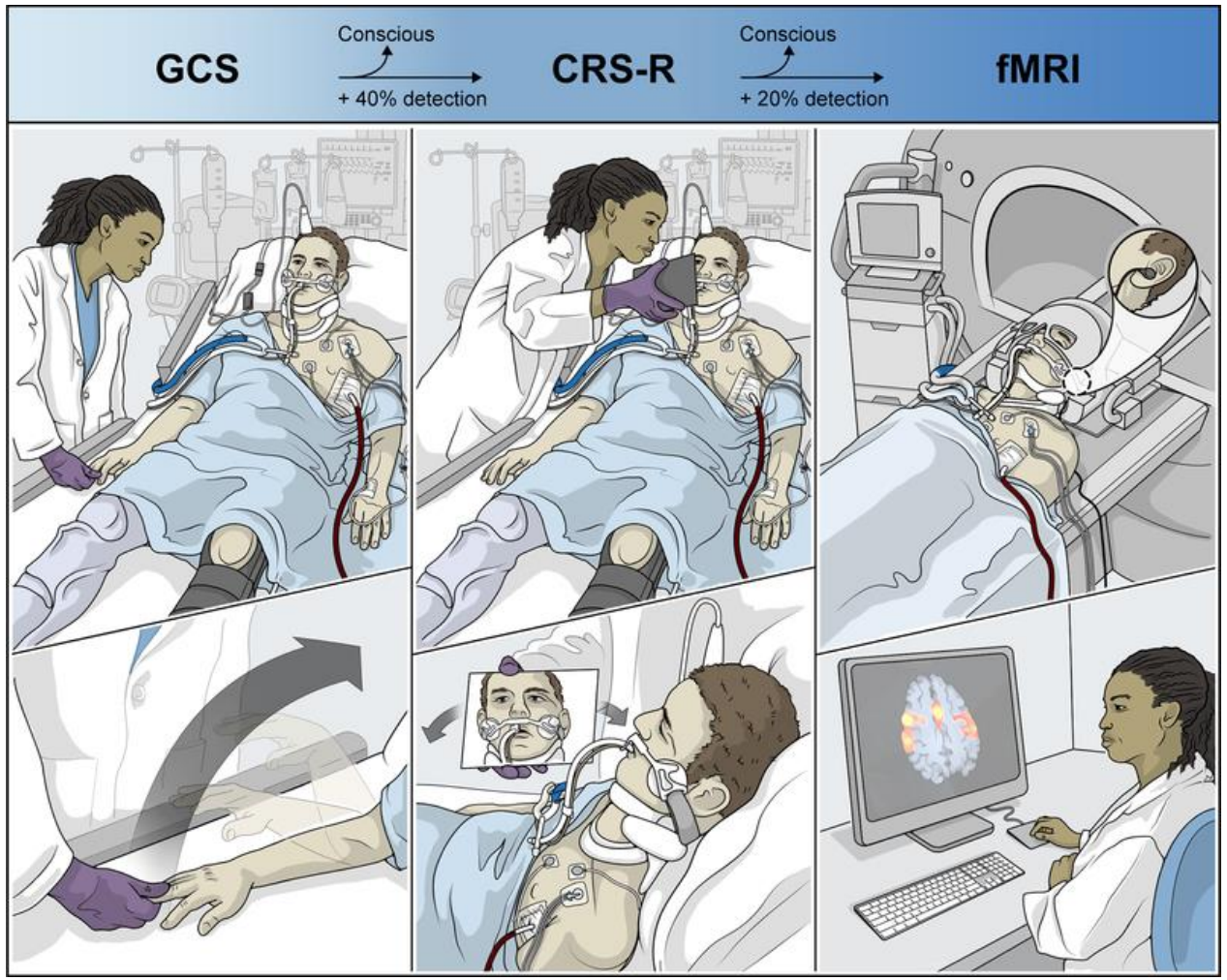


Nolan JP et al., 2025



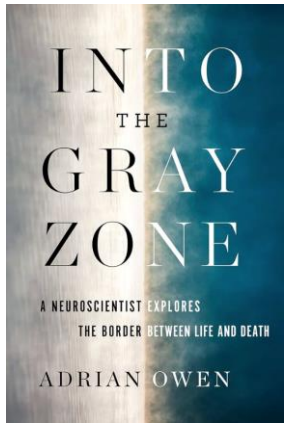
Nolan JP et al., 2025

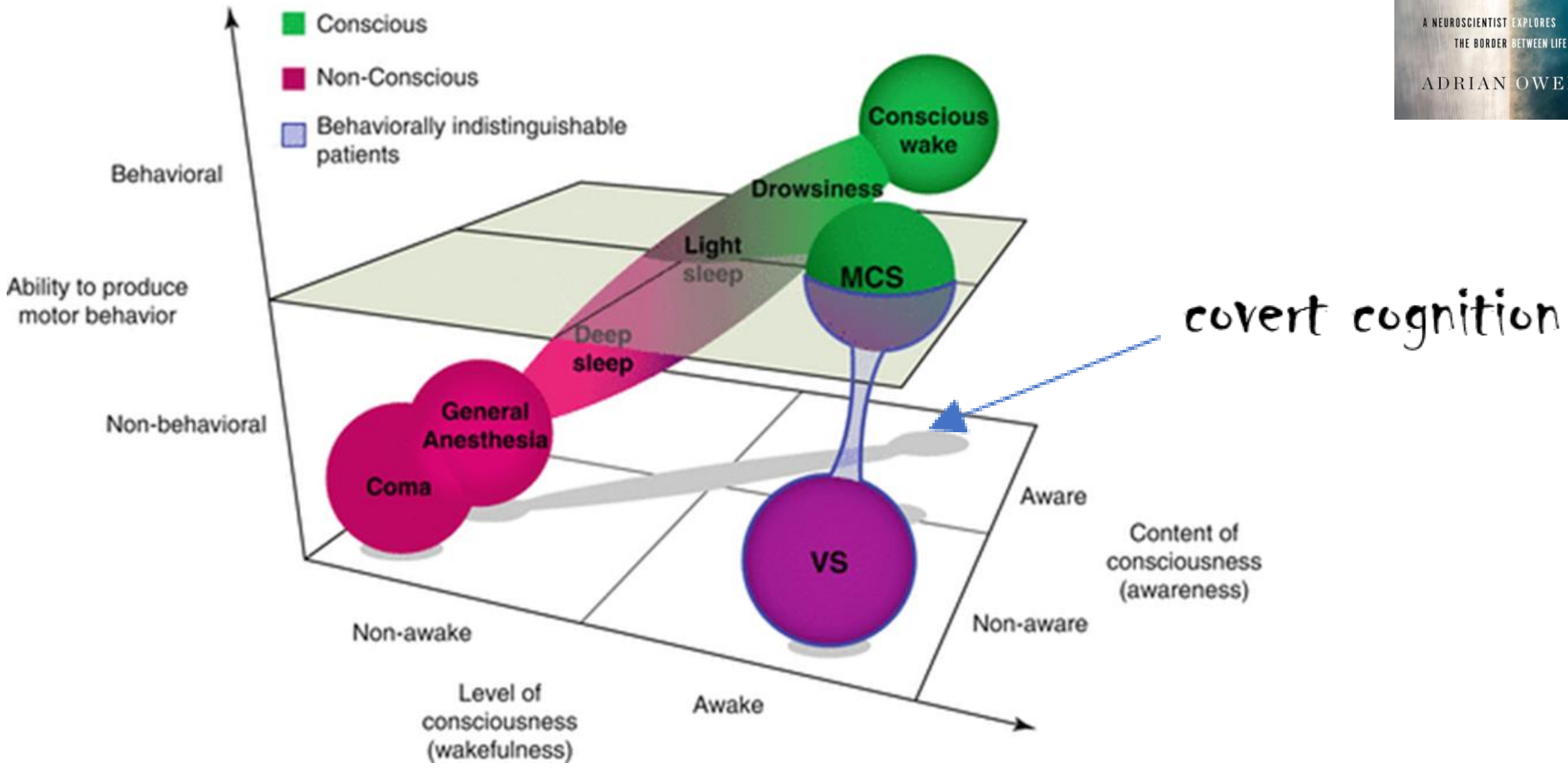
Assessing Consciousness in the ICU



Edlow and Fins. JHTR 2018

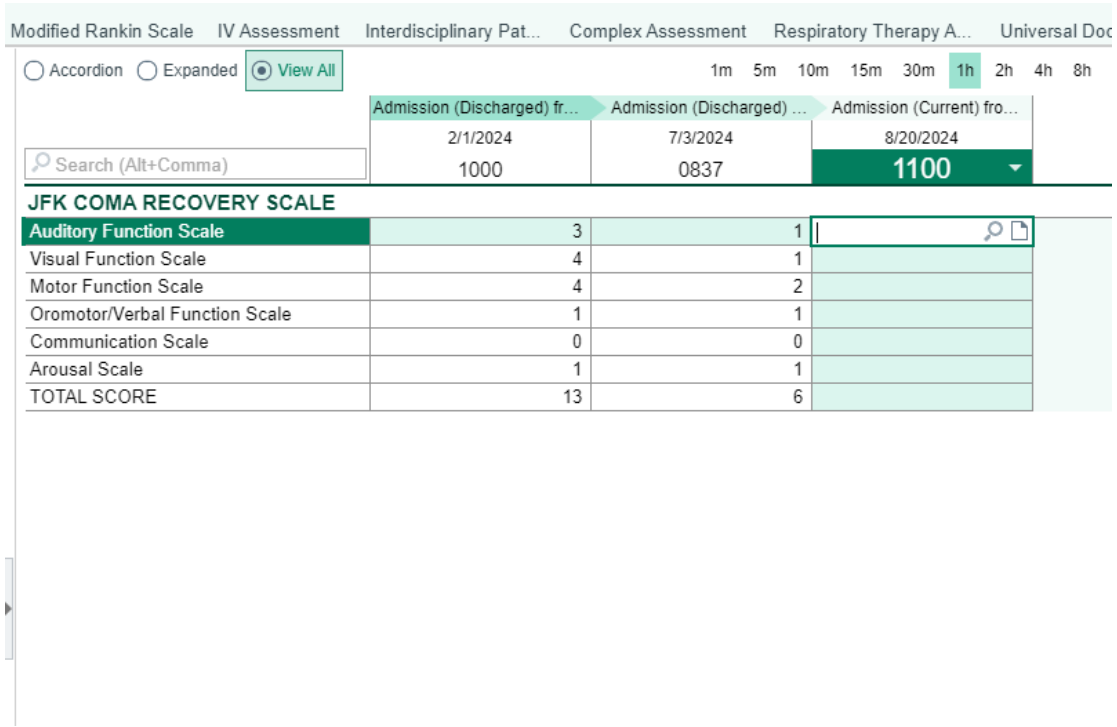
Consciousness





JFK-CRS-R

Standardized assessment outperforms unstructured, one-off bedside exam



Modified Rankin Scale | IV Assessment | Interdisciplinary Pat... | Complex Assessment | Respiratory Therapy A... | Universal Doc

Accordion | Expanded | View All

1m 5m 10m 15m 30m 1h 2h 4h 8h

Search (Alt+Comma)

JFK COMA RECOVERY SCALE	Admission (Discharged) fr... 2/1/2024 1000	Admission (Discharged) ... 7/3/2024 0837	Admission (Current) fro... 8/20/2024 1100
Auditory Function Scale	3	1	
Visual Function Scale	4	1	
Motor Function Scale	4	2	
Oromotor/Verbal Function Scale	1	1	
Communication Scale	0	0	
Arousal Scale	1	1	
TOTAL SCORE	13	6	

JFK COMA RECOVERY SCALE ©2004
Record Form

This form should only be used in association with the "CRS-R ADMINISTRATION AND SCORING GUIDELINES" which provide instructions for standardized administration of the scale.

Patient:	**Diagnosis:**
Date of onset:	**Date of Admission:**

Date										
Assessment	**1**		**2**		**3**		**4**		**5**	
AUDITORY FUNCTION SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
4 – Consistent Movement to Command▪										
3 – Reproducible Movement to Command▪										
2 – Localization to Sound										
1 – Auditory Startle										
0 – None										
VISUAL FUNCTION SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
5 – Object Recognition▪										
4 – Object localization: Reaching*										
3 – Visual Pursuit*										
2 – Fixation*										
1 – Visual Startle										
0 – None										
MOTOR FUNCTION SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
6 – Functional Object Use†										
5 – Automatic Motor Response*										
4 – Object Manipulation*										
3 – Localisation to Noxious Stimulation*										
2 – Flexion Withdrawal										
1 – Abnormal Posturing										
0 – None										
OROMOTOR/VERBAL FUNCTION SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
3 – Intelligible Verbalization▪										
2 – Vocalization/Oral Movement										
1 – Oral Reflexive Movement										
0 – None										
COMMUNICATION SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
2 – Functional: Accurate†										
1 – Non-functional: Intentional▪										
0 – None										
AROUSAL SCALE	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**	**#**	**TCC**
3 – Attention										
2 – Eye Opening w/o Stimulation										
1 – Eye Opening with Stimulation										
0 – Unarousable										
TOTAL SCORE										

* Denotes Minimally Conscious State Minus (MCS-)
▪ Denotes Minimally Conscious State Plus (MCS+)
† Denotes emergence from Minimally Conscious State (eMCS)
TCC Test Completion Code

Seel Arch Phys Med Rehabil 2010

Disorders of Consciousness : A New Era

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cognitive Motor Dissociation in Disorders of Consciousness

Y.G. Bodien, J. Allanson, P. Cardone, A. Bonhomme, J. Carmona, C. Chatelle, S. Chennu, M. Conte, S. Dehaene, P. Finoia, G. Heinonen, J.E. Hersh, E. Kamau, P.K. Lawrence, V.C. Lupson, A. Meydan, B. Rohaut, W.R. Sanders, J.D. Sitt, A. Soddu, M. Valente, A. Velazquez, H.U. Voss, A. Vrosgou, J. Claassen, B.L. Edlow, J.J. Fins, O. Gosseries, S. Laureys, D. Menon, L. Naccache, A.M. Owen, J. Pickard, E.A. Stamatakis, A. Thibaut, J.D. Victor, J.T. Giacino, E. Bagiella, and N.D. Schiff

CONCLUSIONS

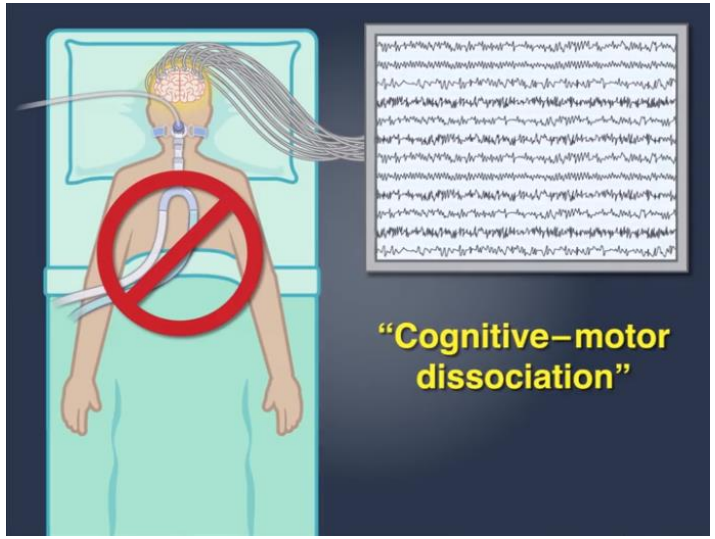
Approximately one in four participants without an observable response to commands performed a cognitive task on fMRI or EEG as compared with one in three participants with an observable response to commands. (Funded by the James S. McDonnell Foundation and others.)

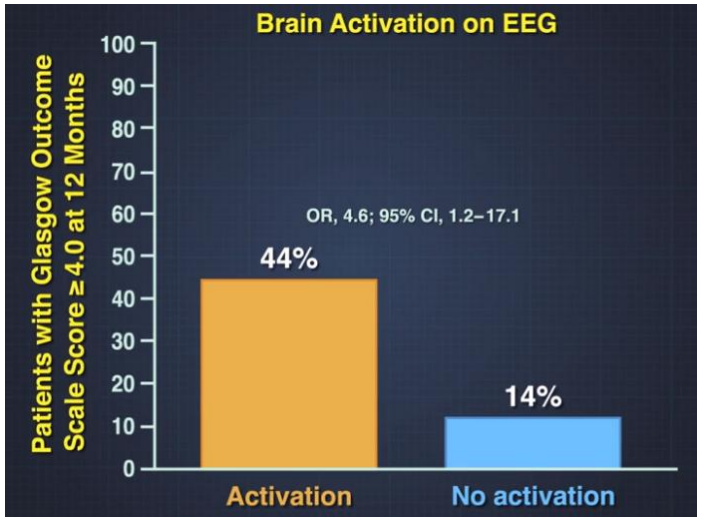
Unresponsive

≠

Unconscious in 25%

CMD: A clinical “blind spot”



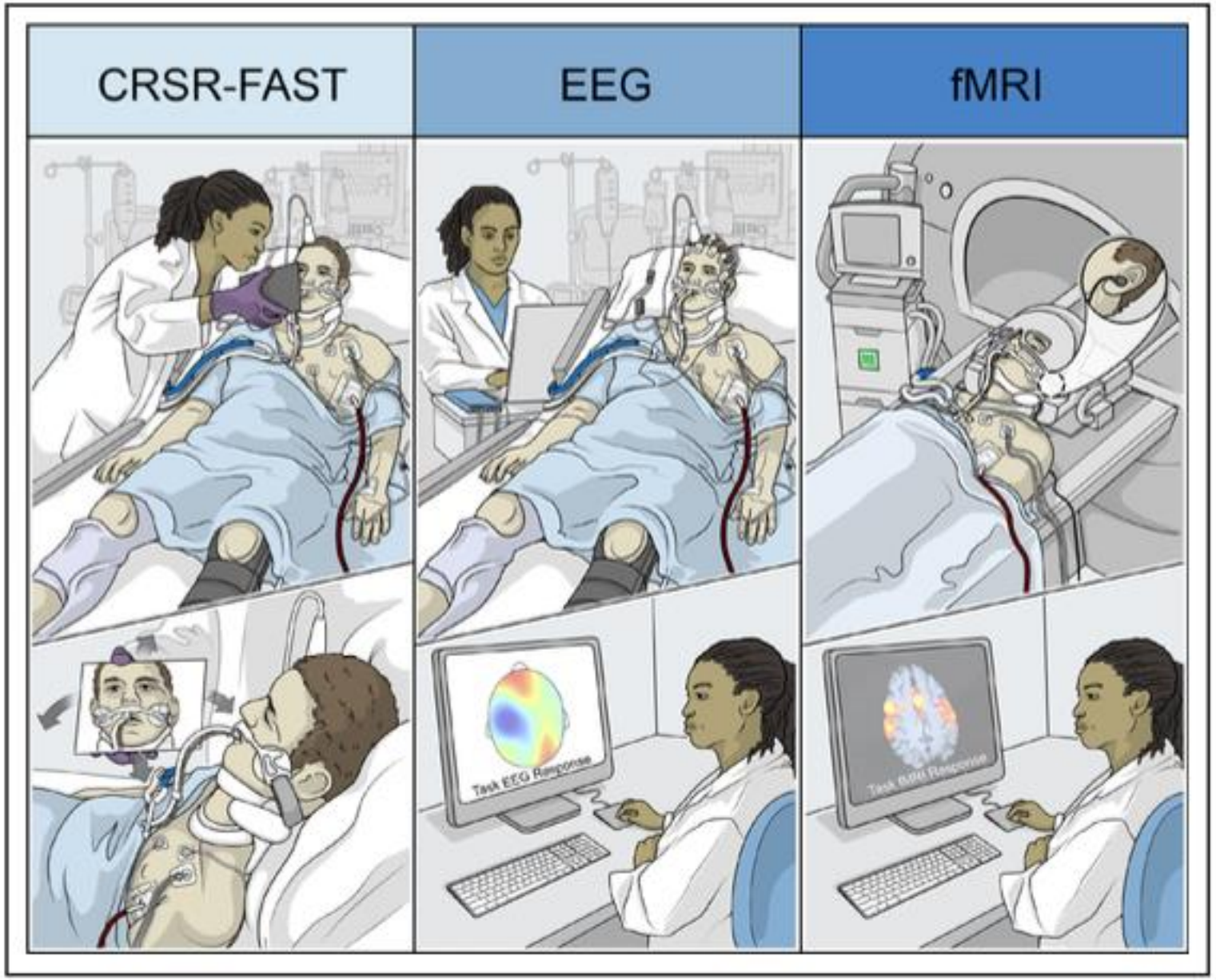


Claassen J, 2019

Table 2. Demographic and Clinical Characteristics of the Participants without an Observable Response to Commands.*

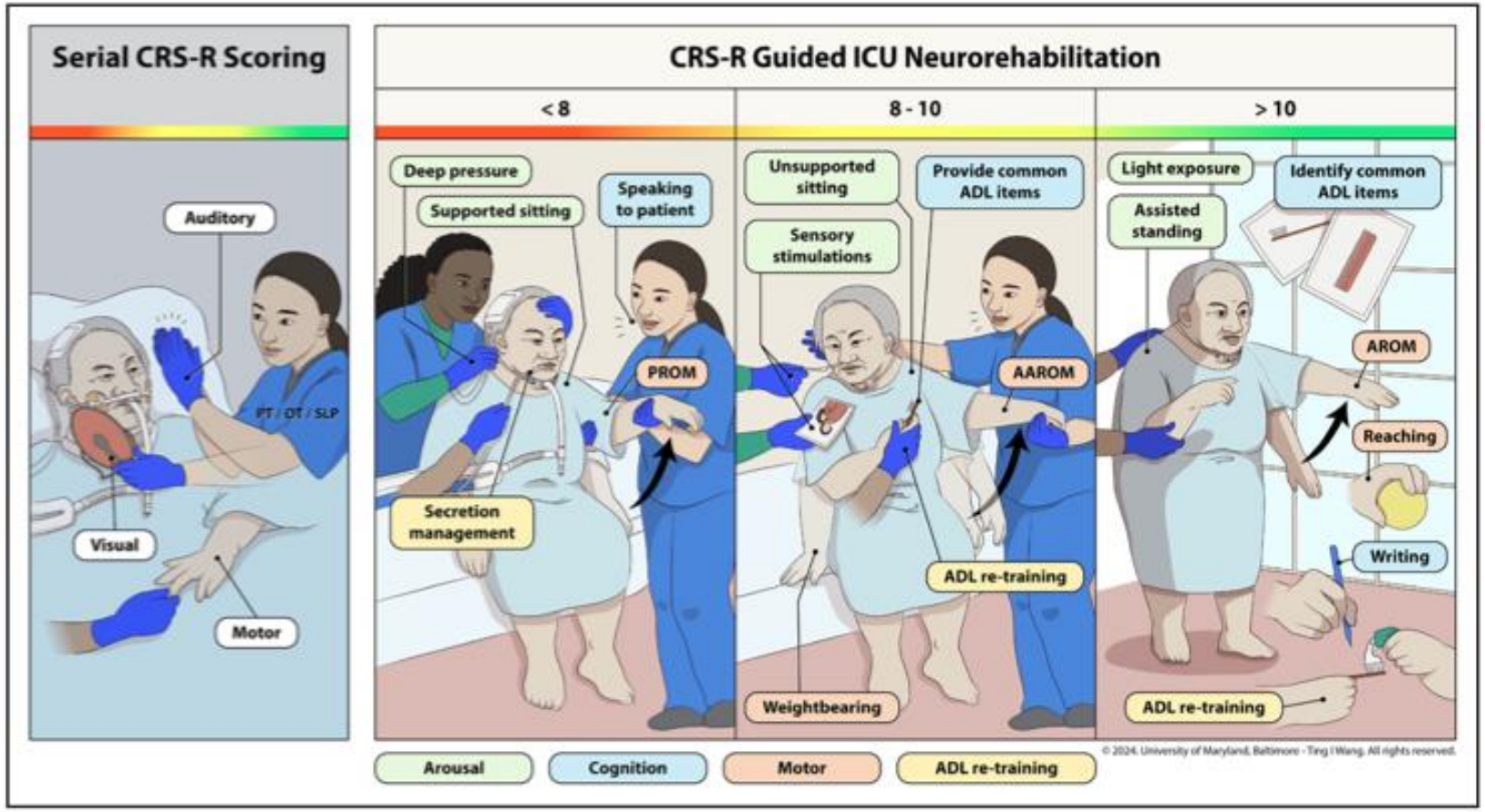
Characteristic	No Observable Response to Commands (N=241)	Response to Commands on Imaging† (N=60)	No Response to Commands on Imaging‡ (N=181)
Diagnosis — no. (%)§			
Coma or vegetative state	140 (58)	28 (47)	112 (62)
Minimally conscious state–minus	101 (42)	32 (53)	69 (38)
Imaging technique — no. (%)			
fMRI only	61 (25)	11 (18)	50 (28)
EEG only	101 (42)	13 (22)	88 (49)
fMRI and EEG	79 (33)	36 (60)	43 (24)
Median age at the time of injury (IQR) — yr	40.2 (25.2–57.2)	30.5 (22.6–43.0)	45.3 (26.7–59.3)
Sex — no. (%)			
Male	146 (61)	39 (65)	107 (59)
Female	93 (39)	21 (35)	72 (40)
Missing	2 (1)	0	2 (1)
Median time between injury and CRS-R assessment (IQR) — mo	6.3 (0.6–16.9)	10.7 (3.7–24.3)	4.3 (0.6–14.2)
Underwent CRS-R assessment <28 days after injury — no. (%)	72 (30)	12 (20)	60 (33)
Underwent CRS-R assessment ≥28 days after injury — no. (%)	169 (70)	48 (80)	121 (67)
Etiologic factor — no. (%)			
Brain trauma	108 (45)	39 (65)	69 (38)
Cardiac arrest or hypoxia	45 (19)	4 (7)	41 (23)
SAH, IVH, ICH, or stroke	48 (20)	9 (15)	39 (22)
Other	40 (17)	8 (13)	32 (18)

Bodien Y, 2024



Edlow, BL, 2024

JFK CRS R



Woodward et al. 2024

Clinical Implementation of fMRI and EEG to Detect Cognitive Motor Dissociation

Lessons Learned in an Acute Care Hospital

Yelena G. Bodien, PhD*, Matteo Fecchio, PhD*, Holly J. Freeman, MS, William R. Sanders, BSc, Anogue Meydan, BS, Phoebe K. Lawrence, BS, John E. Kirsch, PhD, David Fischer, MD, Joseph Cohen, BS, Emily Rubin, MD, Julian H. He, MD, Pamela W. Schaefer, MD, Leigh R. Hochberg, MD, PhD, Otto Rapalino, MD, Sydney S. Cash, MD, PhD, Michael J. Young, MD, MPhil†, and Brian L. Edlow, MD†

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Neurology: Clinical Practice 2025;15:e200390. doi:10.1212/CPJ.0000000000200390

Table 1 Sharing fMRI and EEG Results With Families and Clinicians

Scenario	fMRI or EEG CMD result	Interpretation
1	Data quality unacceptable or irreparable analytic errors	Factors such as excessive motion (fMRI or EEG), signal dropout from a ventricular peritoneal shunt (fMRI), or poor spatial registration (fMRI) prevent data analysis and interpretation
2	Indeterminate	Negative results should be interpreted as indeterminate rather than an "inability to follow commands" because many factors can contribute to a negative response (e.g., fluctuating arousal, normal variability in brain responses, motion artifact, sedation, and task complexity)
3	Possible	Despite the absence of evidence for language function on the behavioral examination, the patient may be able to understand language and follow commands
4	Probable	Despite the absence of evidence for language function on the behavioral examination, the patient probably understands language and follows commands; in patients with acute disorders of consciousness, CMD may be associated with a greater likelihood of achieving at least partial independence

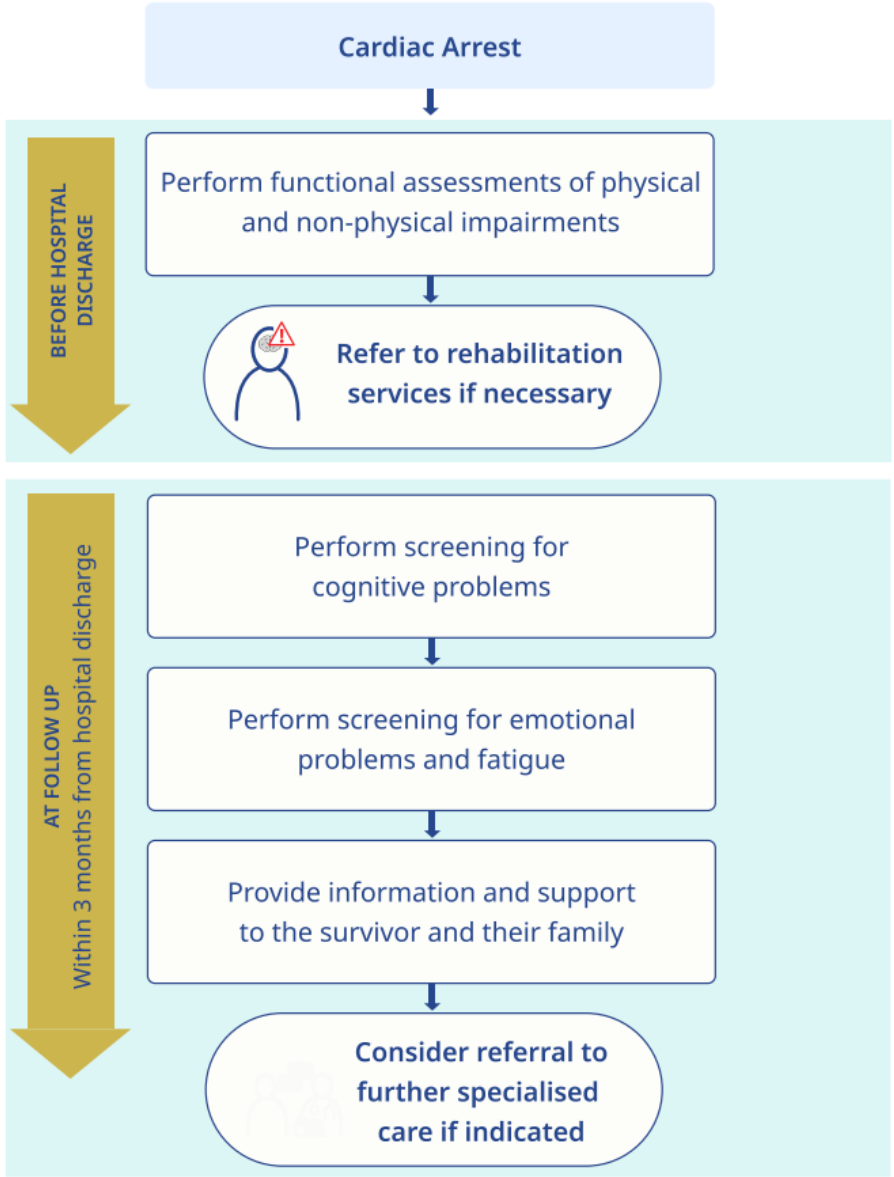
Recommendations for Recovery and Survivorship After Cardiac Arrest		
COR	**LOE**	**Recommendations**
1	**B-R**	1. It is recommended that cardiac arrest survivors and their caregivers have structured assessment and treatment/referral for emotional distress after medical stabilization and before hospital discharge.
1	**C-LD**	2. It is recommended that cardiac arrest survivors have multimodal rehabilitation assessment and treatment for cognitive, physical, neurological, and cardiopulmonary impairments before hospital discharge.
1	**C-LD**	3. It is recommended that cardiac arrest survivors and their caregivers have multidisciplinary discharge planning, to include medical and rehabilitative treatment recommendations and return to activity/work expectations.

What happens to patients with mRS 5 at discharge?

- 36% who never followed (1 y f/up) had no restricted diffusion on MRI
- One year mortality 38% (median survival 4.2 y)
  - Did not differ based on ability to follow commands
- 58% readmitted to hospital within 1 year for at least 8 days
- 5/43 (11%) who did not follow regained ability to follow commands, and 9/43 (21%) were living at home.

Xiao A et al., 2022

Survivorship and Recovery



RESUSCITATION 216 (2025) 110855

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Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

EUROPEAN RESUSCITATION COUNCIL

Clinical paper

Single-arm feasibility trial of a resilience intervention for cardiac arrest survivors and their family caregivers, *Recovering Together after Cardiac Arrest*

Alexander M. Presciutti[a,b,], Danielle La Camera[a], Sarah M. Perman[c], Jonathan Elmer[d], Michael W. Donnino[e,f], Ona Wu[g,h], Robert A. Parker[i], Ana-Maria Vranceanu[a,b]*

Nolan JP et al., 2025

COMA –F

Neurocrit Care
https://doi.org/10.1007/s12028-025-02294-1

NEUROCRITICAL CARE SOCIETY

ORIGINAL WORK

Check for updates

Characterizing Stressors and Coping Strategies Among Caregivers of Patients with Severe Acute Brain Injury by Level of Distress

Katherine J. Meurer[1†], Alexander M. Presciutti[2†], Sarah M. Bannon[3], Rina Kubota[4], Nithyashri Baskaran[5], Jisoo Kim[4], Qiang Zhang[6], Mira Reichman[7], Nathan S. Fishbein[2], Kaitlyn Lichstein[2], Melissa Motta[8], Susanne Muehlschlegel[9], Michael E. Reznik[10], Matthew N. Jaffa[11], Claire J. Creutzfeldt[12], Corey R. Fehnel[13], Amanda D. Tomlinson[14], Craig A. Williamson[15†], Ana-Maria Vranceanu[2†] and David Y. Hwang[16*] COMA-F Investigators

NeuroRecovery Clinic (NRC)

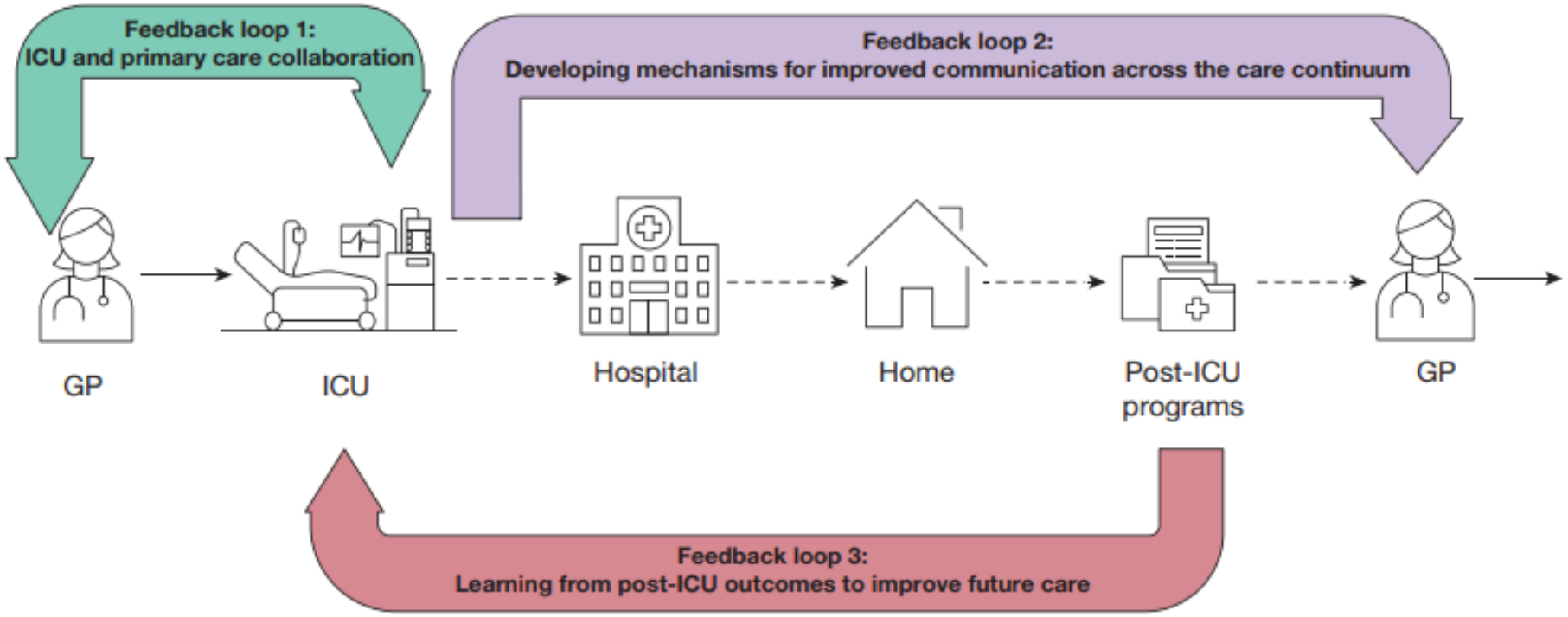

Figure 1 – *A conceptual model of user-derived solutions mapped to feedback pathways across transitions of care from ICU to primary care. GP = general practitioner.*

Chest, 2024

Five Take-Home Messages

- ICH requires urgency
- Selection matters for surgery
- Delay prognostication
- Consciousness may be hidden
- Recovery is long-term

Clinical Neurological Society of America

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Survivorship and Recovery

- In countries that practice WLST, ~80-90% of survivors return home with ≤ 2
- But…
  - Cognitive deficits (0-88%, 29% in TTM2): episodic memory, executive functioning, processing speed
  - Fatigue (20-70%): Does not improve even 5 years after OHCA
  - Anxiety, Depression, PTSD (20-25%): Persistent risk
  - Mobility Limitations/Inactivity: 1/3 of survivors from TTM at 6 mo
  - Restrictions in societal participation / resuming work:
    - 50% return to previous work levels at 6 mo with median return to work at 80 days
  - Co-survivors (family / close friends) commonly report PTSD, anxiety, sleep disturbance

Yaow CYL et al
Heimburg K et al., 2022
Norström EB et al., 2023
Rojas DA et al., 2023

https://doi.org/10.1093/brain/awaf349 BRAIN 2025: 148; 4248–4252 | 4248

BRAIN
UPDATE

Covert consciousness: what's in a name?

Charlène Aubinet,[1,2] Jan Claassen,[3,4] Brian L. Edlow,[5] David Fischer,[6] Olivia Gosseries,[1,2] Christof Koch,[7,8] Daniel Kondziella,[9,10] Marcello Massimini[11,12] and Michael J. Young[5]

Over the past decade, it has become apparent that up to 25% of behaviourally unresponsive patients with acute or chronic disorders of consciousness reveal high spatio-temporal complexity following a direct electrical or magnetic pulse to the brain, highly differentiated EEG responses or voluntary modulation of their brain activity on command, each of which has been interpreted, to varying degrees, as evidence of consciousness.

Practitioners designate this phenomenon using a dizzying variety of terms. The realization that 'unresponsiveness' does not equate to 'unconsciousness' changes how patients should be assessed and how the medical team communicates with them, their families and the world at large. We propose that the term 'covert consciousness' be used in all such communications to designate this subcategory of behaviourally unresponsive patients, with context-appropriate qualifiers and counselling accompanying its use.