MANS/MTQIP

Crystal Mountain, MI
June 8, 2018

Disclosures

- Salary Support for MTQIP from BCBSM/BCN
  - Mark Hemmila
  - Judy Mikhail
  - Jill Jakubus
  - Anne Cain-Nielsen

Introductions - Guest Speakers

- Craig Williamson, MD
  - University of Michigan
  - Assistant Professor of Neurology and Neurosurgery
- Ryan Stork, MD
  - University of Michigan
  - Assistant Professor of Physical Medicine & Rehabilitation
- Sanjay Patra, MD
  - Spectrum Health
  - Neurosurgeon

CME

- The University of Michigan Medical School designates this live activity for a maximum of **4.25** *AMA PRA Category 1 Credit(s)™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.
- Meeting participants will receive an **email** within 24 hours of meeting completion with a link to the meeting evaluation. The evaluation must be completed to receive a CME certificate. The link will remain open for 5 days.

Meeting Objectives

- Topics of interest to
  - Neurosurgery
  - Trauma Surgery
- Discussion
  - Share your views
  - Most of these topics have no correct answer
  - Insight
- Guidance
  - Where do we go?
  - What helps?

Participant Hospitals

Beaumont - Dearborn
Beaumont - Farmington Hills
Beaumont - Royal Oak
Beaumont - Trenton
Beaumont - Troy
Borgess Health
Bronson Methodist Hospital
Covenant HealthCare
Detroit Receiving Hospital
Genesys Health System
Henry Ford Allegiance Hospital
Henry Ford Macomb Hospital
Henry Ford Hospital
Hurley Medical Center
McLaren Lapeer
McLaren Macomb
McLaren Oakland
Mercy Health Muskegon
MidMichigan Medical Center
Munson Medical Center
Mercy Health Saint Mary's
Providence Park Hospital
Sinai-Grace Hospital
Sparrow Hospital
Spectrum Health
St. John Providence Health System
St. Joseph Mercy Hospital Ann Arbor
St. Joseph Mercy Oakland
St. Mary Mercy Livonia Hospital
St. Mary’s of Michigan
University of Michigan Health System
University of Minnesota
UP Health System Marquette

Neuroprotective Effects for TBI

Craig Williamson, MD

Neuroprotection in Traumatic Brain Injury

Craig Williamson

Clinical Assistant Professor

Neurocritical Care Fellowship Director

Disclosures

- I will discuss off-label use of medications
- Otherwise, nothing to disclose

Talk Overview

- Clinical Case
- Sedation and analgesia strategies
- ICP and CPP optimization

Clinical Case

- XX yo male unhelmeted cyclist is struck by an automobile
- GCS 6 in field and on ED arrival. Intubated.
- CT head showed L frontal SDH, small bifrontal contusions and temporal bone fracture
- Briskly localizing upon arrival to neuro ICU. GCS E1V1TM5. EVD is placed

First-line neuroprotective measures

- Elevate head of bed
- Control pain and agitation
- Target normothermia
- Avoid hypotension
- Avoid hypercarbia and hypoxia
  - End-tidal CO_2 helpful for monitoring

Sedation goals in critical illness

Sedation Intensity in the First 48 Hours of Mechanical Ventilation and 180-Day Mortality: A Multinational Prospective Longitudinal Cohort Study*

Yahya Shehabi, PhD, FCICM, FANZCA, EMBA[1,2]; Rinaldo Bellomo, MD (Hons), FRACP, FCICM[3,4,5]; Suhaini Kadiman, MD, M.MED[6]; Lian Kah Ti, MBBS, Mmed[7]; Belinda Howe, RN, BN[8]; Michael C. Reade, MBBS, MPH, Dphil, FCICM[9]; Tien Meng Khoo, MBBS, MRCP, EDIC[10]; Anita Alias, MD, MMed(Anaesth)[11]; Yu-Lin Wong, FANZCA, MMed (ICM)[12]; Amartya Mukhopadhyay, FRCP, MPH[7]; Colin McArthur, MBChB, FANZCA, FCICM[13]; Ian Seppelt, MBBS, BSc (Med), FANZCA, FCICM[14]; Steven A. Webb, MPH, PhD, FCICM[8,15]; Maja Green, PhD, MSc, BSc (Hons)[1]; Michael J. Bailey, PhD, MSc (statistics), BSc (Hons)[1,8]; for the Sedation Practice in Intensive Care Evaluation (SPICE) Study Investig
New Zealand Intensive Care Society Clinical Trials Group

Balzer *et al. Critical Care* (2015) 19:197
DOI 10.1186/s13054-015-0929-2

CRITICAL CARE

RESEARCH Open Access

Early deep sedation is associated with decreased in-hospital and two-year follow-up survival

Felix Balzer[1], Björn Weiß[1], Oliver Kumpf[1], Sascha Treskatsch[1], Claudia Spies[1], Klaus-Dieter Wernecke[2], Alexander Krannich[3] and Marc Kastrup[1*]

TBI-specific analgesia and sedation?

Sedation for critically ill adults with severe traumatic brain injury: A systematic review of randomized controlled trials*

Derek J. Roberts, MD; Richard I. Hall, MD, FRCPC, FCCP; Andreas H. Kramer, MD, MSc, FRCPC; Helen Lee Robertson, MLIS; Clare N. Gallagher, MD, PhD, FRCSC; David A. Zygun, MD, MSc, FRCPC

Objectives: To summarize randomized controlled trials on the effects of sedative agents on neurologic outcome, mortality, intracranial pressure, cerebral perfusion pressure, and adverse drug events in critically ill adults with severe traumatic brain

cealed allocation and six were blinded. Insufficient data exist regarding the effects of sedative agents on neurologic outcome or mortality. Although their effects are likely transient, bolus doses of opioids may increase intracranial pressure and decrease ce-

neurocritical care society Neurocrit Care (2011) 15:175–181
DOI 10.1007/s12028-009-9315-8

PRACTICAL PEARL

Dexmedetomidine Controls Agitation and Facilitates Reliable, Serial Neurological Examinations in a Non-Intubated Patient with Traumatic Brain Injury

Julin F. Tang · Po-Liang Chen · Eric J. Tang · Todd A. May · Shirley I. Stiver

Clinical Case

- ~12 hrs after admission ICP sustains between 20 and 25 mm Hg
- ABG on 30% FiO2: 7.47/34/137
- Head CT shows no interval change in SDH or bifrontal contusions

- Next management step?

Anaesthesia, 1988, Volume 43 (Supplement), pages 42–43

Effect of propofol on cerebral blood flow and metabolism in man

A. VANDESTEENE, V. TREMPONT, E. ENGELMAN,
T. DELOOF, M. FOCROUL, A. SCHOUTENS
AND M. DE ROOD

Summary

Cerebral blood flow, cerebral oxygen consumption, lactate and glucose metabolism were measured in 13 patients during anaesthesia with nitrous oxide, oxygen and enflurane 0.5% and after 30 minutes infusion of propofol. The mean blood concentration

Clinical Case

- Sedation transitioned to propofol → ICP transiently decreased as did systolic blood pressure
  - Started on norepinephrine to maintain CPP > 60

- ICP abruptly increases to 36 mmHg during tracheal suctioning
  - Normalizes with administration of 30 cc 23.4% saline

Anesthesiology
57:242–244, 1982

A Randomized Study of Drugs for Preventing Increases in Intracranial Pressure during Endotracheal Suctioning

PAUL F. WHITE, M.D., PH.D.,* RICHARD M. SCHLOBOHM, M.D.,† LAWRENCE H. PITTS, M.D.,‡
JAMES M. LINDAUER, M.D.§

Prevention of cerebral ischemia and acute intracranial hypertension are the primary goals in managing patients

ants. However, the efficacy of thiopental or lidocaine in controlling ICP in nonparalyzed patients has not been

Clinical case contd.

- A few hours later ICP again spikes to 36 mmHg
  - Normalizes with mannitol administration
- Portable head CT obtained after bolusing propofol and fentanyl

Clinical Contd.

- Patient continued on propofol 80 mcg/kg/min and fentanyl infusion is uptitrated to 200 mcg/hr.
- Bolused 23.4% alternating with mannitol during ICP spikes. Na increases to 155 and serum osms to 330
- ICPs consistently sustaining > 25 with transient spikes into 30s and even low 40s anytime pt is stimulated
- CPP maintained > 60 mmHg except very brief periods during ICP spikes.

- Remaining management options?

Decompressive Craniectomy?

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 21, 2011 VOL. 364 NO. 16

Decompressive Craniectomy in Diffuse Traumatic Brain Injury

D. James Cooper, M.D., Jeffrey V. Rosenfeld, M.D., Lynnette Murray, B.App.Sci., Yaseen M. Arabi, M.D., Andrew R. Davies, M.B., B.S., Paul D'Urso, Ph.D., Thomas Kossmann, M.D., Jennie Ponsford, Ph.D., Ian Seppelt, M.B., B.S., Peter Reilly, M.D., and Rory Wolfe, Ph.D., for the DECRA Trial Investigators and the Australian and New Zealand Intensive Care Society Clinical Trials Group*

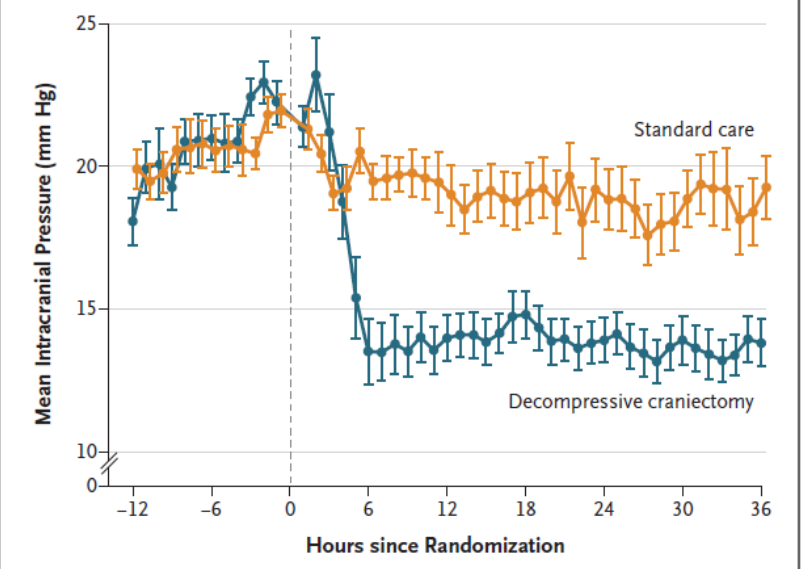
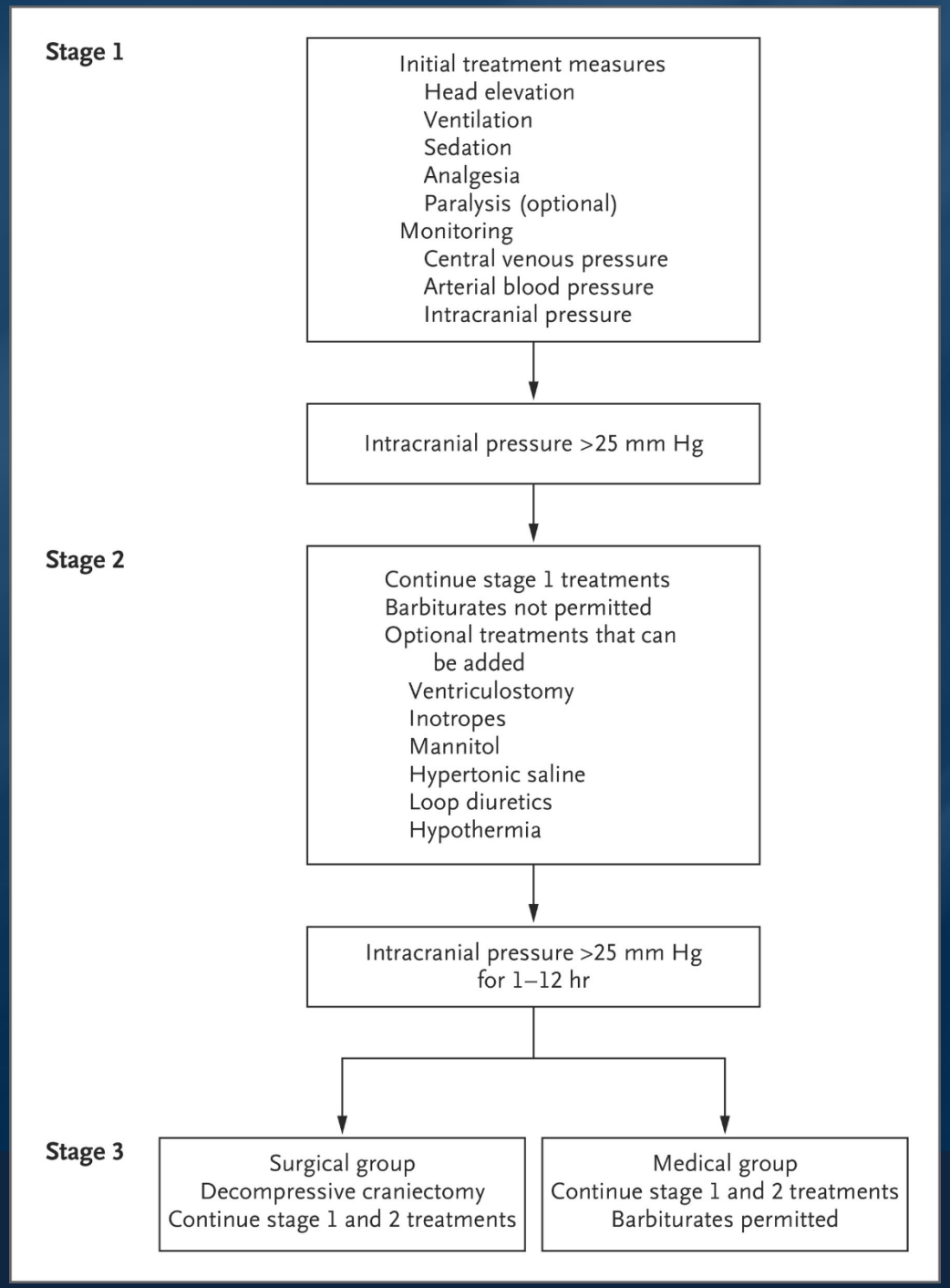
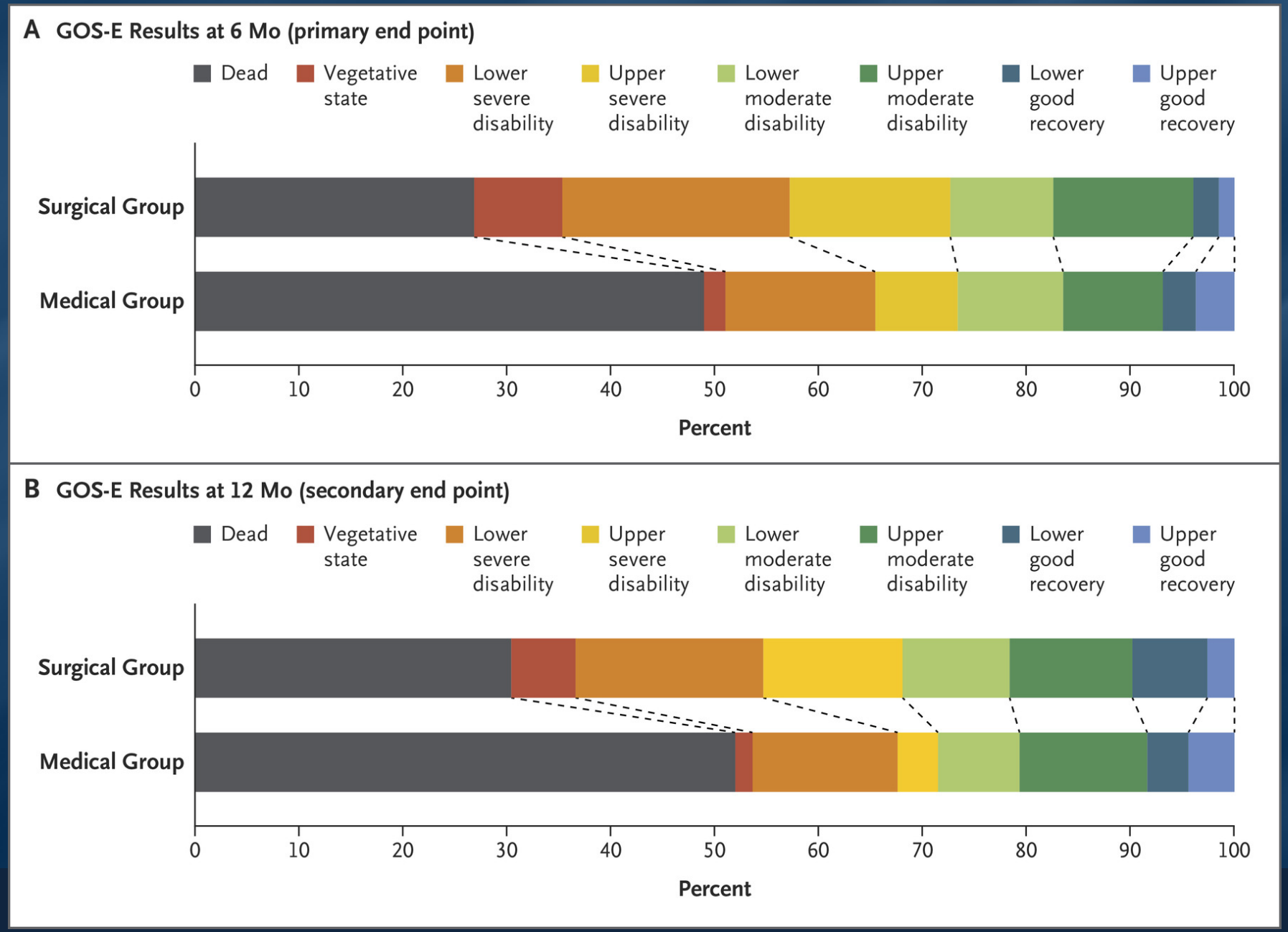


Figure 1. Intracranial Pressure before and after Randomization.
Shown are the mean measurements of intracranial pressure in the two study groups during the 12 hours before and the 36 hours after randomization. The I bars indicate standard errors.

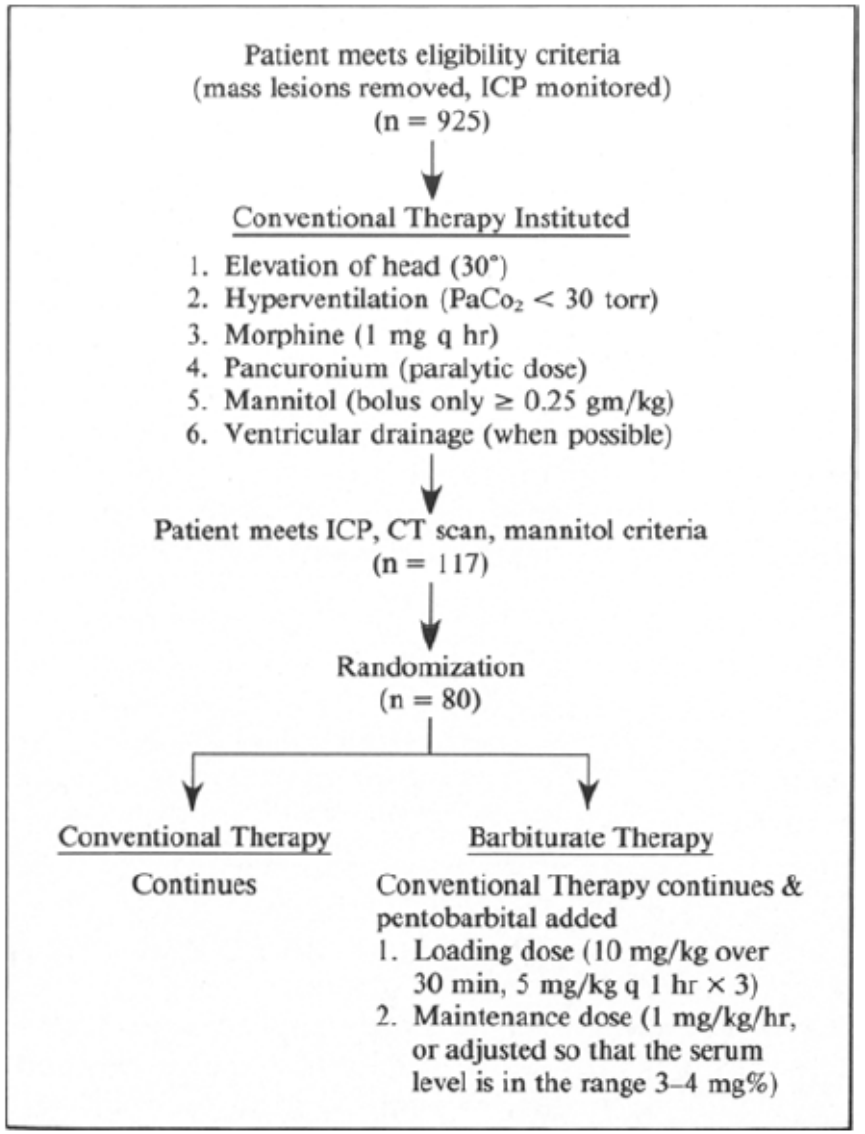

Stage 1
Initial treatment measures
Head elevation
Ventilation
Sedation
Analgesia
Paralysis (optional)
Monitoring
Central venous pressure
Arterial blood pressure
Intracranial pressure
Intracranial pressure >25 mm Hg
Stage 2
Continue stage 1 treatments
Barbiturates not permitted
Optional treatments that can be added
Ventriculostomy
Inotropes
Mannitol
Hypertonic saline
Loop diuretics
Hypothermia
Intracranial pressure >25 mm Hg for 1–12 hr
Stage 3
Surgical group
Decompressive craniectomy
Continue stage 1 and 2 treatments
Medical group
Continue stage 1 and 2 treatments
Barbiturates permitted


A GOS-E Results at 6 Mo (primary end point)
Dead
Vegetative state
Lower severe disability
Upper severe disability
Lower moderate disability
Upper moderate disability
Lower good recovery
Upper good recovery
Surgical Group
Medical Group
0
10
20
30
40
50
60
70
80
90
100
Percent
B GOS-E Results at 12 Mo (secondary end point)
Dead
Vegetative state
Lower severe disability
Upper severe disability
Lower moderate disability
Upper moderate disability
Lower good recovery
Upper good recovery
Surgical Group
Medical Group
0
10
20
30
40
50
60
70
80
90
100
Percent

Pentobarbital?

J Neurosurg 69:15–23, 1988

High-dose barbiturate control of elevated intracranial pressure in patients with severe head injury



Using pentobarbital in TBI

- Place continuous EEG and titrate to deep burst suppression (~1 burst/10s page)

- Load 10 mg/kg over 30 minutes
- Continue 5 mg/kg for 1-3 hrs until adequate sedation achieved on EEG

- Maintenance dose 1 mg/kg titrated to EEG burst suppression

Pentobarbital adverse effects

- Hypotension → increased pressor requirements
- Respiratory depression
- Ileus
  - Gut ischemia
- Venous thromboembolism
- Impaired cough and ciliary clearance → pneumonia and mucus plugging

Clinical case contd.

- ICPs ~ 20-30 with continued brief spikes with nursing care
- Cool to 34 C
- Continue to treat ICP spikes with hyperosmolar therapy
- Develops pneumonia, atelectasis, abrupt mucus plugging leading to severe desaturation
- Tracheostomy placed on post-trauma day 15 when first able to tolerate reverse Trendelenberg
- ICPs normalize by ~ day 18 and pentobarbital weaned
- Subsequently develops recurrent pneumonia → severe ARDS requiring paralysis and prone positioning

Clinical case contd.

- Pt developed stage 2 pressure ulcers
- Severe agitation and withdrawal → methadone and benzodiazepine taper necessary to wean off of high-dose sedation
- Discharged to acute rehab after 34 days
- Improves rapidly → initial neurocognitive performance in the average to above average range. Decannulated
- Neurocognitive scores all above average at the time of discharge from rehab 24 days later
- Patient discharged home and cleared to return to work without restrictions

Clinical case takeaways

- Be cautious in prognostication for young patients with severe intracranial hypertension
- Sustained ICP > 20 can be tolerated provided there is adequate cerebral blood flow and oxygenation
- Patients on prolonged barbiturate infusion *will* develop pneumonia, hypoxic respiratory failure and, usually, sepsis
  - Patient selection is important
  - Closely discuss risks/benefits of craniectomy with neurosurgery and patient's family
- Sedation and analgesia important factors in TBI
  - Avoid unnecessary oversedation, but sometimes it's necessary

Future Directions

ponding editorial in this issue, pp 891–892.

J Neurosurg 120:893–900, 2014

Patient-specific thresholds of intracranial pressure in severe traumatic brain injury

Clinical article

Christos Lazaridis, M.D.,[1,2] Stacia M. DeSantis, Ph.D.,[3] Peter Smielewski, Ph.D.,[1] David K. Menon, M.D., Ph.D., F.Med.Sci.,[4] Peter Hutchinson, F.R.C.S.(SN), Ph.D.,[1] John D. Pickard, F.R.C.S., M.Chir., F.Med.Sci.,[1] and Marek Czosnyka, Ph.D.[1]

Future Directions

- Improved methods to personalize ICP and CPP goals
- New monitoring methods may be helpful … or just provide additional data
  - Brain tissue oxygen monitoring
  - Cerebral blood flow monitoring
  - Autoregulatory assessment
- Better data to guide early prognostication and patient selection for 3rd line ICP therapies
- Clear guidelines for sedation and analgesia
- **High quality collaborative trauma care, not magic bullets, will improve patient outcomes**

Thank you!

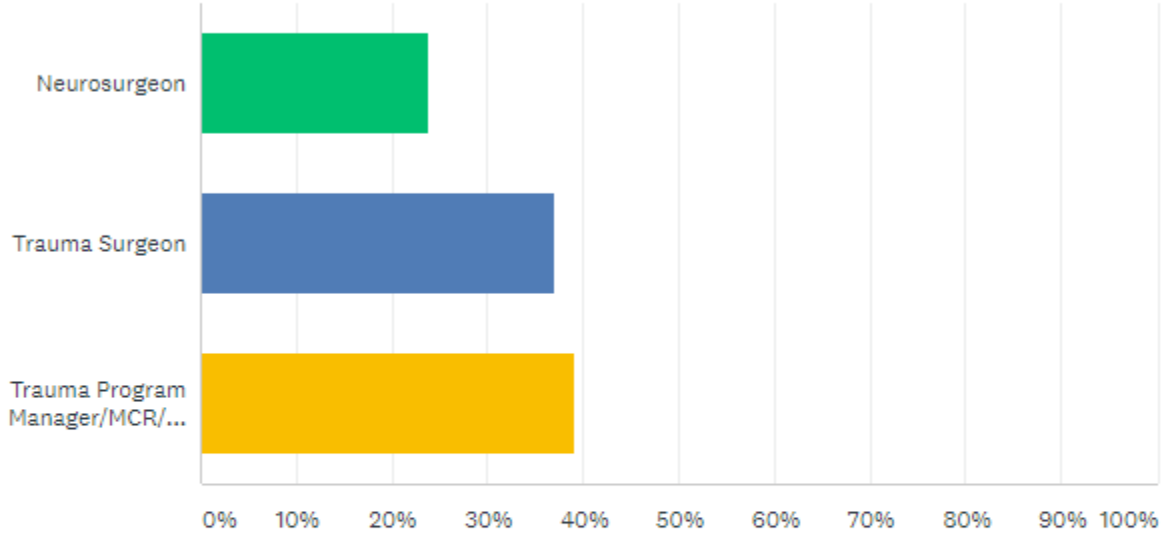
Discussion - Sedation in Head Injury

Jason Heth, MD
Mark Hemmila, MD

Question 1

Please choose your specialty/role?

Answered: 46 Skipped: 0

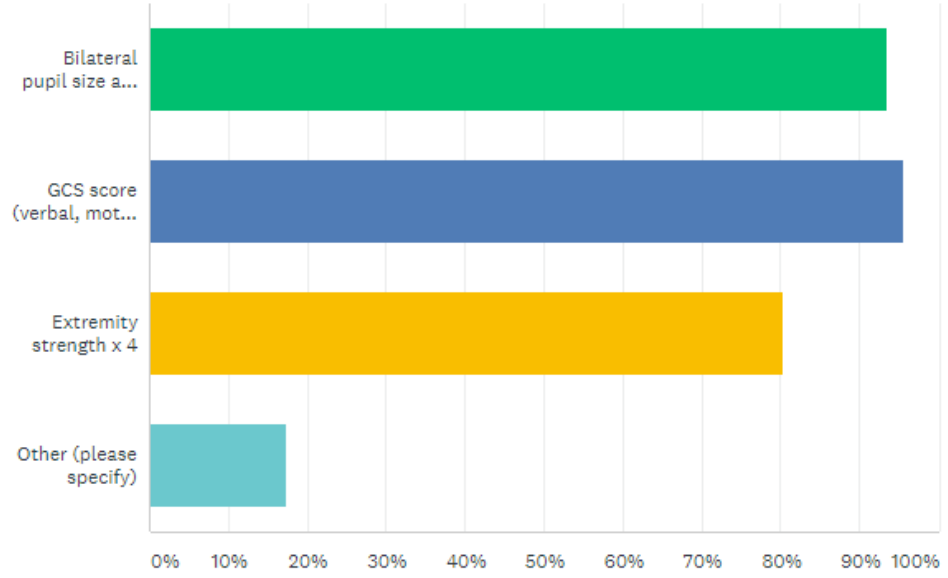


ANSWER CHOICES	RESPONSES	
Neurosurgeon	23.91%	11
Trauma Surgeon	36.96%	17
Trauma Program Manager/MCR/Other	39.13%	18
TOTAL		46

Question 2

What constitutes an appropriate Q1 hour neurological examination for a TBI patient in your ICU? Please select all that apply.

Answered: 46 Skipped: 0



ANSWER CHOICES		RESPONSES	
Bilateral pupil size and reactivity to light.		93.48%	43
GCS score (verbal, motor, eye, total)		95.65%	44
Extremity strength x 4		80.43%	37
Other (please specify)	Responses	17.39%	8
Total Respondents: 46			

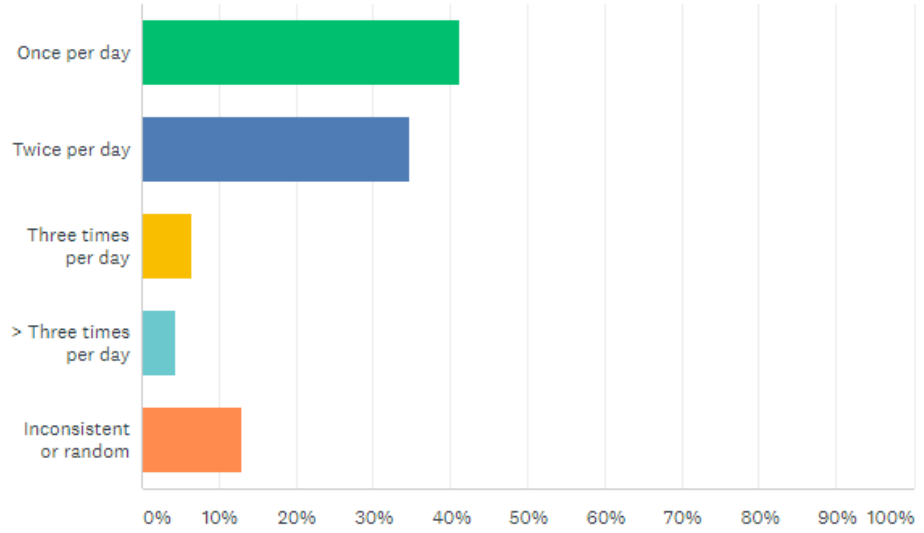
Question 2

- Sensation, fine motor
- Arousability
- Change from baseline

Question 3

For newly admitted (<24 hrs) moderate to severe TBI patient, with a structural lesion that has not been operated on, how often does your neurosurgical team perform a clinical examination?

Answered: 46 Skipped: 0

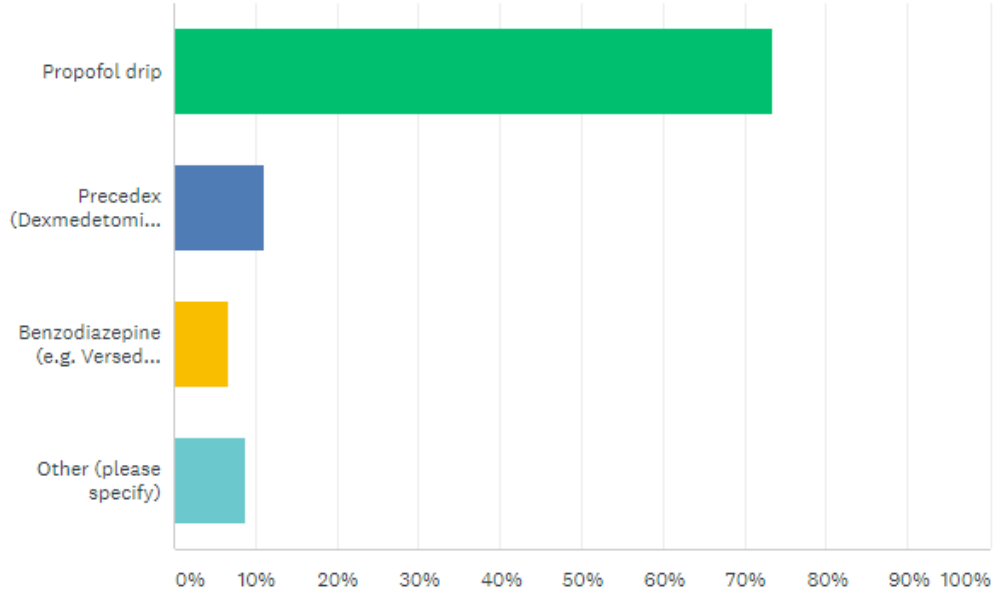


ANSWER CHOICES	RESPONSES	
Once per day	41.30%	19
Twice per day	34.78%	16
Three times per day	6.52%	3
> Three times per day	4.35%	2
Inconsistent or random	13.04%	6
TOTAL		46

Question 4

For an intubated TBI patient what is your preferred sedation regimen?

Answered: 45 Skipped: 1

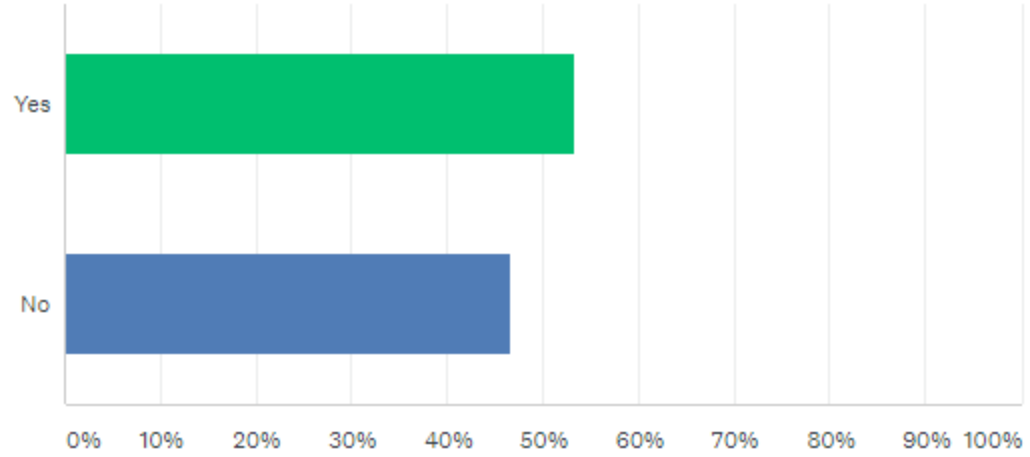


ANSWER CHOICES		RESPONSES	
Propofol drip		73.33%	33
Precedex (Dexmedetomidine) drip		11.11%	5
Benzodiazepine (e.g. Versed) and opiod (e.g. Fentanyl) drips		6.67%	3
Other (please specify)	Responses	8.89%	4
TOTAL			45

Question 5

Does your ICU actively discourage the use of soft patient restraint devices?

Answered: 45 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	53.33%	24
No	46.67%	21
TOTAL		45

Discussion - Anticoagulation in Head Injury

Jason Heth, MD
Mark Hemmila, MD

Anticoagulation

- Reversal
- Prophylaxis
- Resume

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https://doi.org/10.1016/j.jacc.2017.09.1085

EXPERT CONSENSUS DECISION PATHWAY

2017 ACC Expert Consensus Decision Pathway on Management of Bleeding in Patients on Oral Anticoagulants

A Report of the American College of Cardiology Task Force on Expert Consensus Decision Pathways

Life-threatening

- Stop oral anti-coagulant
- Vitamine antagonist
  - 5-10mg IV Vitamin K
  - Reversal agent
- Direct acting oral anticoagulant
  - Direct thrombin inhibitor (dabigatran)
  - Factor Xa inhibitor (apixaban, rivaroxaban)
  - Half-lives
  - Potential reversal

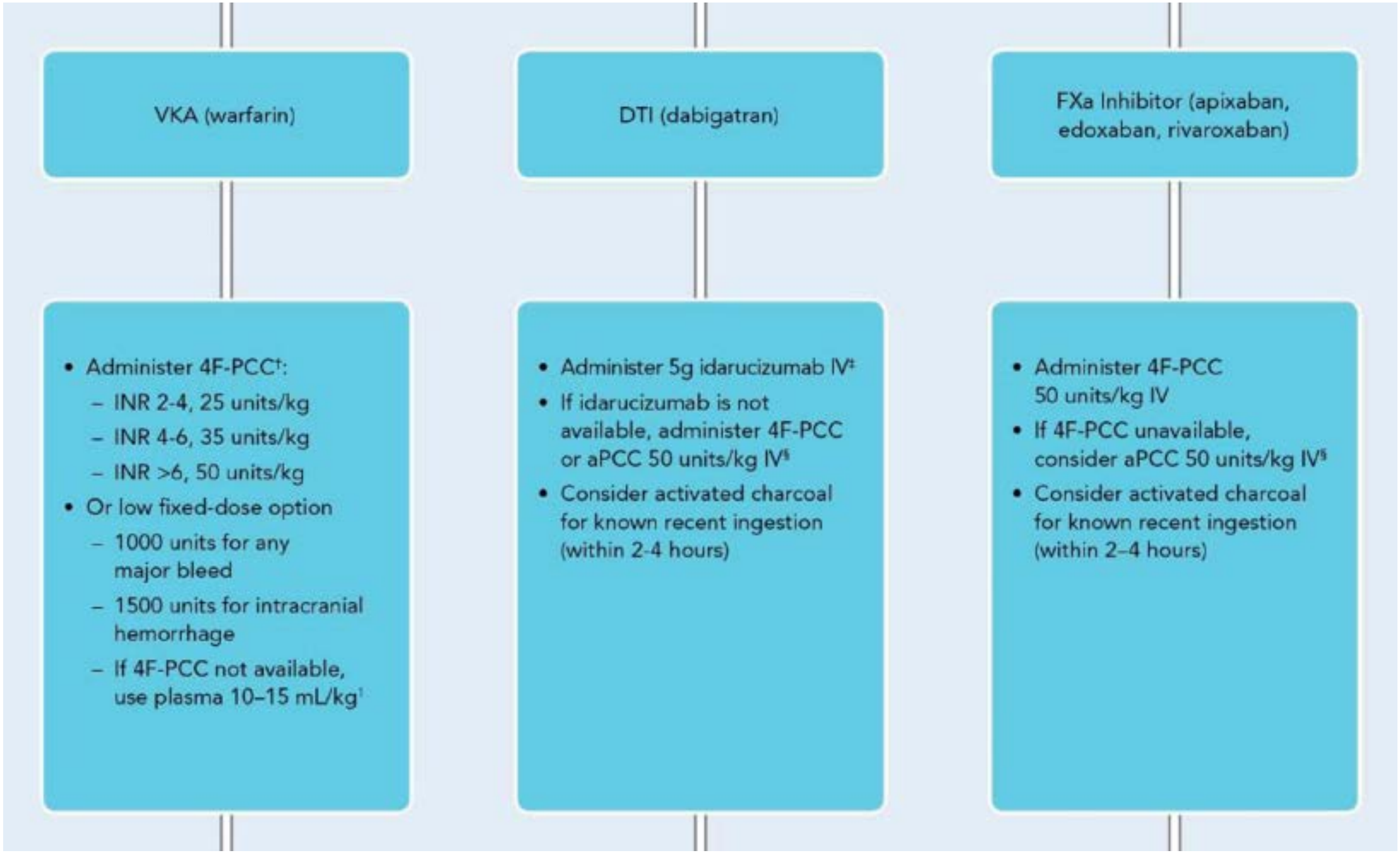

VKA (warfarin)
DTI (dabigatran)
FXa Inhibitor (apixaban, edoxaban, rivaroxaban)
• Administer 4F-PCC†:
– INR 2-4, 25 units/kg
– INR 4-6, 35 units/kg
– INR >6, 50 units/kg
• Or low fixed-dose option
– 1000 units for any major bleed
– 1500 units for intracranial hemorrhage
– If 4F-PCC not available, use plasma 10–15 mL/kg‡
• Administer 5g idarucizumab IV‡
• If idarucizumab is not available, administer 4F-PCC or aPCC 50 units/kg IV§
• Consider activated charcoal for known recent ingestion (within 2-4 hours)
• Administer 4F-PCC 50 units/kg IV
• If 4F-PCC unavailable, consider aPCC 50 units/kg IV§
• Consider activated charcoal for known recent ingestion (within 2–4 hours)

TABLE 4 Recommended Durations for Withholding DOACs Based on Procedural Bleed Risk and Estimated CrCl When There Are No Increased Patient Bleed Risk Factors

	Dabigatran					Apixaban, Edoxaban, or Rivaroxaban		
CrCl, mL/min	≥80	50–79	30–49	15–29	<15	≥30	15–29	<15
Estimated drug half-life, h	13	15	18	27	30 (off dialysis)	6–15	Apixaban: 17 Edoxaban: 17 Rivaroxaban: 9	Apixaban: 17 (off dialysis) Edoxaban: 10-17 (off dialysis) Rivaroxaban: 13 (off dialysis)
Procedural bleed risk								
Low	≥24 h	≥36 h	≥48 h	≥72 h	No data. Consider measuring dTT and/or withholding ≥96 h	≥24 h	≥36 h	No data. Consider measuring agent-specific anti Xa level and/or withholding ≥48 h
Uncertain, intermediate, or high	≥48 h	≥72 h	≥96 h	≥120 h	No data. Consider measuring dTT	≥48 h	No data. Consider measuring agent-specific anti Xa level and/or withholding ≥72 h	

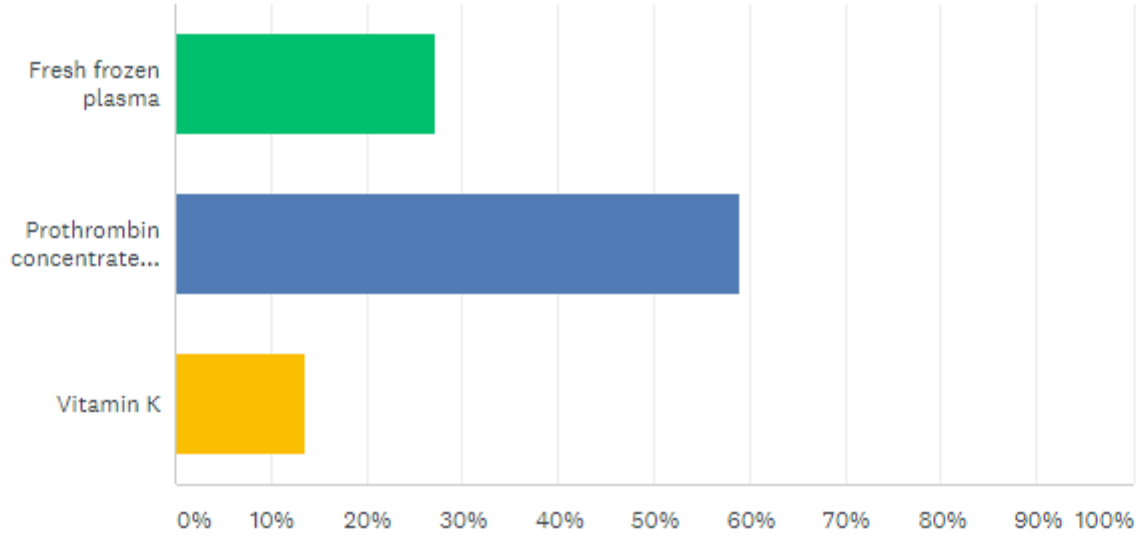
NOTE: The duration for withholding is based upon the estimated DOAC half-life withholding times of 2 to 3 half-lives for low procedural bleeding risk and 4 to 5 drug half-lives for uncertain, intermediate, or high procedural bleeding risk (47-55).

CrCl = creatinine clearance; DOAC = direct-acting oral anticoagulant; dTT = dilute thrombin time.

Question 14

What is your first line anticoagulation reversal agent for a patient on Coumadin with an intracranial injury?

Answered: 44 Skipped: 2

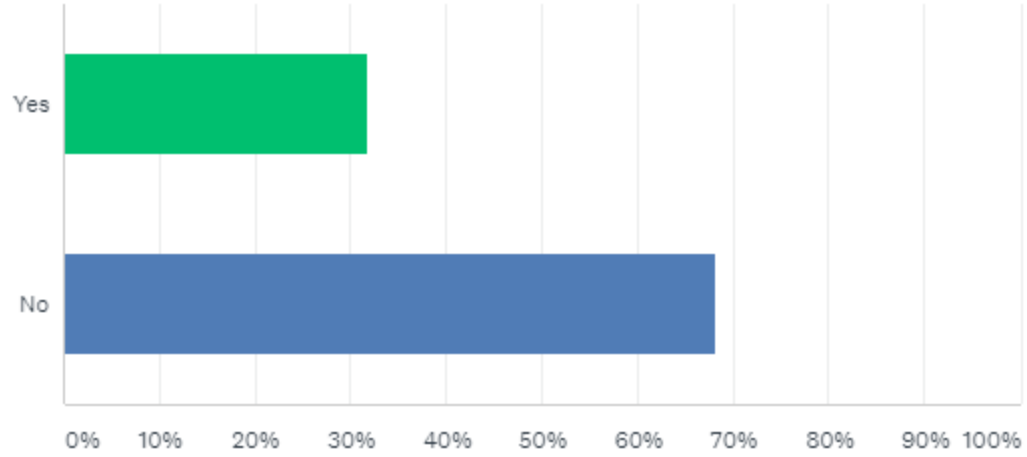


ANSWER CHOICES	RESPONSES	
Fresh frozen plasma	27.27%	12
Prothrombin concentrate complex	59.09%	26
Vitamin K	13.64%	6
TOTAL		44

Question 15

In your practice, do you administer anticoagulation reversal agents for a patient on Coumadin with a potential intracranial injury prior to obtaining a head CT scan?

Answered: 44 Skipped: 2

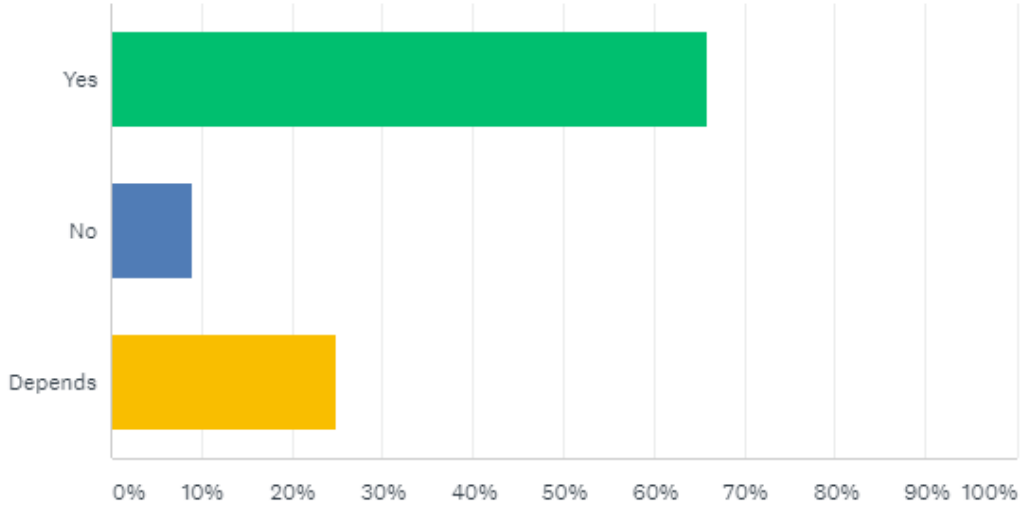


ANSWER CHOICES	RESPONSES	
Yes	31.82%	14
No	68.18%	30
TOTAL		44

Question 6

For a non-intubated, mild to moderate TBI patient, with a structural injury, with a clinical exam that can be followed, do you routinely obtain a repeat head CT scan in a patient with a stable/non-changed clinical exam.

Answered: 44 Skipped: 2

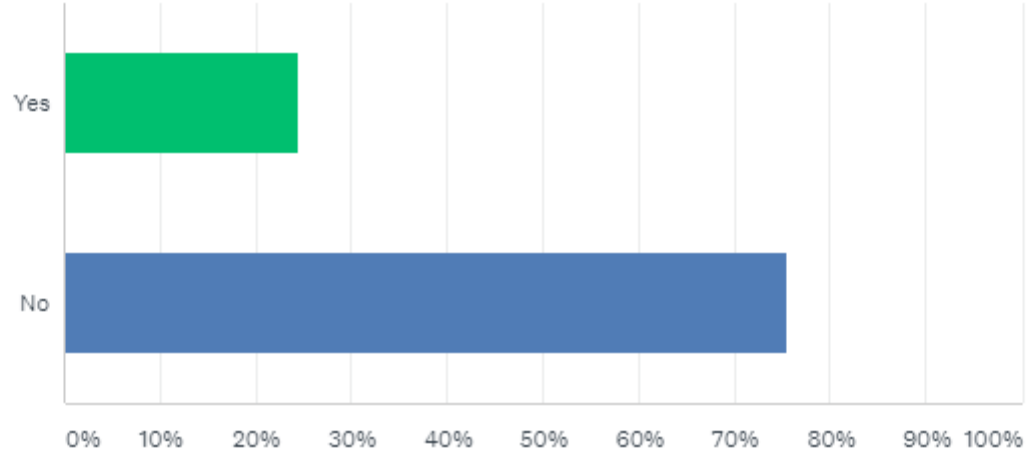


ANSWER CHOICES	RESPONSES	
Yes	65.91%	29
No	9.09%	4
Depends	25.00%	11
TOTAL		44

Question 7

For a non-intubated, mild to moderate TBI patient, with a minor structural injury, with a stable/non-changed clinical exam that can be followed, are you comfortable allowing initiation of VTE pharmacoprophylaxis 24-48 hours after admission without obtaining a repeat head CT scan?

Answered: 45 Skipped: 1

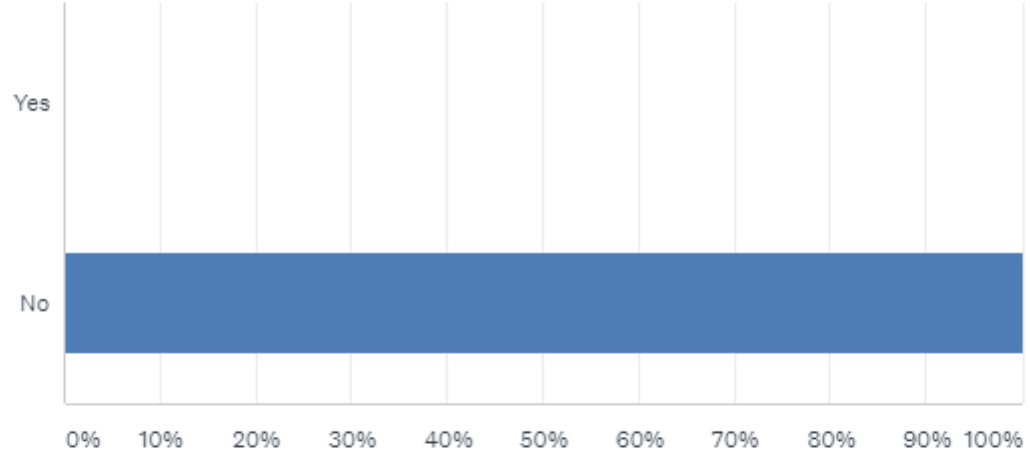


ANSWER CHOICES	RESPONSES	
Yes	24.44%	11
No	75.56%	34
TOTAL		45

Question 7 (Neurosurgeons)

For a non-intubated, mild to moderate TBI patient, with a minor structural injury, with a stable/non-changed clinical exam that can be followed, are you comfortable allowing initiation of VTE pharmacoprophylaxis 24-48 hours after admission without obtaining a repeat head CT scan?

Answered: 11 Skipped: 0

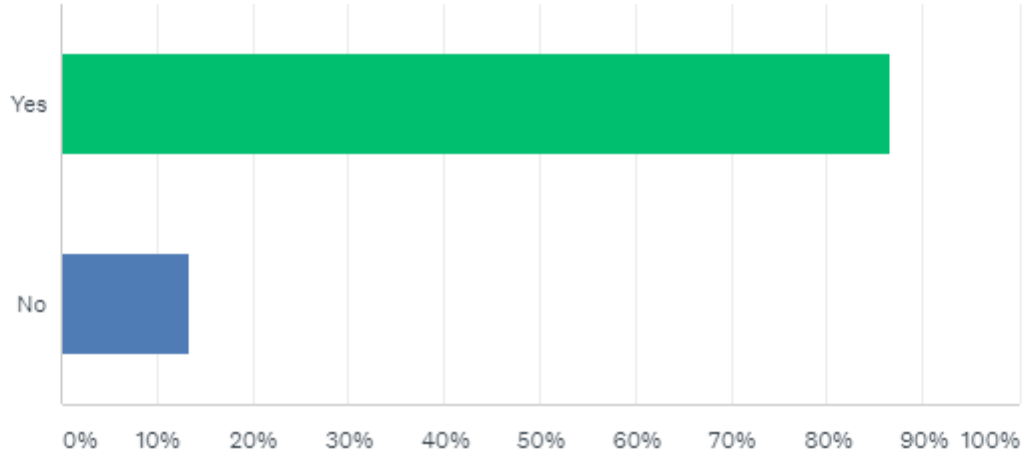


ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	100.00%	11
TOTAL		11

Question 8

For a non-intubated, mild to moderate TBI patient, with a minor structural injury, with a stable/non-changed clinical exam that can be followed, and a stable non-changed repeat head CT scan are you comfortable allowing initiation of VTE pharmacoprophylaxis 24-48 hours after admission?

Answered: 45 Skipped: 1

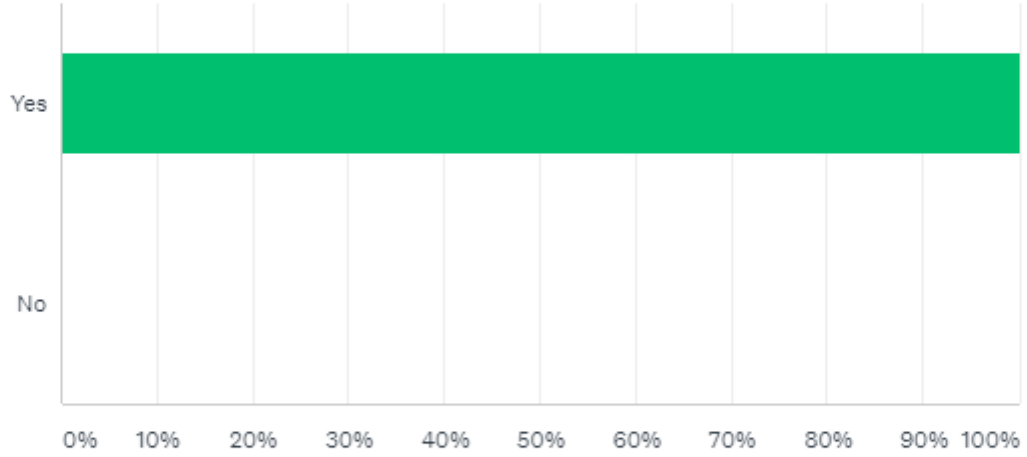


ANSWER CHOICES	RESPONSES	
Yes	86.67%	39
No	13.33%	6
TOTAL		45

Question 8 (Neurosurgeons)

For a non-intubated, mild to moderate TBI patient, with a minor structural injury, with a stable/non-changed clinical exam that can be followed, and a stable non-changed repeat head CT scan are you comfortable allowing initiation of VTE pharmacoprophylaxis 24-48 hours after admission?

Answered: 11 Skipped: 0

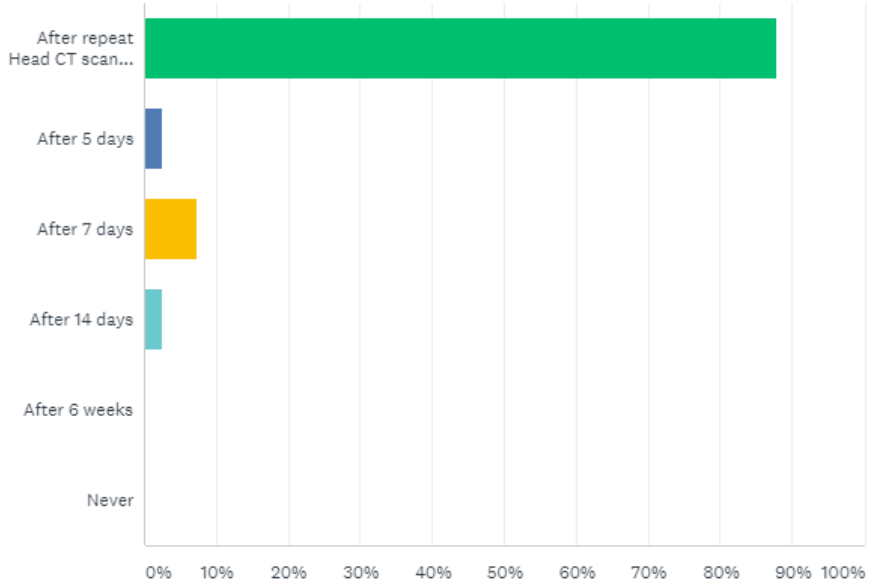


ANSWER CHOICES	RESPONSES	
Yes	100.00%	11
No	0.00%	0
TOTAL		11

Question 11 (New)

When do you allow initiation of VTE prophylaxis in a TBI patient with evidence of intracranial hemorrhage and no evidence of ongoing bleeding?

Answered: 41 Skipped: 5

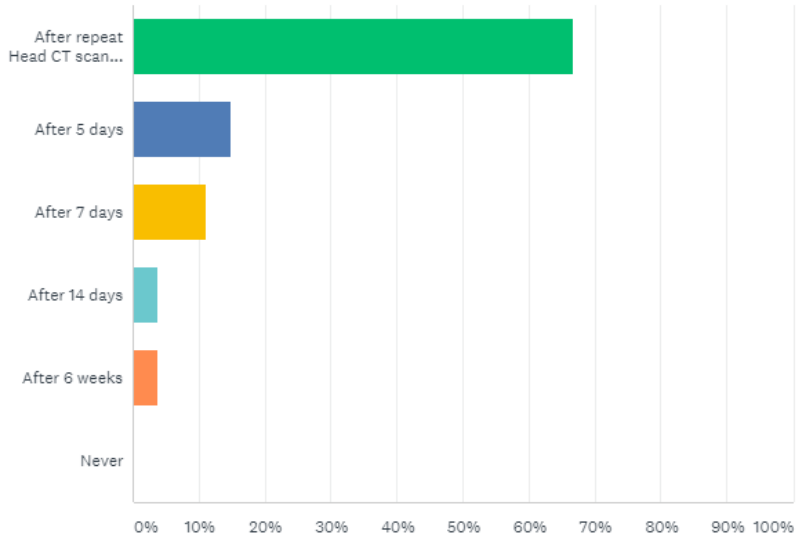


ANSWER CHOICES	RESPONSES	
After repeat Head CT scan with stabilization of brain injury findings in 24-48 hrs.	87.80%	36
After 5 days	2.44%	1
After 7 days	7.32%	3
After 14 days	2.44%	1
After 6 weeks	0.00%	0
Never	0.00%	0
TOTAL		41

Question 11 (Compare)

When do you allow initiation of VTE prophylaxis in a TBI patient with evidence of intracranial hemorrhage and no evidence of ongoing bleeding?

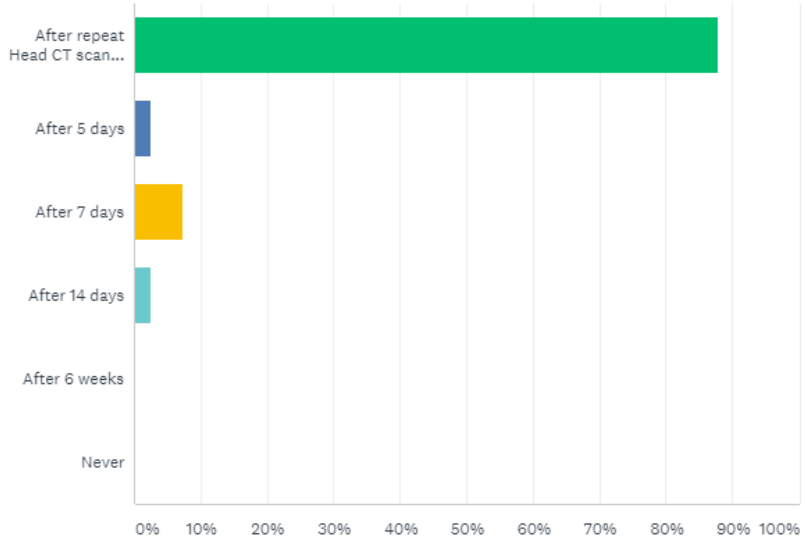
Answered: 27 Skipped: 0



ANSWER CHOICES	RESPONSES	
After repeat Head CT scan with stabilization of brain injury findings in 24-48 hrs.	66.67%	18
After 5 days	14.81%	4
After 7 days	11.11%	3
After 14 days	3.70%	1
After 6 weeks	3.70%	1
Never	0.00%	0
TOTAL		27

When do you allow initiation of VTE prophylaxis in a TBI patient with evidence of intracranial hemorrhage and no evidence of ongoing bleeding?

Answered: 41 Skipped: 5

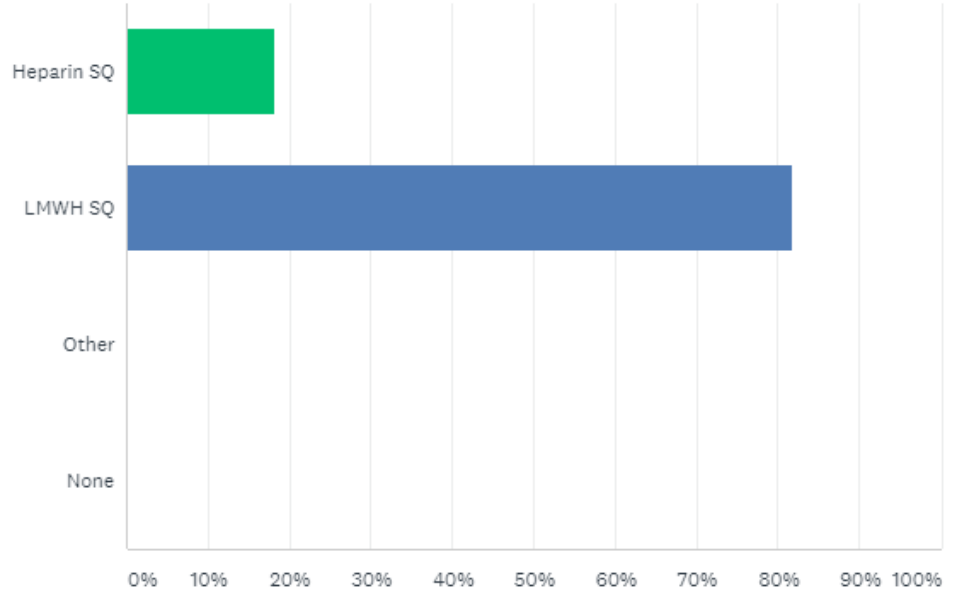


ANSWER CHOICES	RESPONSES	
After repeat Head CT scan with stabilization of brain injury findings in 24-48 hrs.	87.80%	36
After 5 days	2.44%	1
After 7 days	7.32%	3
After 14 days	2.44%	1
After 6 weeks	0.00%	0
Never	0.00%	0
TOTAL		41

Question 12 (New)

What agent do you prefer for venous thromboembolism (VTE) prophylaxis in a TBI patient?

Answered: 44 Skipped: 3

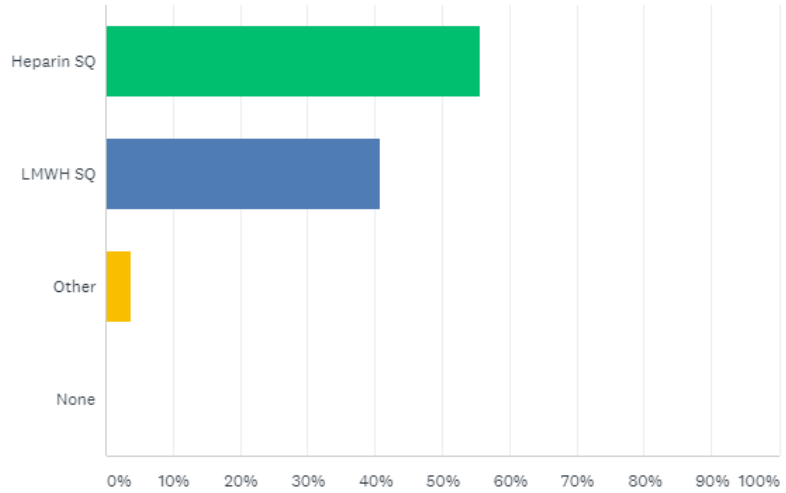


ANSWER CHOICES	RESPONSES	
Heparin SQ	18.18%	8
LMWH SQ	81.82%	36
Other	0.00%	0
None	0.00%	0
TOTAL		44

Question 13 (Compare)

What agent do you prefer for venous thromboembolism (VTE) prophylaxis in a TBI patient?

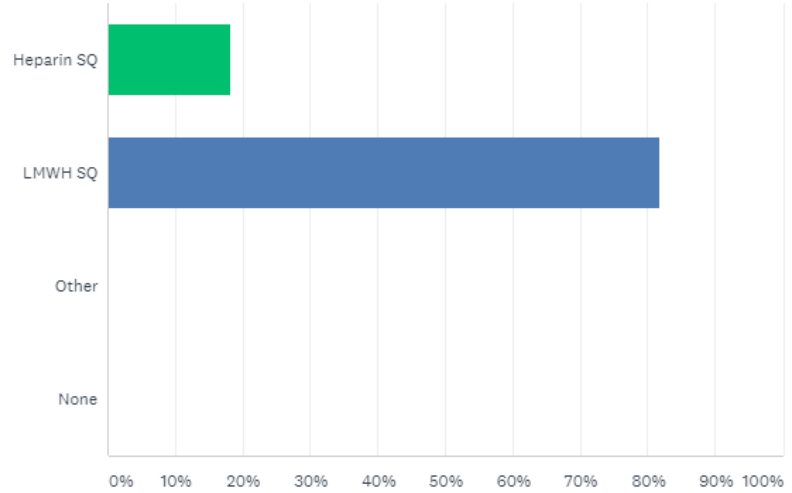
Answered: 27 Skipped: 0



ANSWER CHOICES	RESPONSES	
Heparin SQ	55.56%	15
LMWH SQ	40.74%	11
Other	3.70%	1
None	0.00%	0
TOTAL		27

What agent do you prefer for venous thromboembolism (VTE) prophylaxis in a TBI patient?

Answered: 44 Skipped: 3



ANSWER CHOICES	RESPONSES	
Heparin SQ	18.18%	8
LMWH SQ	81.82%	36
Other	0.00%	0
None	0.00%	0
TOTAL		44

Unfractionated heparin versus low-molecular-weight heparin for venous thromboembolism prophylaxis in trauma

Benjamin N. Jacobs, MD, Anne H. Cain-Nielsen, MS, Jill L. Jakubus, MHSA, MS, PA-C, Judy N. Mikhail, PhD, RN, John J. Fath, MD, Scott E. Regenbogen, MD, *and* **Mark R. Hemmila, MD**, *Ann Arbor, Michigan*

BACKGROUND: Venous thromboembolism (VTE) is a common complication in trauma patients. Pharmacologic prophylaxis is utilized in trauma patients to reduce their risk of a VTE event. The Eastern Association for the Surgery of Trauma guidelines recommend use of low-molecular-weight heparin (LMWH) as the preferred agent in these patients. However, there is literature suggesting that unfractionated heparin (UFH) is an acceptable, and less costly, alternative VTE prophylaxis agent with equivalent efficacy in trauma patients. We examined data from the Michigan Trauma Quality Improvement Program to perform a comparative effectiveness study of UFH versus LMWH on outcomes for trauma patients.

METHODS: We conducted an analysis of the Michigan Trauma Quality Improvement Program data from January 2012 to December 2014. The data set contains information on date, time, and drug type of the first dose of VTE prophylaxis. Thirty-seven thousand eight hundred sixty-eight patients from 23 hospitals were present with an Injury Severity Score of 5 or greater and hospitalization for more than 24 hours. Patients were excluded if they died within 24 hours or received no pharmacologic VTE prophylaxis or agents other than UFH or LMWH while admitted to the hospital. We compared patients receiving LMWH to those receiving UFH. Outcomes assessed were VTE event, pulmonary embolism, deep vein thrombosis, and mortality during hospitalization. We used a generalized estimating equation approach to fit population-averaged logistic regression models with the type of first dose of VTE prophylaxis as the independent variable. Unfractionated heparin was considered the reference value. Timing of the first dose of VTE prophylaxis was entered into the model in addition to standard covariates. Odds ratios were generated for each of the dependent variables of interest.

RESULTS: The analysis cohort consisted of 18,010 patients. Patients administered LMWH had a decreased risk of mortality (odds ratio, 0.64; confidence interval, 0.49–0.83), VTE (odds ratio, 0.67; confidence interval, 0.53–0.84), pulmonary embolism (odds ratio, 0.53; confidence interval, 0.35–0.79), and deep vein thrombosis (odds ratio, 0.73; confidence interval, 0.57–0.95) when compared with UFH following risk adjustment and accounting for hospital effect. The reduced risk of a VTE event for patients receiving LMWH was most pronounced for patients in the lower injury-severity categories.

CONCLUSIONS: In our examination of VTE prophylaxis drug effectiveness, LMWH was found to be superior to UFH in reducing the incidence of mortality and VTE events among trauma patients. Therefore, LMWH should be the preferred VTE prophylaxis agent for use in hospitalized trauma patients. (*J Trauma Acute Care Surg.* 2017;83: 151–158.

LEVEL OF EVIDENCE: Therapeutic, level III.

KEY WORDS: Collaborative quality improvement; complications; quality improvement; trauma outcomes; venous thromboembolism; venous thromboembolism prophylaxis.

VTE Prophylaxis Study

- Date range: 1/1/2012 to 12/31/2014
- Inclusion:
  - MTQIP patient
  - VTE prophylaxis with heparin or LMWH
- Exclusion:
  - Direct admit
  - Transfer out
  - Dead and hospital days <=1
  - Trauma centers who joined after 1/1/2012

Unadjusted Outcomes

Outcome	Heparin	LMWH	p-value
Patients, N	7,786	10,224	--
Mortality, % (N)	2.1 (166)	1.4 (139)	<0.001
DVT, % (N)	2.1 (161)	1.5 (153)	<0.001
Pulmonary Embolism, % (N)	0.8 (66)	0.5 (52)	0.01
VTE, % (N)	2.7 (207)	1.9 (190)	<0.001

Risk Adjustment

- Patient Characteristics
- Insurance status
- Physiology
- Injuries
- Comorbidities
- Intubation status
- Transfer status
- Timing of initiation of VTE prophylaxis

Adjusted Outcomes

	Outcome	N	OR	95% CI
★	VTE Event, with Hospital Effect	18,010	0.67	0.53-0.84
	VTE Event by ISS categories			
★	5-15	13,328	0.70	0.49-0.99
★	16-24	3,035	0.46	0.31-0.70
	≥ 25	1,647	1.05	0.72-1.53

Adjusted Outcomes

	Outcome	N	OR	95% CI
★	PE, with Hospital Effect	18,010	0.53	0.35-0.79
	PE by ISS categories			
★	5-15	13,328	0.41	0.23-0.73
★	16-24	3,035	0.41	0.19-0.87
	≥ 25	1,647	1.2	0.60-2.38

Adjusted Outcomes

	Outcome	N	OR	95% CI
★	DVT, with Hospital Effect	18.010	0.73	0.57-0.95
	DVT by ISS categories			
	5-15	13,328	0.82	0.54-1.25
★	16-24	2,919	0.50	0.32-0.80
	≥ 25	1,505	1.18	0.79-1.77

Adjusted Outcomes

	Outcome	N	OR	95% CI
★	Mortality, with Hospital Effect	18,010	0.64	0.49-0.83
	Mortality by ISS categories			
	5-15	13,328	0.81	0.56-1.18
	16-24	3,035	0.75	0.43-1.30
★	≥ 25	1,647	0.55	0.36-0.84

Effectiveness of low-molecular-weight heparin versus unfractionated heparin to prevent pulmonary embolism following major trauma: A propensity-matched analysis

James P. Byrne, MD, William Geerts, MD, Stephanie A. Mason, MD, David Gomez, MD, PhD, Christopher Hoeft, MA, Ryan Murphy, MPH, Melanie Neal, MS, *and* **Avery B. Nathens, MD, PhD**, *Toronto, Ontario, Canada*

Annals of Surgery. 266(3):463–469, SEP 2017
DOI: 10.1097/SLA.0000000000002359, , PMID: 28650361
Issn Print: 0003-4932
Publication Date: 2017/09/01

Pharmacological Thromboembolic Prophylaxis in Traumatic Brain Injuries: Low Molecular Weight Heparin Is Superior to Unfractionated Heparin

Elizabeth Benjamin; Gustavo Recinos; Alberto Aiolfi; Kenji Inaba; Demetrios Demetriades

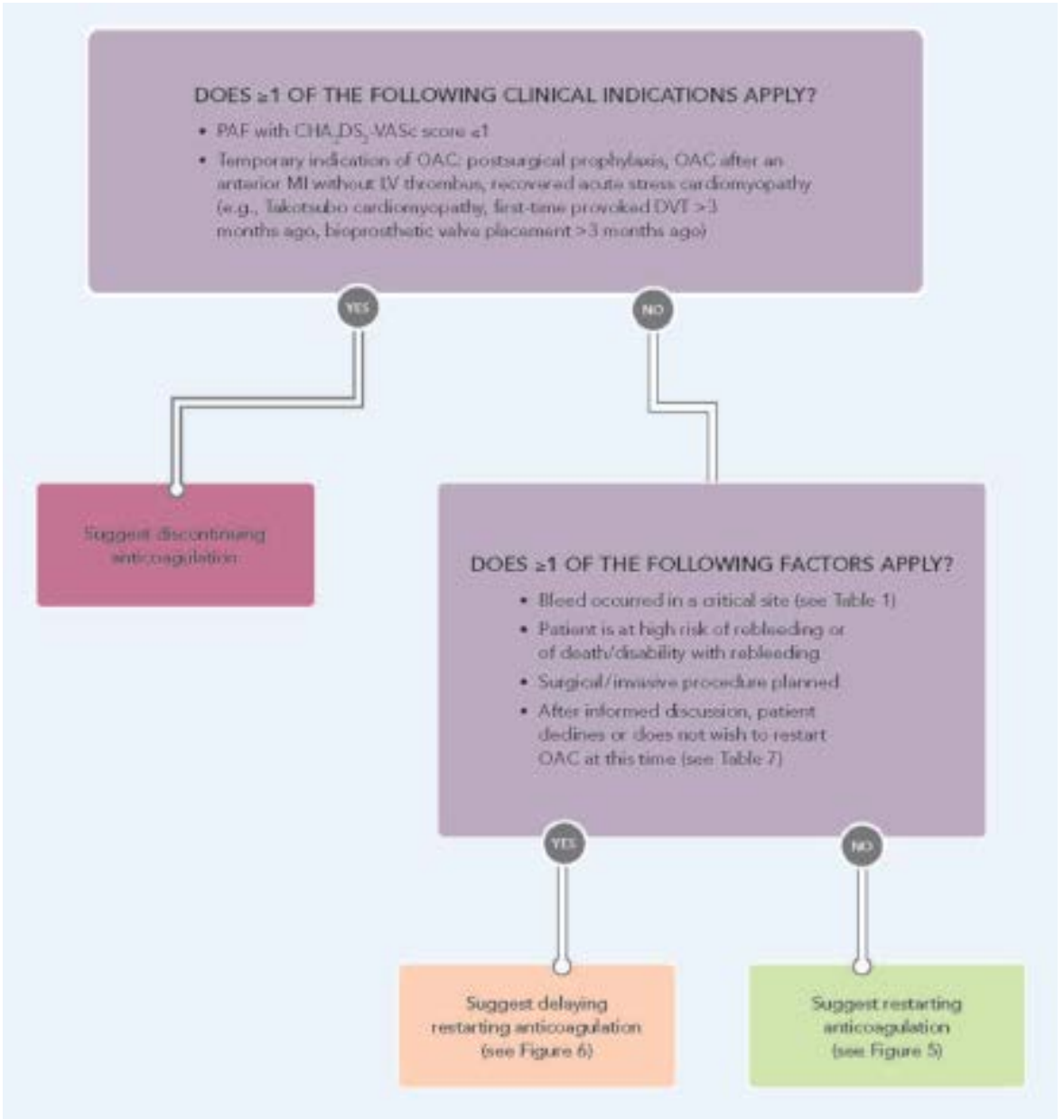

DOES ≥1 OF THE FOLLOWING CLINICAL INDICATIONS APPLY?
• PAF with CHA2DS2-VASc score ≤1
• Temporary indication of OAC: postsurgical prophylaxis, OAC after an anterior MI without LV thrombus, recovered acute stress cardiomyopathy (e.g., Takotsubo cardiomyopathy), first-time provoked DVT >3 months ago, bioprosthetic valve placement >3 months ago)
YES
NO
Suggest discontinuing anticoagulation
DOES ≥1 OF THE FOLLOWING FACTORS APPLY?
• Bleed occurred in a critical site (see Table 1)
• Patient is at high risk of rebleeding or of death/disability with rebleeding
• Surgical/invasive procedure planned
• After informed discussion, patient declines or does not wish to restart OAC at this time (see Table 7)
YES
NO
Suggest delaying restarting anticoagulation (see Figure 6)
Suggest restarting anticoagulation (see Figure 5)

TABLE 6 Indications for Anticoagulation With High Thrombotic Risk

Indication	Patient Characteristics
Mechanical valve prosthesis	■ Mechanical valve + additional thrombotic considerations: AF, CHF, prior stroke/TIA ■ Caged-ball or tilting disc aortic valve prosthesis ■ Stroke/TIA within 6 months
AF	■ AF with $CHADS_2$ score ≥4 (or CHA_2DS_2-VASc score ≥6) (84) ■ Stroke/TIA within 3 months ■ Stroke risk ≥10% per year ■ Rheumatic valve disease or mitral stenosis
VTE	■ VTE within 3 months ■ History of unprovoked or recurrent VTE ■ Active cancer and history of cancer-associated VTE
Prior thromboembolism with interruption of anticoagulation	
Left ventricular or left atrial thrombus	
Left ventricular assist device (LVAD)	

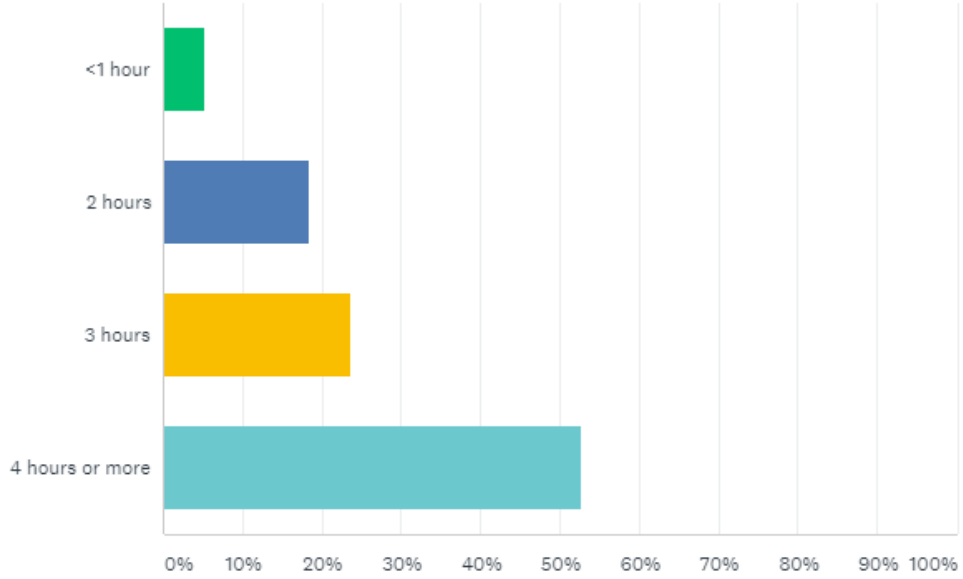
Discussion - Timing of OR in Head Injury

Jason Heth, MD
Mark Hemmila, MD

Question 9

What is the maximum duration of an orthopedic surgery operation that you are comfortable with in a moderate to severe TBI patient with a stable exam and/or stable/non-concerning ICP monitor readings?

Answered: 38 Skipped: 9

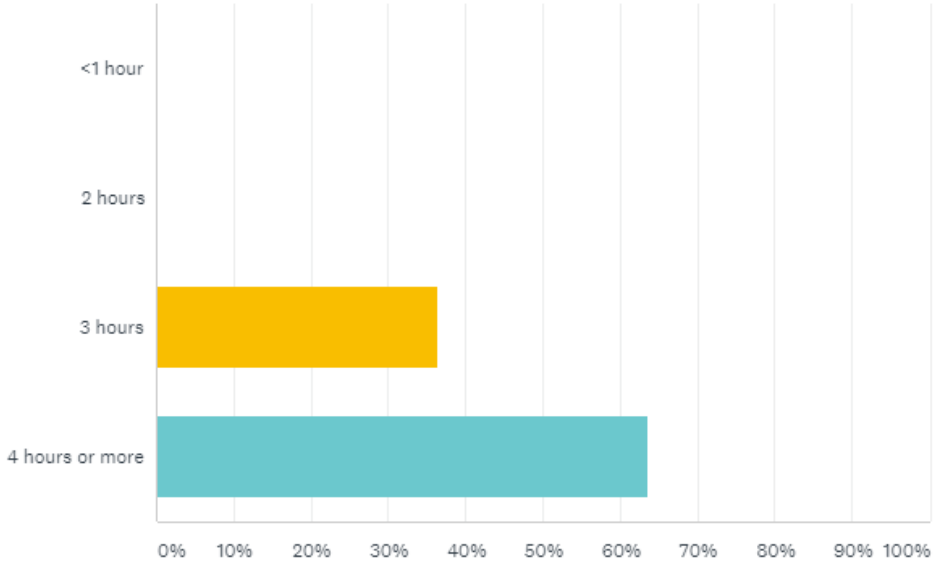


ANSWER CHOICES	RESPONSES	
<1 hour	5.26%	2
2 hours	18.42%	7
3 hours	23.68%	9
4 hours or more	52.63%	20
TOTAL		38

Question 9 (Neurosurgeon)

What is the maximum duration of an orthopedic surgery operation that you are comfortable with in a moderate to severe TBI patient with a stable exam and/or stable/non-concerning ICP monitor readings?

Answered: 11 Skipped: 0

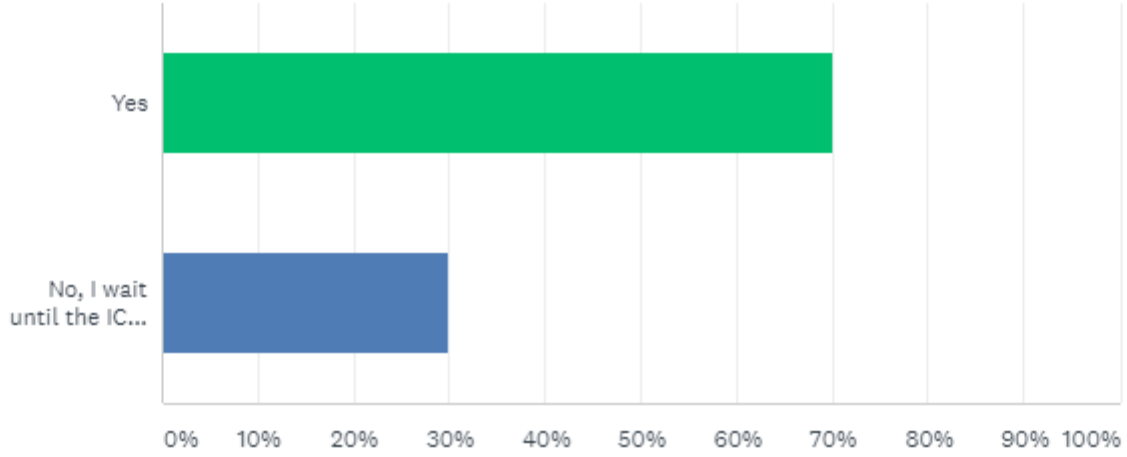


ANSWER CHOICES	RESPONSES	
<1 hour	0.00%	0
2 hours	0.00%	0
3 hours	36.36%	4
4 hours or more	63.64%	7
TOTAL		11

Question 10

Do you allow stable TBI patients to go to the OR with an ICP monitor for repair of non-life threatening injuries?

Answered: 40 Skipped: 7

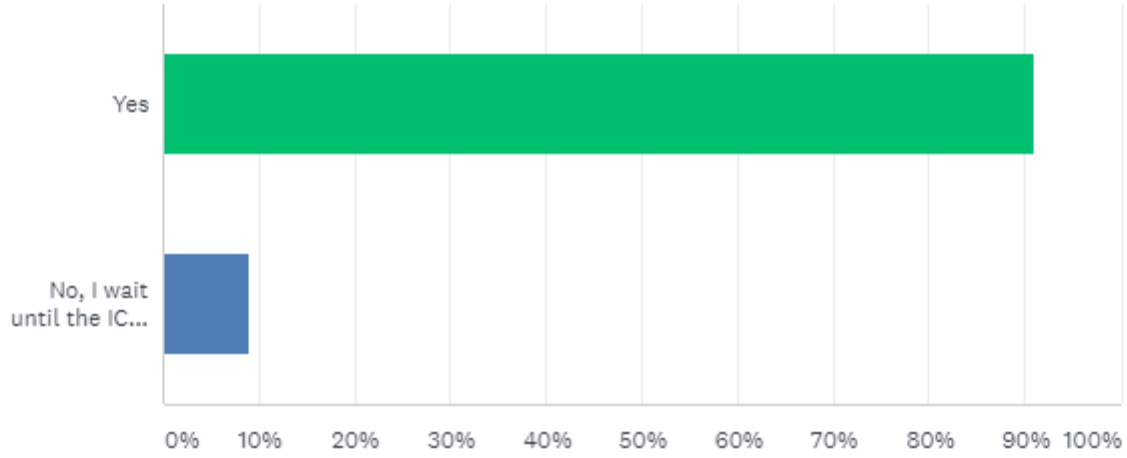


ANSWER CHOICES	RESPONSES	
Yes	70.00%	28
No, I wait until the ICP monitor is discontinued before allowing operative intervention for non-life threatening injuries.	30.00%	12
TOTAL		40

Question 10 (Neurosurgeon)

Do you allow stable TBI patients to go to the OR with an ICP monitor for repair of non-life threatening injuries?

Answered: 11 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	90.91%	10
No, I wait until the ICP monitor is discontinued before allowing operative intervention for non-life threatening injuries.	9.09%	1
TOTAL		11

Break

Conceptualization of Functional Outcomes Following TBI

Ryan Stork, MD

Conceptualization of Functional Outcomes Following Traumatic Brain Injury

Ryan Stork, MD
Clinical Lecturer
Brain Injury Medicine & Rehabilitation
Department of Physical Medicine & Rehabilitation
Michigan Medicine
University of Michigan

A Bit About Me

- Residency:
- Fellowship
- Role at U of M

Objectives

- Understand basic framework for conceptualizing rehabilitation outcomes

- Appreciate the flaws in classification scheme of TBI severity
  - Research implications
  - Functional outcome implications

Importance of Conceptual Framework When Discussing TBI

- Poor evidence base in TBI Rehabilitation

- Need to account for:
  - Injury characteristics
  - Premorbid functioning
  - Age

- Weakness in TBI Research
  - Caveat: Zolpidem Studies (cross-over design)

Post-traumatic Amnesia

State of confusion that occurs immediately following a traumatic brain injury that is characterized by disorientation and inability to recall new information

Measurement of Post-traumatic Amnesia

- Galveston Orientation Amnesia Test (GOAT)
- Orientation Log (O-Log)
- Marker of diffuse axonal injury

Classification of TBI Severity

Variable	Mild	Moderate	Severe
GCS (Initial, best, worst)	13-15	9-12	3-8
Duration of PTA	< 1 day	1-7 days	> 7 days
Duration of LOC	< 30 minutes	≤ 24 hours	> 24 hours

Main Outcome Scales for TBI

- Glasgow Outcome Scale
- Disability Rating Scale

Glasgow Outcome Scale

CATEGORY	DESCRIPTION
1 Death	Self-evident criteria
2 VS (alive but unconscious)	Prolonged unconsciousness with no verbalization, no following of commands. Absent awareness of self and environment; patient may open eyes; absence of cortical function as judged behaviorally; characterized by the presence of sleep–wake cycles
3 Severe disability (conscious but dependent)	Patient unable to be independent for any 24-hr period by reason of residual mental and/or physical disability
4 Moderate disability (independent but disabled)	Patient with residual deficits that do not prevent independent daily life; patient can travel by public transport and work in a sheltered environment
5 Good recovery (mild to no residual effects)	Return to normal life; there may be minor or no residual deficits

Glasgow Outcome Scale - Extended

1	Death	D
2	Vegetative state	VS
3	Lower severe disability	SD -
4	Upper severe disability	SD +
5	Lower moderate disability	MD -
6	Upper moderate disability	MD +
7	Lower good recovery	GR -
8	Upper good recovery	GR +

Disability Rating Scale

TBI NATIONAL DATABASE COLLECTION FORM

Patient Name: _____ **Date of Rating:**_____

F.GROOMING (COGNITIVE ABILITY ONLY)

- ☐ (0.0) Complete
- ☐ (1.0) Partial
- ☐ (2.0) Minimal
- ☐ (3.0) None

Does the patient show awareness of how and when to perform this activity? Ignore motor disabilities that interfere with carrying out this function. (This is rated under Level of Functioning described below.) Grooming refers to bathing, washing, brushing of teeth, shaving, combing or brushing of hair and dressing.
0-COMPLETE: continuously shows awareness that he knows how to groom self and can convey unambiguous information that he knows when this activity should occur.
1-PARTIAL: intermittently shows awareness that he knows how to groom self and/or can intermittently convey reasonably clearly information that he knows when the activity should occur.
2-MINIMAL: shows questionable or infrequent awareness that he knows in a primitive way how to groom self and/or shows infrequently by certain signs, sounds, or activities that he is vaguely aware when the activity should occur.
3-NONE: shows virtually no awareness at any time that he knows how to groom self and cannot convey information by signs, sounds, or activity that he knows when the activity should occur.

G.LEVEL OF FUNCTIONING (PHYSICAL, MENTAL, EMOTIONAL OR SOCIAL FUNCTION))

- ☐ (0.0) Completely Independent
- ☐ (1.0) Independent in special environment
- ☐ (2.0) Mildly Dependent-Limited assistance (non-resid - helper)
- ☐ (3.0) Moderately Dependent-moderate assist (person in home)
- ☐ (4.0) markedly Dependent-assist all major activities, all times
- ☐ (5.0) Totally Dependent-24 hour nursing care.

0-COMPLETELY INDEPENDENT: able to live as he wishes, requiring no restriction due to physical, mental, emotional or social problems.
1-INDEPENDENT IN SPECIAL ENVIRONMENT: capable of functioning independently when needed requirements are met (mechanical aids)
2-MILDLY DEPENDENT: able to care for most of own needs but requires limited assistance due to physical, cognitive and/or emotional problems (e.g., needs non-resident helper).
3-MODERATELY DEPENDENT: able to care for self partially but needs another person at all times. (person in home)
4-MARKEDLY DEPENDENT: needs help with all major activities and the assistance of another person at all times.
5-TOTALLY DEPENDENT: not able to assist in own care and requires 24-hour nursing care.

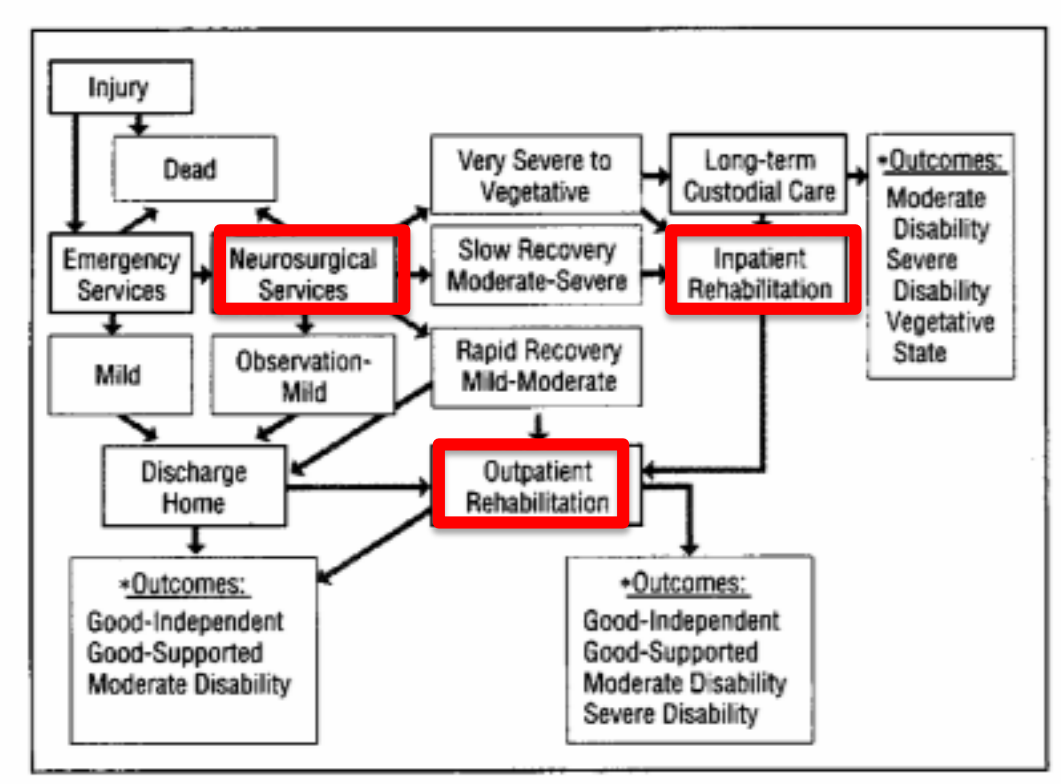
H."EMPLOYABILITY"(AS A FULL TIME WORKER, HOMEMAKER, OR STUDENT)

- ☐ (0.0) Not Restricted
- ☐ (1.0) Selected jobs, competitive
- ☐ (2.0) Sheltered workshop, Non-competitive
- ☐ (3.0) Not Employable

0-NOT RESTRICTED: can compete in the open market for a relatively wide range of jobs commensurate with existing skills; or can initiate, plan execute and assume responsibilities associated with homemaking; or can understand and carry out most age relevant school assignments.
1-SELECTED JOBS, COMPETITIVE: can compete in a limited job market for a relatively narrow range of jobs because of limitations of the type described above and/or because of some physical limitations; or can initiate, plan, execute and assume many but not all responsibilities associated with homemaking; or can understand and carry out many but not all school assignments.
2-SHELTERED WORKSHOP, NON-COMPETITIVE: cannot compete successfully in a job market because of limitations described above and/or because of moderate or severe physical limitations; or cannot without major assistance initiate, plan, execute and assume responsibilities for homemaking; or cannot understand and carry out even relatively simple school assignments without assistance.
3-NOT EMPLOYABLE: completely unemployable because of extreme psychosocial limitations of the type described above, or completely unable to initiate, plan, execute and assume any responsibilities associated with homemaking; or cannot understand or carry out any school assignments.

3-NONE: shows virtually no awareness at any time that he knows how to toilet and cannot convey information by signs, sounds, or activity that he knows when the activity should occur.

Spectrum of Outcomes Following TBI



Katz D, et al. "Predicting course of recovery and outcome for patients admitted to rehabilitation" *Arch Neurology* 1994. 51: 661-670

Katz and Alexander Prospective Outcome Study (1994)

- 243 consecutive IPR patients over 3 years
- Ages: 8-89
- Cause of injury
  - MVA
  - Pedestrian struck by car
  - Fall < 6 feet
  - Fall > 6 feet

Table 1. Age and Gender Breakdown of Patient Sample

Age Group, y	Sex		Total
	M	F	
<20	46	12	58
20-39	99	15	114
40-59	17	8	25
>60	24	22	47
Total	186	57	243

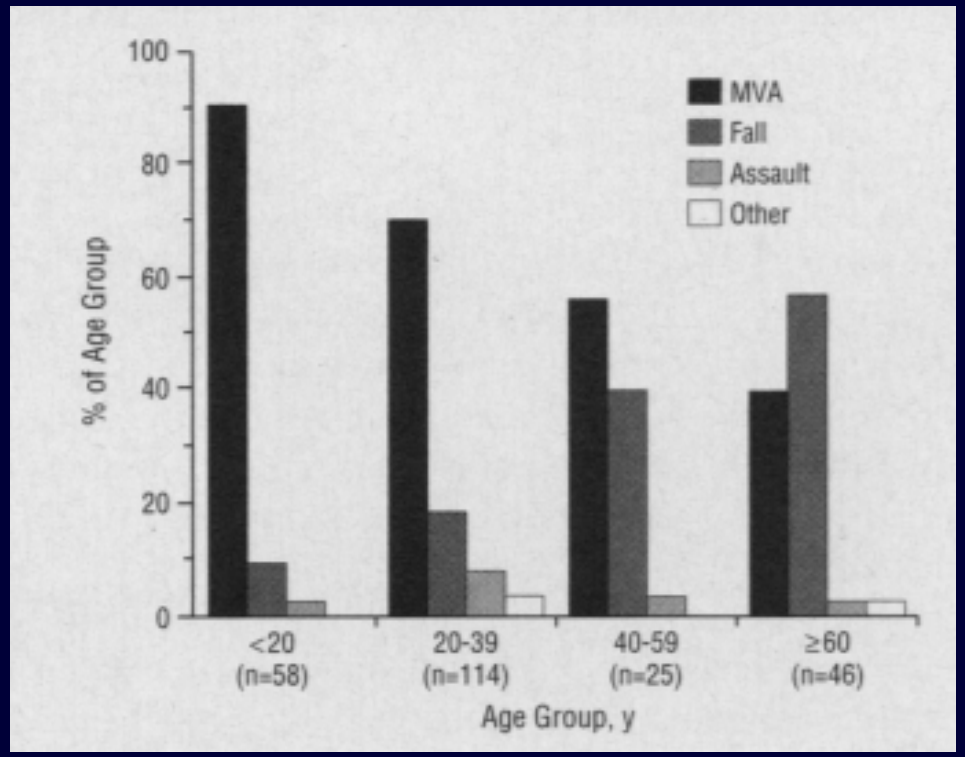
Katz D, et al. "Predicting course of recovery and outcome for patients admitted to rehabilitation" *Arch Neurology* 1994. 51: 661-670

Katz and Alexander Hypotheses

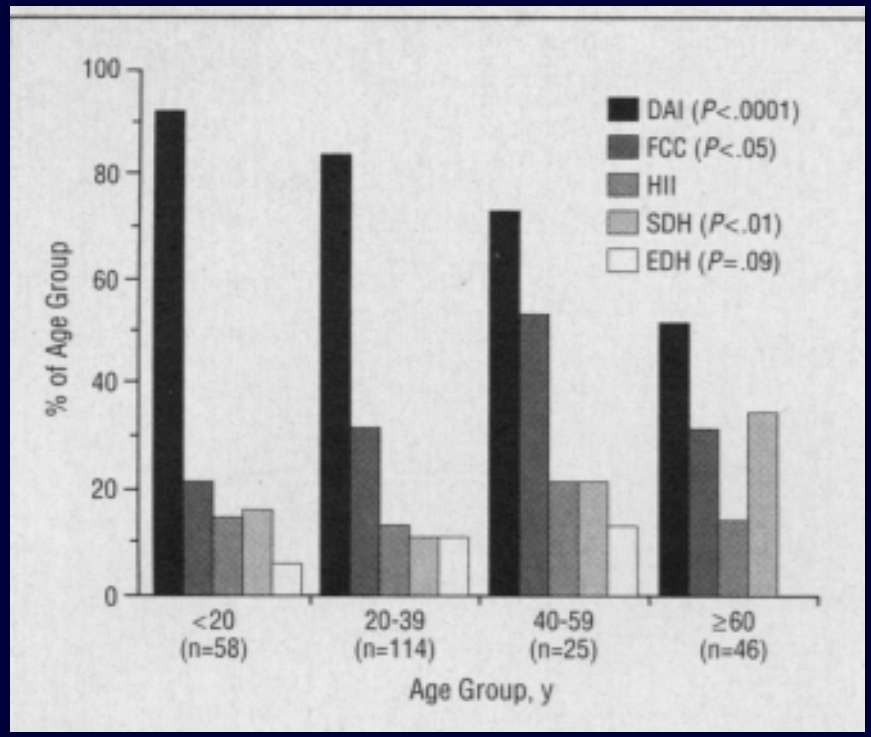
- Rehab populations can be characterized by those variables of demonstrable significance in neurosurgical series

- Neurologic injury subtypes should have different implications for recovery and may require different research strategies

Cause of Injury



Proportions of Subtypes of Neuropathology



Relationship Between Severity Variables

Relationship Tested	DAI			FCC		
	No.	R^2	F Test (P)	No.	R^2	F Test (P)
GCS-LOC	169	.116	<.0001	21	.020	.545
GCS-PTA	164	.233	<.0001	22	.073	.223
LOC-PTA	175	.575	<.0001	22	.047	.332

Duration of Coma and Outcome

Length of Coma	GR	MD	SD	VS
< 1 hr	70%	17%	13%	
< 1 day	58%	42%		
1-7 days	58%	37%	5%	
1-2 weeks	39%	61%		
2-3 weeks		67%	33%	
3-4 weeks		67%	22%	11%
> 4 weeks		38%	62%	

Duration of PTA and Outcome

Length of PTA	GR	MD	SD	VS
0-2 weeks	80%	13%	7%	
2-4 weeks	60%	40%		
4-8 weeks	46%	54%		
8-12 weeks	18%	64%	18%	
12-16 weeks		73%	27%	
16-24 weeks		80%	20%	
> 24 weeks		12%	88%	

Influence of Neuropathology on Predictors of Outcome

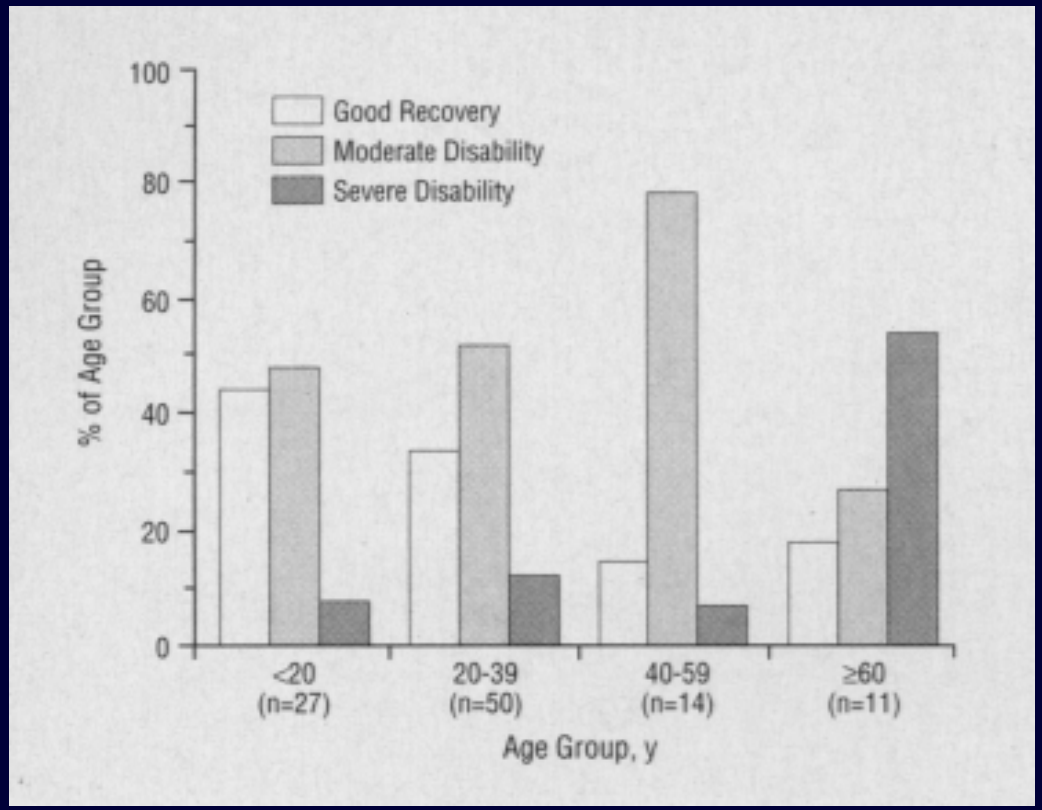
Table 2. Relationships of Severity and Outcome Variables in Patients With Diffuse Axonal Injury (DAI) or Focal Cortical Contusion (FCC)*

Relationship Tested	DAI			FCC		
	No.	R^2	F Test (P)	No.	R^2	F Test (P)
GCS-LOC	169	.116	<.0001	21	.020	.545
GCS-PTA	164	.233	<.0001	22	.073	.223
LOC-PTA	175	.575	<.0001	22	.047	.332
GCS-GOS at 6 mo	149	.135	<.0001	20	.101	.171
GCS-GOS at 12 mo	110	.081	<.005	15	.141	.168
LOC-GOS at 6 mo	153	.259	<.0001	20	.002	.851
LOC-GOS at 12 mo	115	.278	<.0001	16	.003	.853
PTA-GOS at 6 mo	147	.447	<.0001	21	.207	<.05
PTA-GOS at 12 mo	110	.476	<.0001	16	.000	.967

Interaction of Age and Prediction of GOS at 12 months

- Interaction with GCS
  - Significant interaction on GOS at 12 months
    - Worse outcome for any GCS score if older than 60
- Interaction with LOC
  - Significant interaction on GOS at 12 months
- Interaction with PTA
  - Better outcome at 12 months if < 20 years-old
  - Worse outcome at 12 months if > 60 years-old

Proportion of GOS at 12 Months by Age Group



Relation of Age to Change in GOS Between 6 and 12 months

- Significant relationship between GOS at 6 and 12 months

- Younger than 40 years-old
  - Better chance at improved outcomes from 6 to 12 months
  - Rate of recovery similar

Recovery of Consciousness

Traumatic Brain Injury

Duration of VS	3 months	6 months	12 months
1 month	33%	46%	52%
			GR 7% MD 17% SD 28%
3 months			35%
			GR or MD 16% SD 19%
6 months			16%
			GR or MD 4% SD 12%

Medical aspects of the persistent vegetative state. The Multi Society Task Force on PVS. *N Engl J Med* 1994; 330(21): 1499-1508

Recovery of Consciousness

Non-traumatic Brain Injury

Duration of VS	3 months	6 months	12 months
1 month	11%	15%	15%
			GR 1% MD 3% SD 11%
3 months			7%
			GR or MD 1% SD 6%
6 months			0%

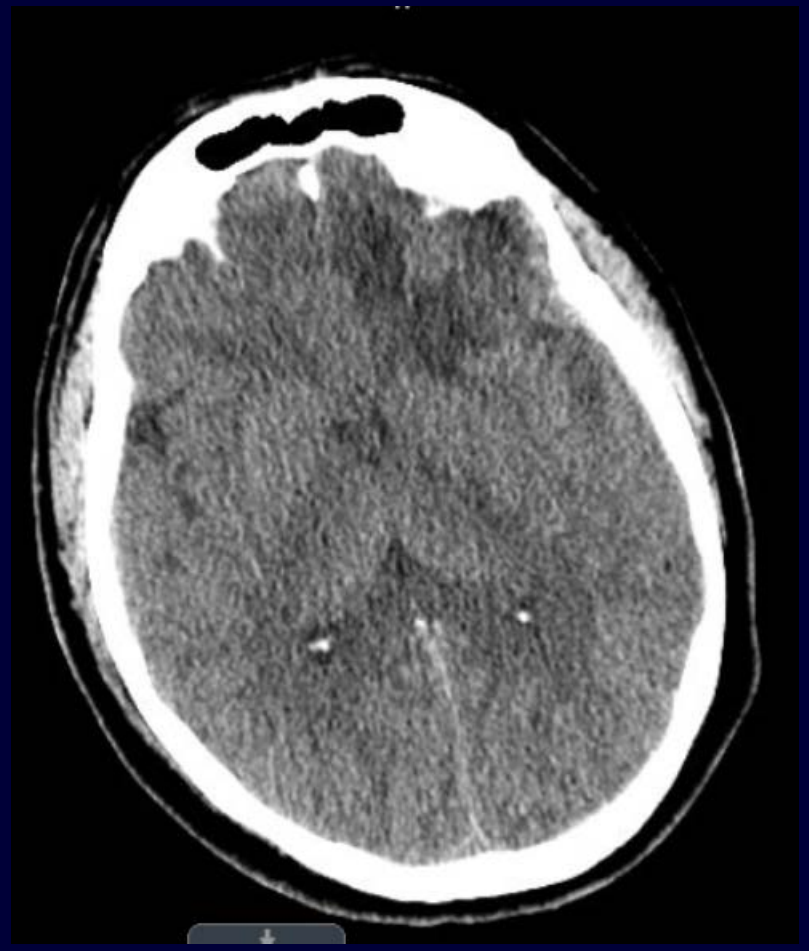
Medical aspects of the persistent vegetative state. The Multi Society Task Force on PVS. *N Engl J Med* 1994; 330(21): 1499-1508

XX year-old male fall at work XX/XX/XX

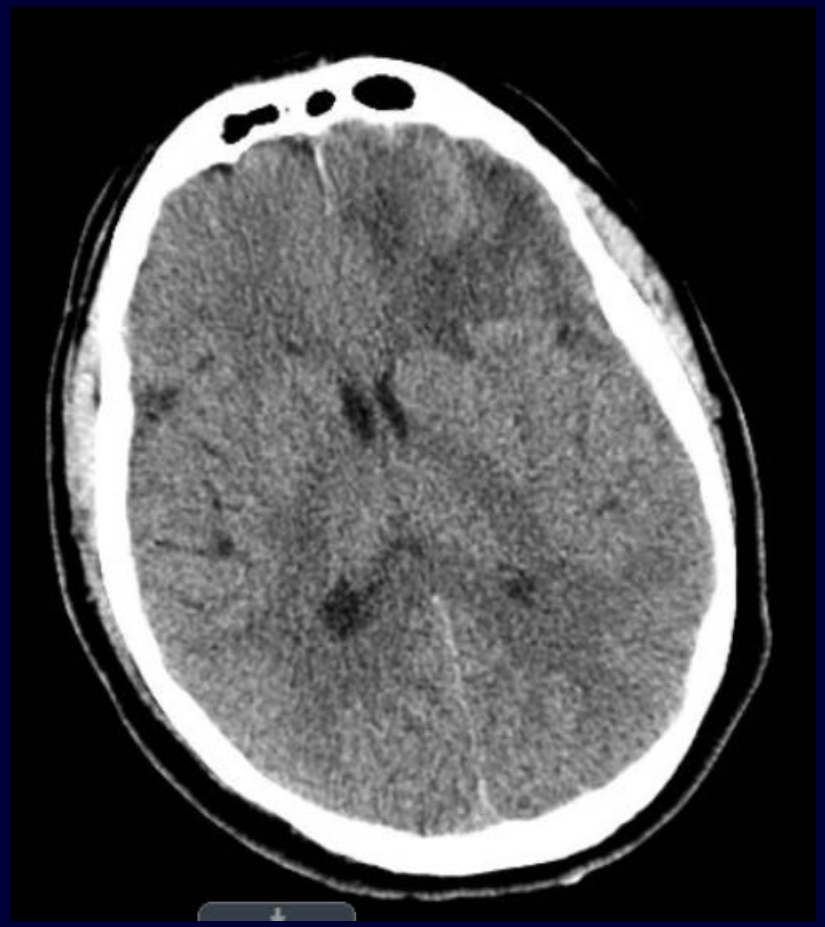
- GCS in ER 13 (E3V4M6)
- PTA approximately 2 weeks
  - Katz study showed about 80% return to work at 12 months
- Prominent left frontal contusion
  - Neurobehavioral deficits

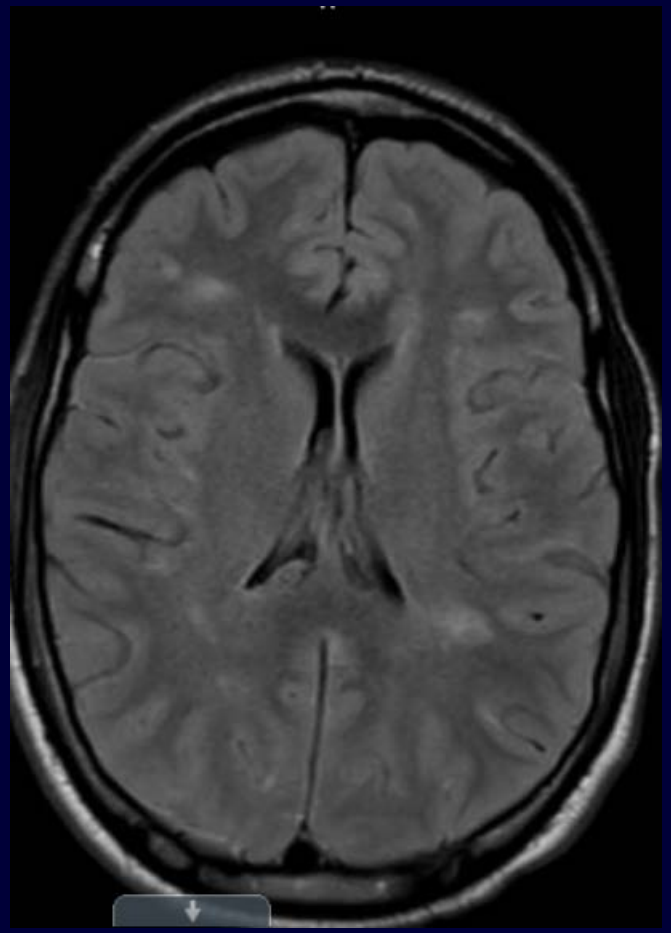
XX year-old male fall at work XX/XX/XX

XX year-old male fall at work XX/XX/XX



XX year-old male fall at work XX/XX/XX

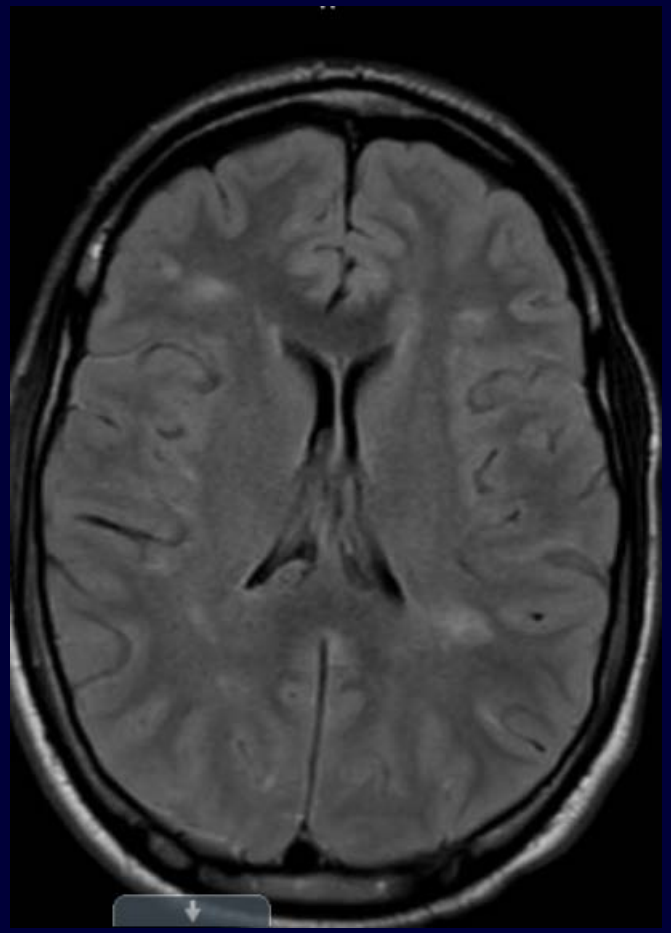




XX year-old male in MVC XX/XX/XX

- GCS in ER: 14 (E4V4M6)
- PTA for approximately 2 weeks

XX year-old male in MVC XX/XX/XX



XX year-old male in MVC XX/XX/XX

- Last clinic visit XX/XX/XX

- Assessment: XX y.o. Male who was the restrained passenger in a motor vehicle collision on XX/XX/XX, resulting a severe traumatic brain injury characterized primarily be diffuse axonal injury with no significant focal contusions. Both he and his mother are reporting being at his baseline. Neuropsychological testing was ordered at previous visit but patient cancelled this. Although his severity of brain injury is classified as severe, based his duration of PTA (around 14 days) I would expect a strong cognitive and functional recovery from a brain injury standpoint.

XX year-old male fall from ladder XX/XX/XX

- GCS 13 in ER
- In PTA as of yesterday (X days)

XX year-old male fall from ladder XX/XX/XX

XX year-old male fall from ladder XX/XX/XX

XX year-old bike versus motor vehicle XX/XX/XX

- GCS in ER 8-9 (E1-2V2M5)
- Out of PTA as of XX/XX/XX (X days)

XX year-old bike versus motor vehicle XX/XX/XX

Objectives

- Understand basic framework for conceptualizing rehabilitation outcomes

- Appreciate the flaws in classification scheme of TBI severity
  - Research implications
  - Functional outcome implications

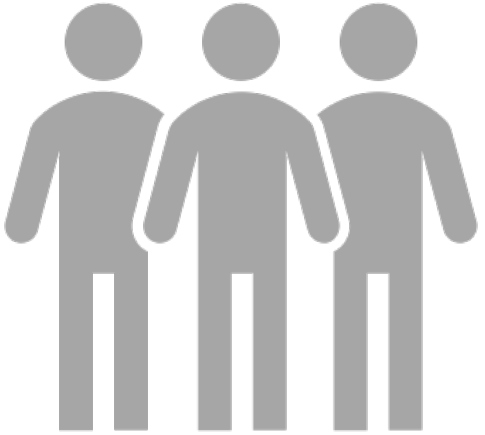
Long-Term Outcomes

Jill Jakubus, PA-C

How do you know your long-term outcomes for the care you provide?

Literature

TBI Model Systems Collaboration TBIMS Programme (1987)



Defense and Veterans Brain Injury Center TBI Registry

Literature – *Lancet Neurol 2017*

Traumatic brain injury 4

The chronic and evolving neurological consequences of traumatic brain injury

Lindsay Wilson, William Stewart, Kristen Dams-O'Connor, Ramon Diaz-Arrastia, Lindsay Horton, David K Menon, Suzanne Polinder

Traumatic brain injury (TBI) can have lifelong and dynamic effects on health and wellbeing. Research on the long-term consequences emphasises that, for many patients, TBI should be conceptualised as a chronic health condition. Evidence suggests that functional outcomes after TBI can show improvement or deterioration up to two decades after injury, and rates of all-cause mortality remain elevated for many years. Furthermore, TBI represents a risk factor for a variety of neurological illnesses, including epilepsy, stroke, and neurodegenerative disease. With respect to neurodegeneration after TBI, post-mortem studies on the long-term neuropathology after injury have identified complex persisting and evolving abnormalities best described as polypathology, which includes chronic traumatic encephalopathy. Despite growing awareness of the lifelong consequences of TBI, substantial gaps in research exist. Improvements are therefore needed in understanding chronic pathologies and their implications for survivors of TBI, which could inform long-term health management in this sizeable patient population.

Lancet Neurol 2017; 16: 813–25

This is the fourth in a Series of four papers about traumatic brain injury

See Comment page 766

See In Context page 775

Division of Psychology, University of Stirling, Stirling, UK (Prof L Wilson PhD, L Horton MRes); **Department of Neuropathology, Queen Elizabeth University Hospital, Glasgow, UK** (W Stewart MBChB); **Institute of Neuroscience and Psychology, University of Glasgow, Glasgow, UK** (W Stewart); **Department of Rehabilitation**

Introduction

Evidence accumulated in the past decades has led to recognition that, for many patients, traumatic brain injury (TBI) does not cease to evolve after the acute past decade have enabled better characterisation of late neurodegenerative features associated with TBI.

Other reviews have provided detailed accounts of long-term pathology,[33,34] imaging,[35] disease,[1,10,36]

Literature – *Lancet Neurol 2017*

Traumatic brain i

The chronic and ev
brain injury

Lindsay Wilson, William Stewart, Kristen

**Traumatic brain injury (TBI) ca
term consequences emphasises
Evidence suggests that function
after injury, and rates of all-cau
factor for a variety of neurologic
to neurodegeneration after TBI,
complex persisting and evolving
encephalopathy. Despite growin
Improvements are therefore ne
TBI, which could inform long-te**

Introduction

Evidence accumulated in the
recognition that, for many pa
injury (TBI) does not cease to

***Panel:* Major long-term consequences of traumatic brain injury**

Function

- Disability or limitations to activity[3]
- Limitations to societal participation (eg, employment)[7]
- Cognitive deficits[8,9]
- Emotional problems[10]
- Behavioural change[11]

Disease

- Mild cognitive impairment[10,12]
- Neurodegenerative diseases
  - Alzheimer's disease or dementia[13,14]
  - Parkinson's disease or parkinsonism[10,15,16]
  - Dementia with Lewy bodies[14,17]
  - Frontotemporal dementia[17]
  - Amyotrophic lateral sclerosis[10,18]
  - Chronic traumatic encephalopathy[13,19]
- Post-traumatic epilepsy[20,21]
- Stroke[22,23]
- Neuroendocrine disorders[24,25]
- Psychiatric illness[10,26]

Mortality

- Mortality of any cause or reduced life expectancy[27,28]

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counts of
isease,[1,10,14]

Lancet Neurol 2017; 16: 813–25

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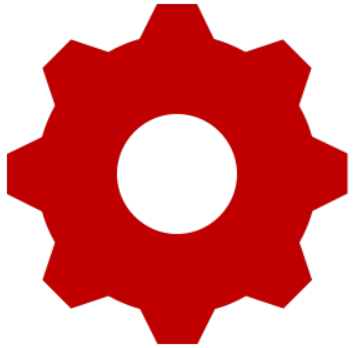
Current State

TBIMS Programme

Defense and Veterans Brain Injury Center TBI Registry



Centers for Disease Control and Prevention

Current State

Contents lists available at ScienceDirect

Journal of Safety Research

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

Special report from the CDC

CDC's efforts to improve traumatic brain injury surveillance☆,☆☆

Jeneita M. Bell, * Matthew J. Breiding, [1] Lara DePadilla [1]

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, United States

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Available online 19 April 2017

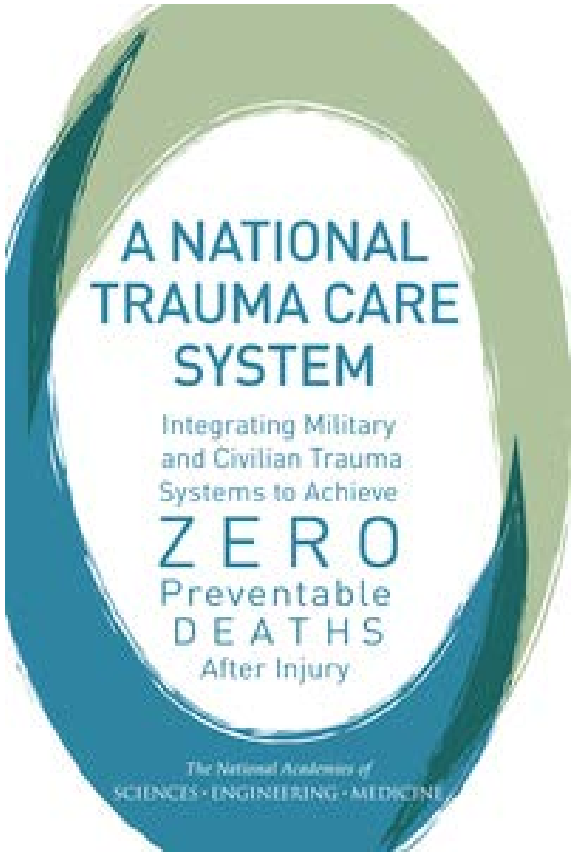
Keywords:
Traumatic
Brain
Injury
Sports
Survey

ABSTRACT

Introduction: Youth sports concussion has become a prominent public health issue due to growing concern about the risk of long-term health effects. Method: A broad spectrum of stakeholders has convened to propose solutions, including a committee of the National Academy of Sciences (NAS) who systematically examined the issue and, in a 2014 report, made a series of recommendations to better address this public health problem. Results: Among these recommendations, the NAS committee called for CDC to develop a plan for a comprehensive surveillance system to better quantify the incidence and outcomes of youth sports concussion among children 5 to 21 years of age. Since the release of the NAS report, CDC has taken action to address this recommendation and, in the process, develop strategies to improve traumatic brain injury (TBI) surveillance more broadly. The challenges outlined by the NAS committee with respect to producing comprehensive incidence estimates of youth sports concussion are not exclusive to youth sports concussion, but also apply to TBI surveillance overall. In this commentary, we will discuss these challenges, the process CDC has undertaken to address them and describe our plan for improving TBI and youth sports concussion surveillance.

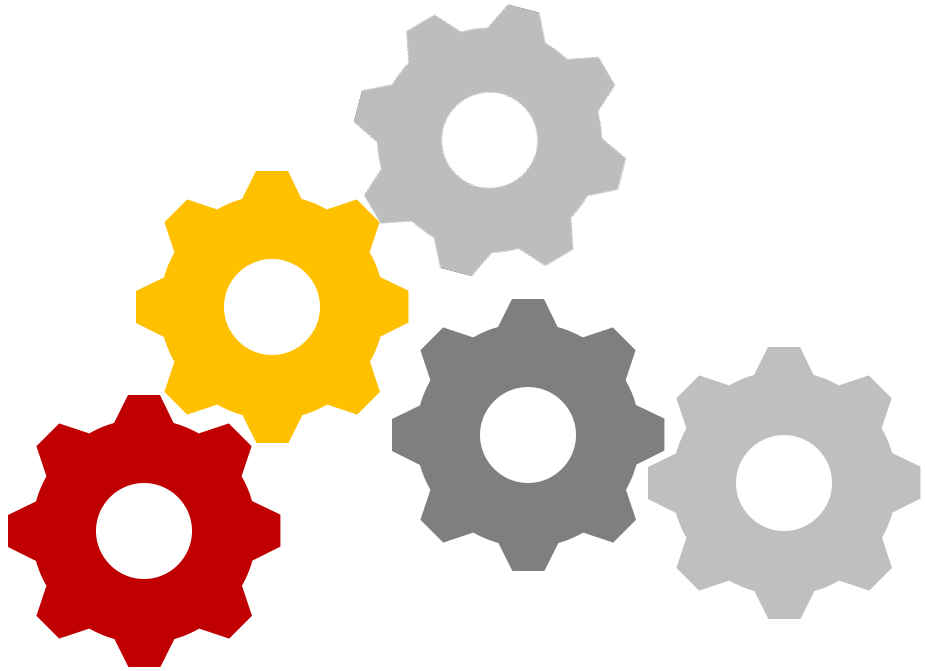
Published by Elsevier Ltd.

Target State



Learning Health System

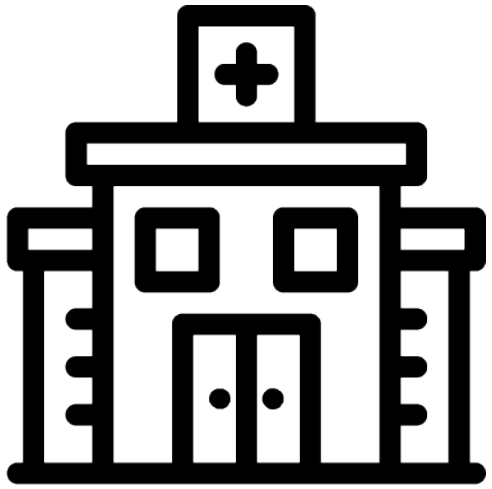
Target State



What else is missing here?

Target State

Logistics

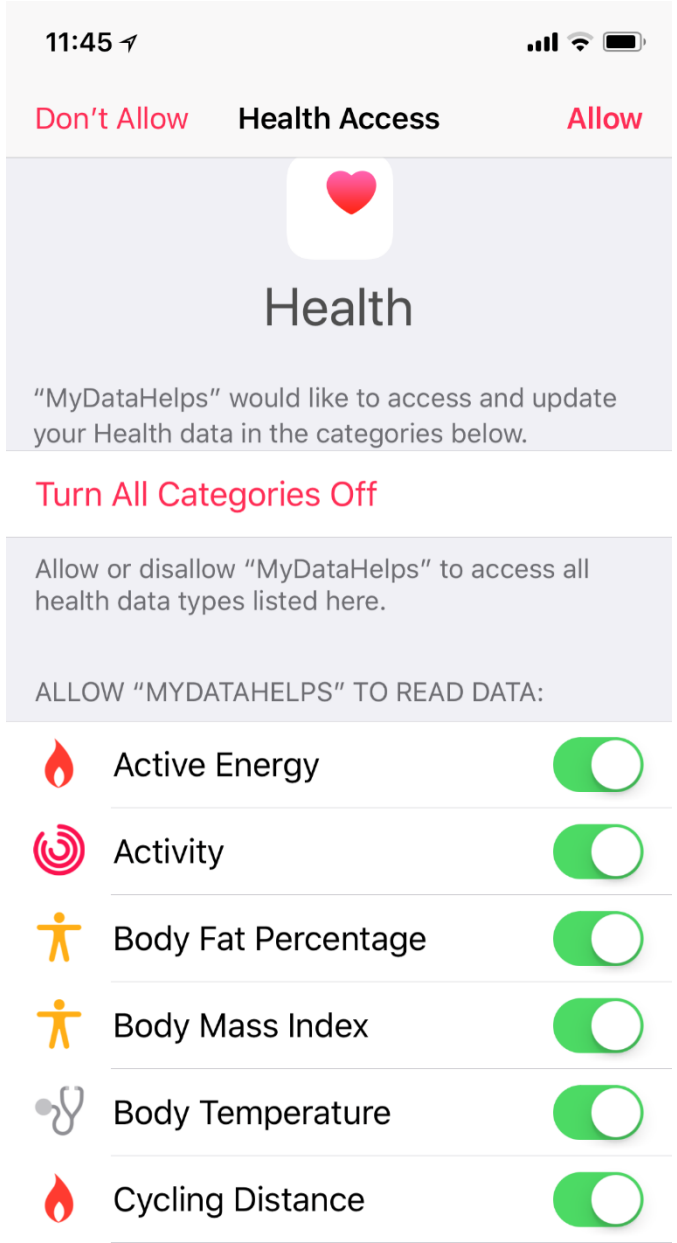


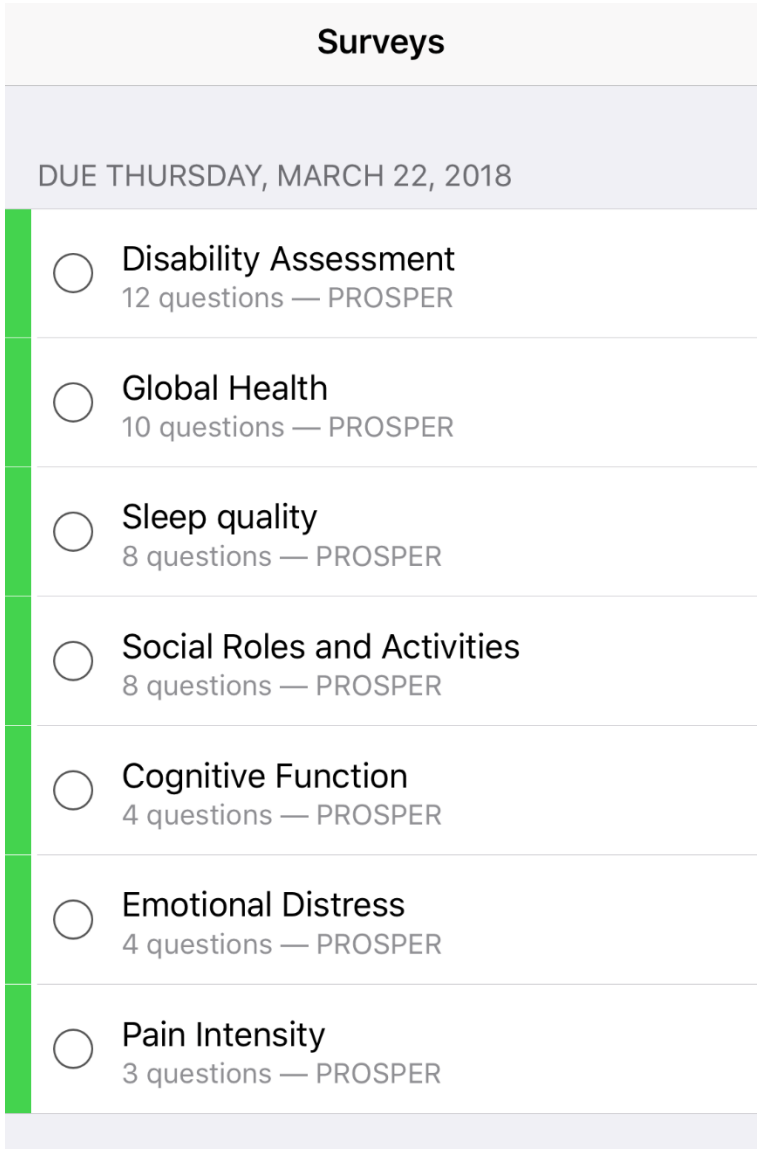
Discharge

App Store

MyDataHelps

Passive & Active Data





Active Data

- Disability Assessment
  12 questions — PROSPER
- Global Health
  10 questions — PROSPER
- Sleep quality
  8 questions — PROSPER
- Social Roles and Activities
  8 questions — PROSPER
- Cognitive Function
  4 questions — PROSPER
- Emotional Distress
  4 questions — PROSPER
- Pain Intensity
  3 questions — PROSPER

In the past 30 days, how much difficulty did you have in

STANDING FOR LONG PERIODS SUCH AS 30 MINUTES?

0 - None

1 - Mild

2 - Moderate

3 - Severe

4 - Extreme or cannot do

Active Data

- Disability Assessment
  12 questions — PROSPER
- Global Health
  10 questions — PROSPER
- Sleep quality
  8 questions — PROSPER
- Social Roles and Activities
  8 questions — PROSPER
- Cognitive Function
  4 questions — PROSPER
- Emotional Distress
  4 questions — PROSPER
- Pain Intensity
  3 questions — PROSPER

IN GENERAL, WOULD YOU SAY YOUR QUALITY OF LIFE IS

- Excellent
- Very good
- Good
- Fair
- Poor

Active Data

- Disability Assessment
  12 questions — PROSPER
- Global Health
  10 questions — PROSPER
- Sleep quality
  8 questions — PROSPER
- Social Roles and Activities
  8 questions — PROSPER
- Cognitive Function
  4 questions — PROSPER
- Emotional Distress
  4 questions — PROSPER
- Pain Intensity
  3 questions — PROSPER

I HAVE TROUBLE DOING ALL OF THE FAMILY ACTIVITIES THAT I WANT TO DO

- Never
- Rarely
- Sometimes
- Usually
- Always

Active Data

- Disability Assessment
  12 questions — PROSPER
- Global Health
  10 questions — PROSPER
- Sleep quality
  8 questions — PROSPER
- Social Roles and Activities
  8 questions — PROSPER
- Cognitive Function
  4 questions — PROSPER
- Emotional Distress
  4 questions — PROSPER
- Pain Intensity
  3 questions — PROSPER

In the past 7 days

I HAVE HAD TO WORK HARDER THAN USUAL TO KEEP TRACK OF WHAT I WAS DOING

- Never
- Rarely (once)
- Sometimes (two or three times)
- Often (about once a day)
- Very often (several times a day)

Active Data

- Disability Assessment
  12 questions — PROSPER
- Global Health
  10 questions — PROSPER
- Sleep quality
  8 questions — PROSPER
- Social Roles and Activities
  8 questions — PROSPER
- Cognitive Function
  4 questions — PROSPER
- Emotional Distress
  4 questions — PROSPER
- Pain Intensity
  3 questions — PROSPER

HOW INTENSE WAS YOUR AVERAGE PAIN

- Had no pain
- Mild
- Moderate
- Severe
- Very severe

Our questions. . .

After all the interventions, how does the patient do?

Does this person make it back to earning a living?

Does anyone have to help them take care of them self?

Can they move on their own?

Now it’s your turn. . .

What would you want to know and why?

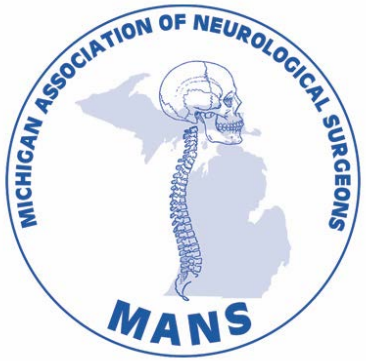
Cervical Spine Clearance

Jason Heth, MD
Mark Hemmila, MD

Cervical Spinal Cord Issues

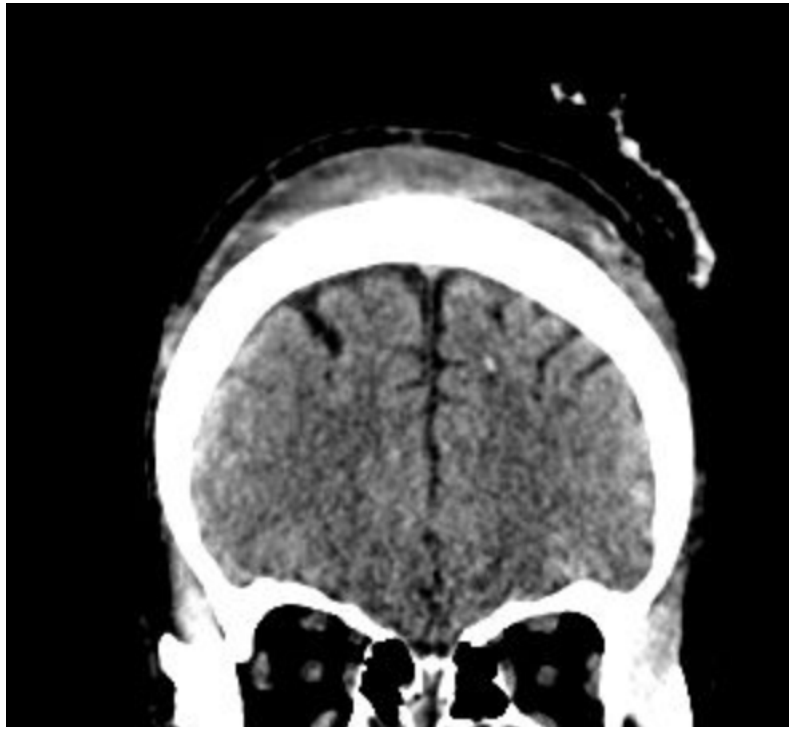
Joint Meeting of MANS and MTQIP

June 8, 2018



XX yom found of the expressway unconscious in the drivers seat with car impacted from top and ceiling collapsed into cabin. Intubated. Upon evaluation at first hospital was GCS13, transported to tertiary care for management

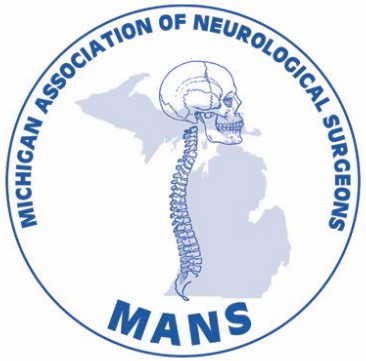
PE: PERRL, face symmetric MOTOR: Squeezes hands and wiggles toes bilaterally. Gives thumbs up in right hand and is more brisk in right upper as compared to left upper.



What Next Steps would you or your center
Wait until extubated?
Flex-Ex?
MRI?

XX yof MVA
Left chest tube placed in the field
Original GCS 7T
Mental Status: Does not open eyes to pain. Pupils are equal, round, and reactive to light. Localizes with the right upper extremity. No movement in the left upper extremity. Briskly withdraws bilateral lower extremities.
ICP monitor placed

What next step for C spine clearance would you or your center take?

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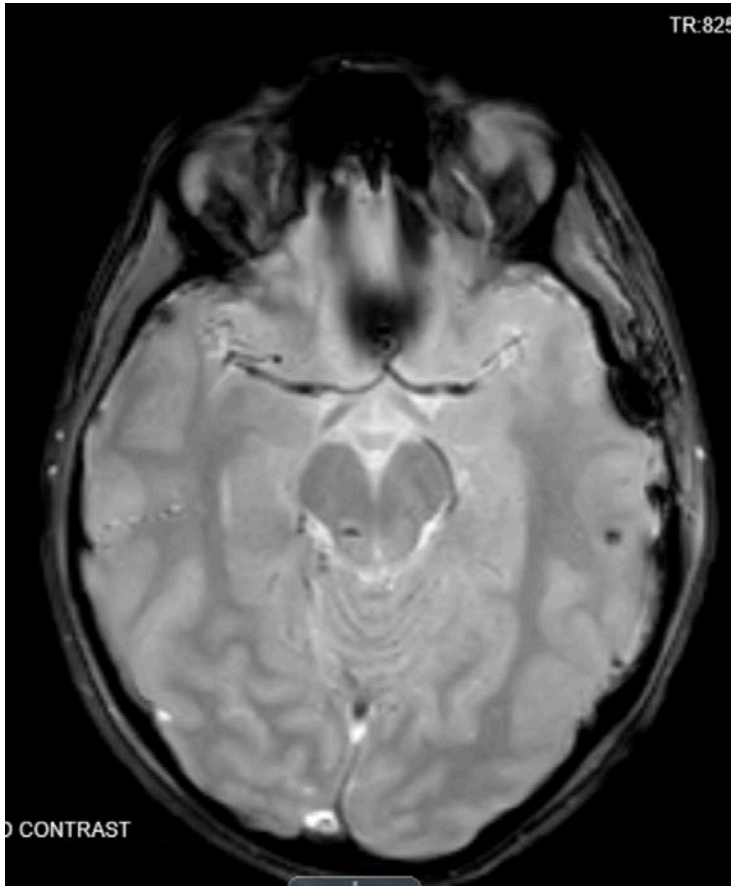

TR:825
CONTRAST

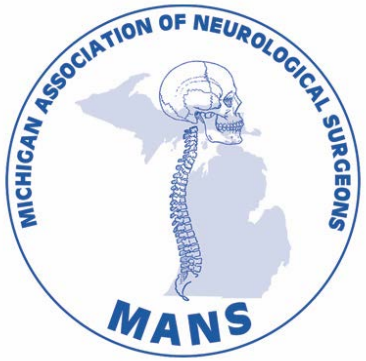
J Trauma Acute Care Surg. 2015 February ; 78(2): 430–441. doi:10.1097/TA.0000000000000503.

Cervical spine collar clearance in the obtunded adult blunt trauma patient: A systematic review and practice management guideline from the Eastern Association for the Surgery of Trauma

Mayur B. Patel, MD, MPH, **Stephen S. Humble**, **Daniel C. Cullinane, MD**, **Matthew A. Day, MD**, **Randeep S. Jawa, MD**, **Clinton J. Devin, MD**, **Margaret S. Delozier**, **Lou M. Smith, MD**, **Miya A. Smith**, **Jeannette M. Capella, MD, MEd**, **Andrea M. Long, MD**, **Joseph S. Cheng, MD, MS**, **Taylor C. Leath, BS, MPH**, **Yngve Falck-Ytter, MD**, **Elliott R. Haut, MD, PhD**, and **John J. Como, MD, MPH**

RECOMMENDATION

In obtunded adult blunt trauma patients, we conditionally recommend cervical collar removal after a negative high-quality C-spine CT scan result alone (Fig. 3). This conditional recommendation is based on very low-quality evidence but places a strong emphasis on the high negative predictive value of high-quality CT imaging in excluding the critically important unstable C-spine injury. Our recommendation is further supported by the high costs of MRI or other additional imaging. Adjunctive imaging after a high-quality CT scan increases the number of low-value diagnoses, places patients at risk for unnecessary treatment plans, puts patients with multiple injuries at risk by moving them out of the intensive care unit to the resource-limited MRI suite, and at best, results in the same clinical action of collar removal. However, the use of this approach may result in a nonzero rate of neurologic deterioration.



XX yof w/ h/o small intraventricular lesion fell down a set of stairs. In the field GCS 3.
Improved to following commands on initial eval. Zygomatic fracture, cribriform plate fracture, extremity abrasions
Intubated, She keeps her eyes closed, but awakens them to command. She nods appropriately to questioning.
Her pupils are equal, round, and reactive. Abrasion over her left eye with some periorbital ecchymosis.
Her face is symmetric at rest and with activation. No obvious CSF rhinorrhea. Full strength in her upper and lower extremities, both proximally and distally, No hyperreflexia or clonus in her upper or lower extremities. In a C-Collar

Next steps with multiple injuries?
Wait for extubation & clinical clearance?
MRI?
Flexion-extension?

Neurosurgery. 2013 Mar;72 Suppl 2:2-3. doi: 10.1227/NEU.0b013e3182772981.

The 2012 Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injury.

Cozzens JW, Prall JA, Holly L.

RECOMMENDATIONS

Awake, Asymptomatic Patient

Level 1

- In the awake, asymptomatic patient who is without neck pain or tenderness, who has a normal neurological examination, is without an injury detracting from an accurate evaluation, and who is able to complete a functional range of motion examination; radiographic evaluation of the cervical spine is not recommended.
- Discontinuance of cervical immobilization for these patients is recommended without cervical spinal imaging.

Awake, Symptomatic Patient

Level I

- In the awake, symptomatic patient, high-quality computed tomography (CT) imaging of the cervical spine is recommended.
- If high-quality CT imaging is available, routine 3-view cervical spine radiographs are not recommended.
- If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available) if necessary to further define areas that are suspicious or not well visualized on the plain cervical x-rays.

Level III

- In the awake patient with neck pain or tenderness and normal high-quality CT imaging or normal 3-view cervical spine series (with supplemental CT if indicated), the following recommendations should be considered:
  1. Continue cervical immobilization until asymptomatic,
  2. Discontinue cervical immobilization following normal and adequate dynamic flexion/extension radiographs,
  3. Discontinue cervical immobilization following a normal magnetic resonance imaging (MRI) obtained within 48 hours of injury (limited and conflicting Class II and Class III medical evidence), or,
  4. Discontinue cervical immobilization at the discretion of the treating physician.

Neurosurgery. 2013 Mar;72 Suppl 2:2-3. doi: 10.1227/NEU.0b013e3182772981.

The 2012 Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injury.

Cozzens JW, Prall JA, Holly L.

Obtunded or Unevaluable Patient

Level I

- In the obtunded or unevaluable patient, high-quality CT imaging is recommended as the initial imaging modality of choice. If CT imaging is available, routine 3-view cervical spine radiographs are not recommended.
- If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available) if necessary to further define areas that are suspicious or not well visualized on the plain cervical x-rays.

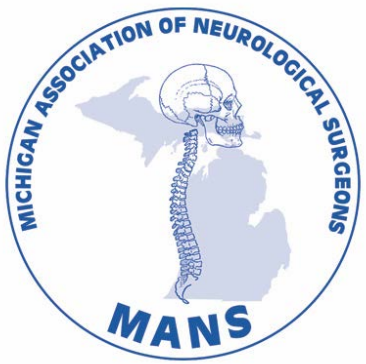
Level II

- In patients in whom there is a high clinical suspicion of injury yet have a normal high-quality CT imaging study, it is recommended that the decisions for further patient management involve physicians trained in the diagnosis and management of spinal injuries.

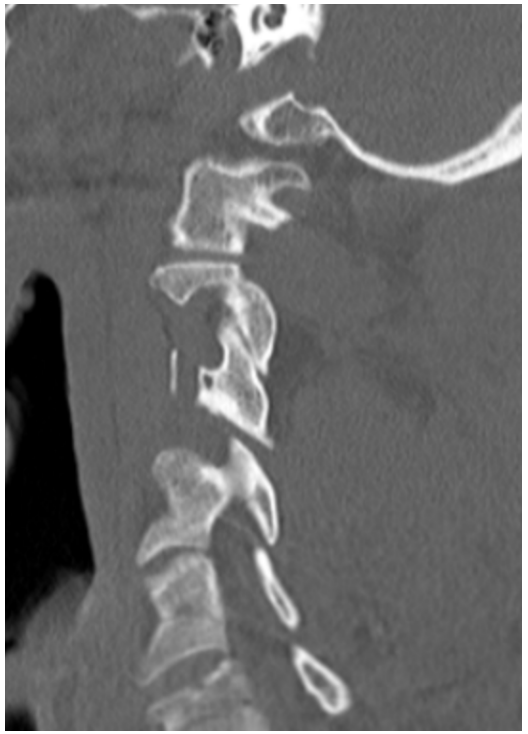
Level III

- In the obtunded or unevaluable patient with a normal high-quality CT or normal 3-view cervical spine series, the following recommendations should be considered:
  1. Continue cervical immobilization until asymptomatic,
  2. Discontinue cervical immobilization following a normal MRI study obtained within 48 hours of injury, (limited and conflicting Class II and Class III medical evidence), or,
  3. Discontinue cervical immobilization at the discretion of the treating physician.

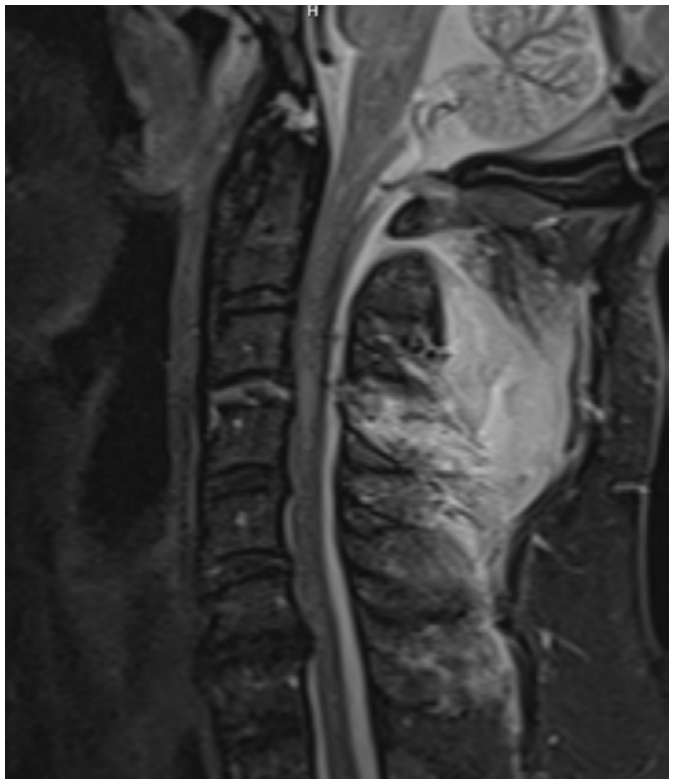
- In the obtunded or unevaluable patient with a normal high-quality CT, the routine use of dynamic imaging appears to be of marginal benefit and is not recommended.



XX yom s/p cardiac stenting 3 months prior
on ticagrelor (Brilinta) (elimination t1/2 7hrs, 9hrs active metabolite
syncope→ fall --> no volitional motion below deltoids, light touch discrimination >50%



When to operate?
ticagrelor (Brilinta) (elimination t1/2 7hrs, 9hrs for its active metabolite)



Cervical Spine Clearance Protocols in Level 1 Trauma Centers in the United States

SPINE Volume 39, Number 5, pp 356-361
2014

Alexander A. Theologis, MD, Robert Dionisio, BS, Robert Mackersie, MD, Robert Trigg McClellan, MD, and Murat Pekmezci, MD

- 191 Level I trauma centers, 166 responded, 57% had a protocol, 29% did not have a protocol

TABLE 4. Clearance Options in a Patient With Persistent Neck Pain and a Negative CT Scan

Method	No. of Institutions (%)
Flexion-extension	32 (30)
Not specified	19 (17)
MRI	15 (14)
Clinics	13 (12)
MRI/flex-ext	13 (12)
C-collar/MRI/flex-ext	8 (7)
Consult	3 (3)
Discontinue C-collar	4 (4)
C-collar/MRI	1 (1)
Total	108

TABLE 5. Methods to Clear the Cervical Spine in Patients who are Obtunded

Method	No. of Institutions (%)
MRI	33 (30)
Not specified	30 (28)
CT only	16 (15)
MRI/flex-ext	6 (5)
C-collar/CT only/MRI	6 (5)
CT only/MRI	4 (4)
C-collar	2 (2)
C-collar/MRI	2 (2)
Consult	2 (2)
CT only/MRI/flex-ext	2 (2)
Flex-ext	2 (2)
MRI (physician decision)	2 (2)
C-collar/MRI/flex-ext	1 (1)
Total	108

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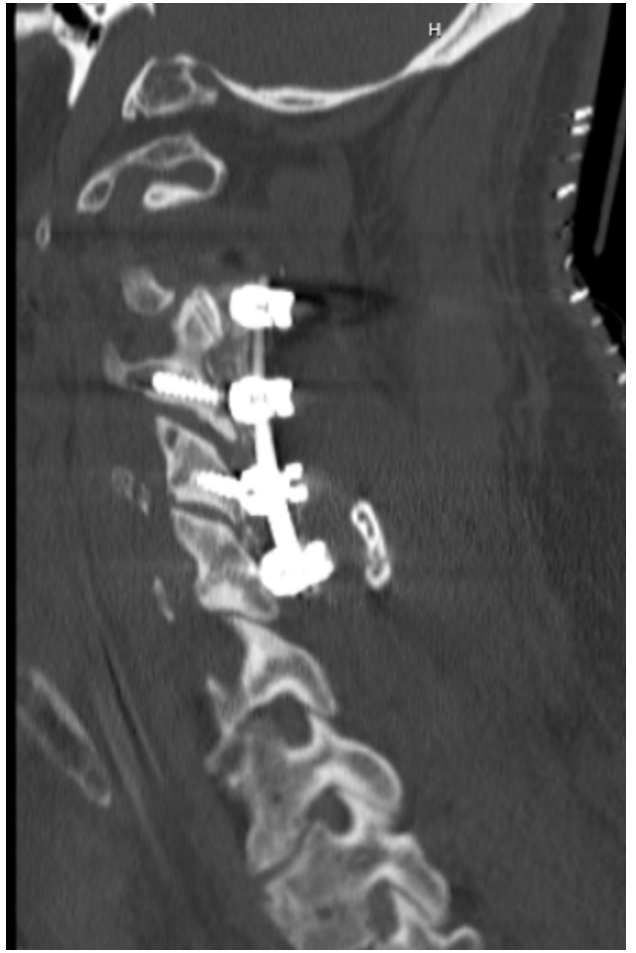
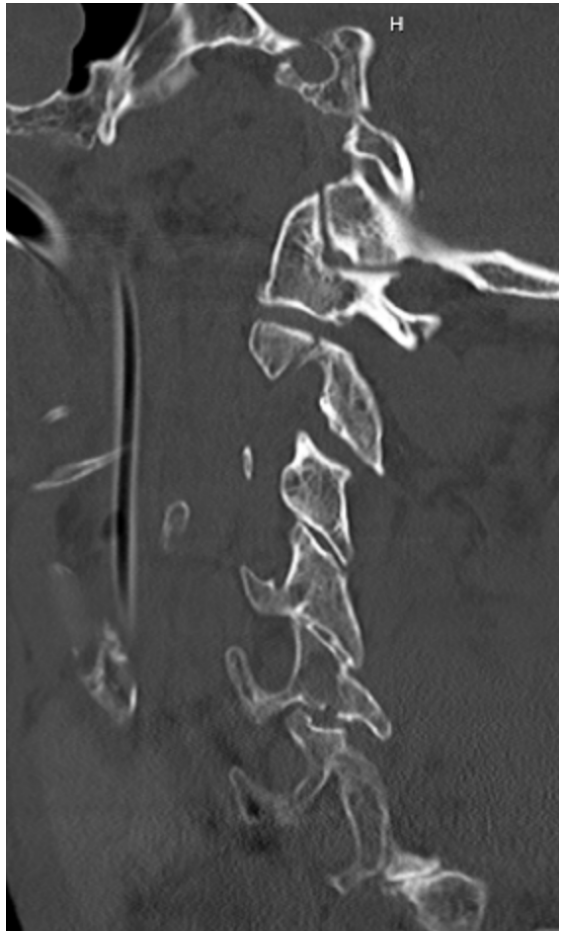
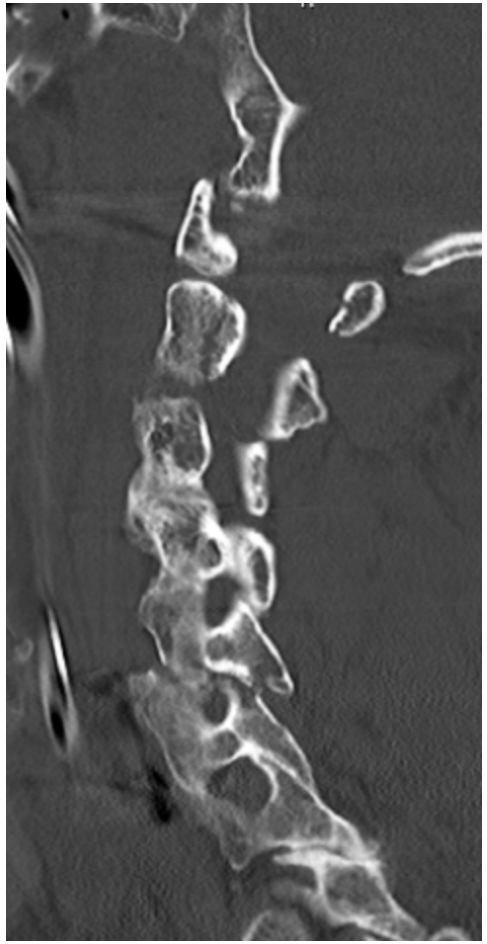
XX yom: Post-op



XX y.o. male with history significant for COPD, hypertension, PVOD s/p stenting and on Plavix who presents with Fall from roof. The patient fell off a roof, and has been unresponsive since that event. On EMS arrival he did have a GCS of 3. The patient's wife was concerned about possible period of cardiac arrest and provided CPR briefly. Attempted intubation in the field, unsuccessful. Brought to the emergency department with active bagging in place.





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Malpractice Premiums

176 working days per year.
General Surgery = $46,806 or $269 per diem
Neurosurgery = $72,538 or $412 per day

Malpractice Insurance Per FTE Neurosurgeon

Malpractice Insurance Costs (N=482)
Mean / Median = $48,887 / $36,977
% (25/75/90) = $22,011 / $57,731 / $$114,696

MICHIGAN ASSOCIATION OF NEUROLOGICAL SURGEONS
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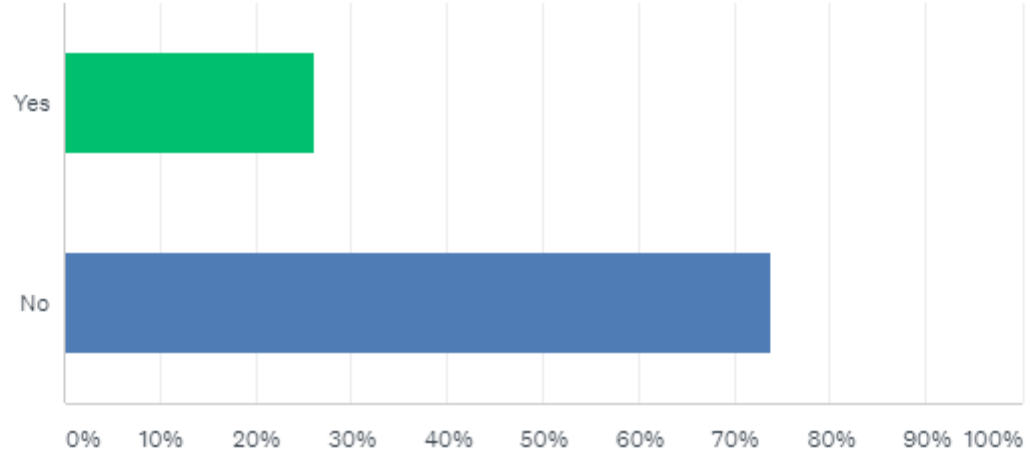
Question 16

If an intoxicated trauma patient has a negative c-spine CT scan are you comfortable clearing the cervical spine and removing the collar in the absence of a reliable physical exam?

Answered: 46 Skipped: 1

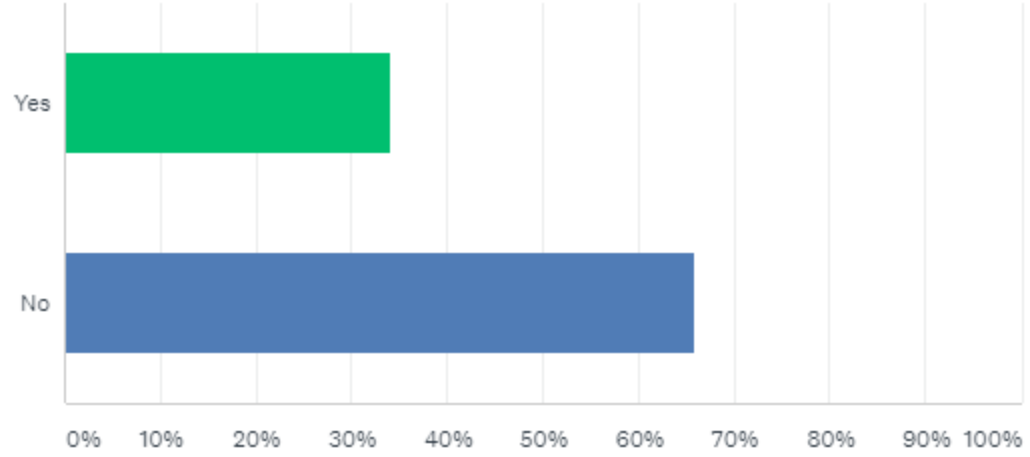


ANSWER CHOICES	RESPONSES	
Yes	26.09%	12
No	73.91%	34
TOTAL		46

Question 17

If an intubated trauma patient has a negative c-spine CT scan are you comfortable clearing the cervical spine and removing the collar in the absence of a reliable physical exam?

Answered: 44 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	34.09%	15
No	65.91%	29
TOTAL		44

C-Spine Literature

- Negative Predictive Value
  - Probability that subjects with a **negative** screening test truly don't have the disease.
- Obtunded or Intubated, 99.7%
- Intoxicated, 99.2-100%

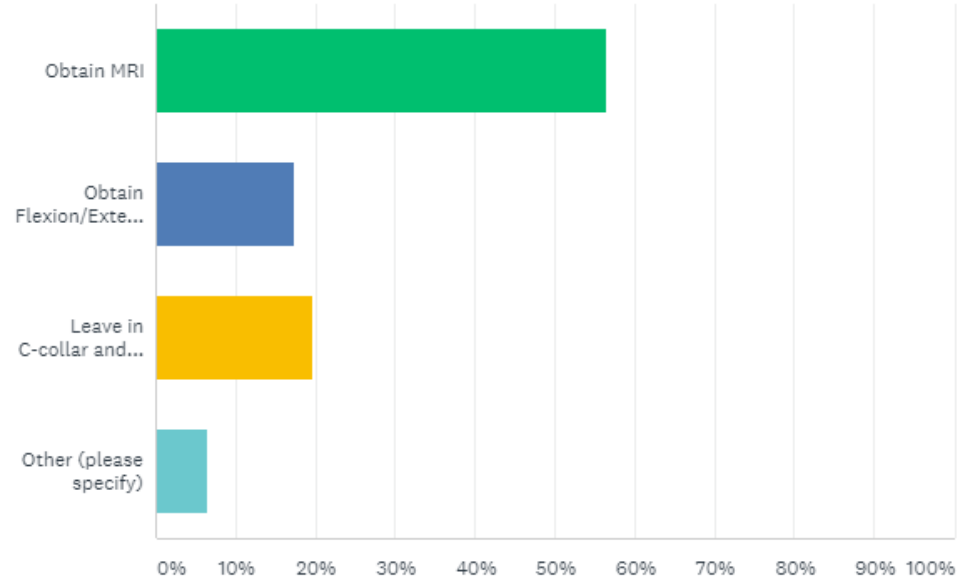
Serious conflict in practice

- Protocol for intubated patient considers MRI after negative CT Scan (Michigan)
- “EMS stopping using c-collars in field due to lack of supporting evidence and potential harm.” (Minnesota)

Question 18

How do you manage a patient with a negative c-spine CT scan that has pain on physical examination?

Answered: 46 Skipped: 1



ANSWER CHOICES		RESPONSES	
Obtain MRI		56.52%	26
Obtain Flexion/Extension views		17.39%	8
Leave in C-collar and reexamine in clinic in 2 weeks		19.57%	9
Other (please specify)	Responses	6.52%	3
TOTAL			46

APP Placement of ICP Monitors

Sanjay Patra, MD

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SPECTRUM HEALTH
The Medical Group

Can midlevel providers place external ventricular drains safely and accurately?

Sanjay Patra MD MSc

Director Epilepsy Surgery

Director Brain Trauma

Spectrum Health Medical Group

Associate Clinical Professor Michigan State University

College of Human Medicine
MICHIGAN STATE UNIVERSITY

SPECTRUM HEALTH
The Medical Group

Disclosures

Research grant from Boston Scientific

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SPECTRUM HEALTH
The Medical Group

Objectives

- Review Data on EVD accuracy and complications rates
- Report most recent results from Spectrum Health experience using MLP
- Go over protocol employed for training

Background

- EVD’s used to treat a variety of pathology:
  - TBI, hemorrhage, hydrocephalus, cerebral edema
- Pressure transducer currently gold standard for ICP measurement
- At most level 1 trauma centers placement is by: Neurosurgeon or Resident

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Background

Due to the urgency of neurosurgical pathologies and the lack of qualified residents at most hospitals, midlevel practitioner (MLP) placement of EVDs would be advantageous.

No studies addressing the safety and accuracy of EVD placement by mid-levels

Evidence for Bolt monitor's?

- Successful placement of ICP bolts by MLP's , Neurointesnsivisits, and trauma surgeons has been shown to be safe (Kaups et al., 1998; Ekeh AP et al., 2012; Sadaka F et al., 2013)
- EVD placement is significantly more technically challenging.
  - Placement into lateral ventricular system near foramen of Monroe
  - Higher complications rates including infection and hemorrhage compared to bolt (Lo CH et al, 2007)

EVD complication

-7% hemorrhage rate (meta analysis of 2428 patients)

-0.6 % hemorrhage requiring surgery

-Infections rates: 0-40% (4.3% with abx impregnated EVDs placed in the ICU)

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Spectrum experience

Our first PA had extensive experience in placing EVDs at her practice

As new PA's joined the group they would place at least 5 EVD's under direct supervision of senior PA or attending neurosurgeon

Up to 3 attempts.

Neurosurgeons evaluate imaging and interpret history on all patients prior to placement

All PA's have involvement in OR cases

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Study Objective

To assess the accuracy and complication rates of MLP and neurosurgeon EVD placement.

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Methods

Retrospective Cohort of all patients with EVD placed from Jan 2012-Sept 2016

Safety and accuracy compared

Safety: hemorrhage, infection, CSF leak

Accuracy: tip in lateral ventricular system: yes/no, Does the EVD function appropriately Y/N

Demographics

	Midlevel Practitioner (MLP) n=238	Neurosurgeon (NS) n=70	Total n=308
Age (y), mean ± standard deviation	54.5 ± 18.4	51.5 ± 15.5	53.8 ± 17.8
Male, n (%)	128 (53.8%)	37 (52.9%)	165 (53.6%)
Admission Diagnosis, n (%)			
TBI	48 (20.1%)	12 (17.1%)	60 (19.5%)
Aneurysmal SAH*	65 (27.3%)	31 (44.3%)	96 (31.2%)
Non-aneurysmal spontaneous hemorrhage	90 (37.8%)	15 (21.4%)	105 (34.1%)
Other	35 (14.7%)	12 (17.1%)	47 (15.3%)
Location site of placement			
Right Frontal	197 (82.8%)	54 (77.1%)	251 (81.5%)
Left Frontal	38 (16.0%)	15 (21.4%)	53 (17.2%)
Right Occipital	3 (1.3%)	0 (0.0%)	3 (1.0%)
Left Occipital	0 (0.0%)	1 (1.4%)	1 (0.3%)

Accuracy

Functioning EVD placed within the lateral ventricular system

PA (n=238) 87.4%

Attending (n=70): 90.0%

$P = 0.5557$

Complications

	Initial MLP Placement n=238	Initial Neurosurgeon Placement n=70	Placement Following Abandoned MLP Attempts n = 14
GCS Scores			
Pre-procedure, mean ± standard deviation	10.10 ± 4.52	10.13 ± 4.93	8.67 ± 4.18
Post-procedure, mean ± standard deviation	10.31 ± 4.50	10.39 ± 4.76	8.11 ± 4.26
Complications, n (%)			
All hemorrhages	16 (6.7%)	3 (4.3%)	1 (7.1%)
IVH	4 (1.7%)	0 (0%)	0 (0%)
IPH	8 (3.4%)	2 (2.9%)	0 (0%)
SDH	3 (1.3%)	1 (1.4%)	1 (7.1%)
SAH	1 (0.42%)	0 (0%)	0 (0%)
Infection	2 (0.84%)	1 (1.4%)	0 (0%)
CSF Leak	1 (0.42%)	1 (1.4%)	0 (0%)

Experience?

	n	Accuracy
Experience, months		
0-9	90	79/84 (94.0%)
10-19	80	69/77 (89.6%)
20+	55	50/52 (96.2%)

$P = 0.3195$

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Study weakness

Retrospective

Did the MLP's require more passes? 1.2/placement similar to literature at 1.4/placement

Did neurosurgeons place the EVD's in patient they deemed to be more difficult?

can not rule this out given patients with SAH were more likely to have EVDs placed by neurosurgeon

Presenting GCS was similar

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Protocol Utilized

At least 5 independent procedures under supervision by senior MLP or Neurosurgeon until deemed safe by senior MLP

Neurosurgeons evaluated all cases including imaging prior to placement of EVD's

Neurosurgeons within 20 mins of hospital

At our hospital MLPs have considerable procedural involvement, including training within the operating room in regard to sterile technique, hemostasis, and fundamental wound closure technique

Conclusion

EVD placement by adequately trained MLPs is accurate and safe, with similar rates of hemorrhage and infection, to that of neurosurgeons if a training protocol involving supervision is implemented

Allows for more prompt delivery of treatment without disruption of the neurosurgeons clinical and operative schedule in busy trauma centers without resident coverage

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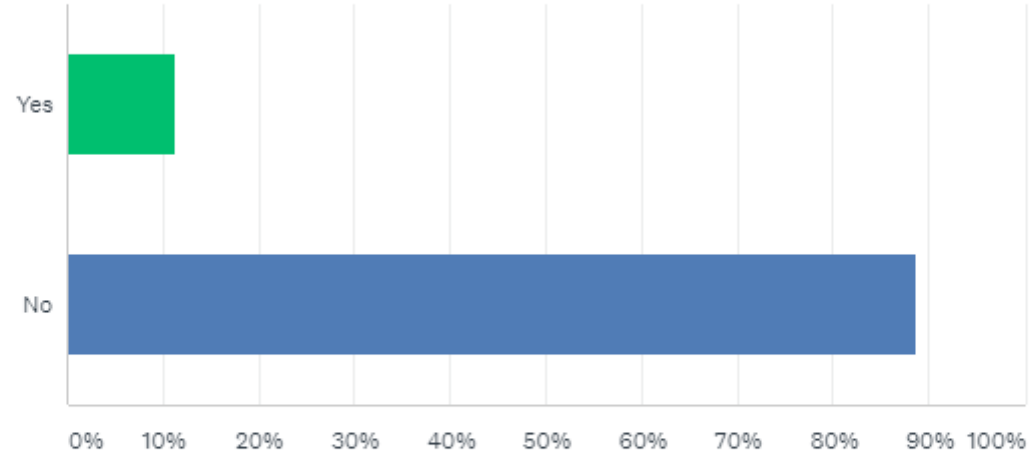
Questions

Question 19

Do you utilize advanced practitioners (PA or NP's) at your hospital to insert ICP monitors or ventriculostomies?

Answered: 44 Skipped: 3

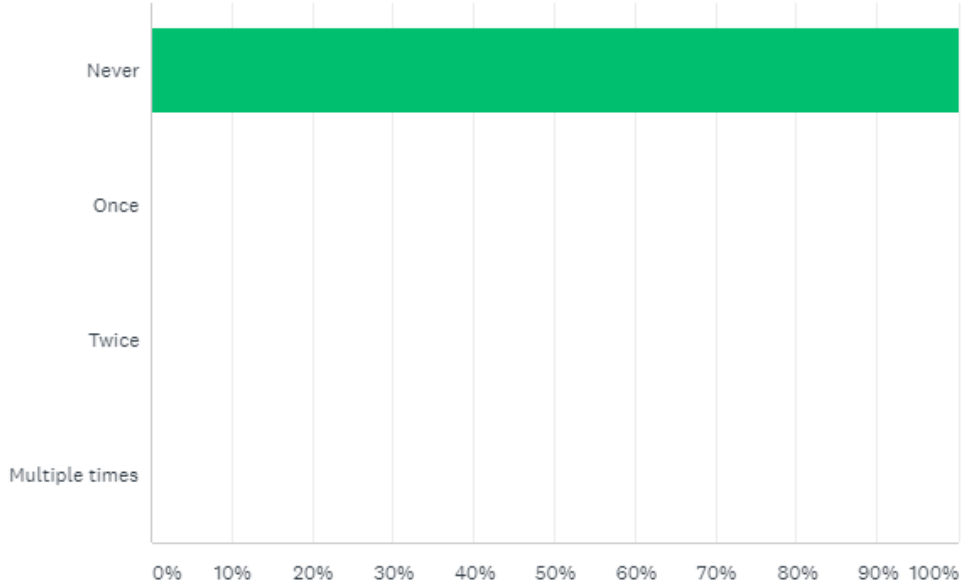


ANSWER CHOICES	RESPONSES	
Yes	11.36%	5
No	88.64%	39
TOTAL		44

Question 20

Have you received a notice of intent or been sued for issues regarding placement of an ICP monitor by an Advanced Practice Provider (PA/NP)?

Answered: 42 Skipped: 5



ANSWER CHOICES	RESPONSES	
Never	100.00%	42
Once	0.00%	0
Twice	0.00%	0
Multiple times	0.00%	0
TOTAL		42

CME

- Meeting participants will receive an **email** within 24 hours of meeting completion with a link to the meeting evaluation. The evaluation must be completed to receive a CME certificate. The link will remain open for 5 days.
- Make sure we have your **email** address.
- Contact Jennifer O'Gorman if you have problems.
  - 734 763-2854
  - jogorman@med.umich.edu

Conclusion

- Questions?
- Adjourn