

SOUTHERN
ANESTHESIA
MANAGEMENT
INTENSIVISTS DIVISION

ICU Management of Acute Stroke

• **Ronald M Roan, MD**

- Neurocritical Care (UCNS)
- Critical Care Medicine (ABA)
- Anesthesiology (ABA)
- Hospice & Palliative Medicine (ABA)
- Medical Quality (ABMQ)



Disclosures

References

Stroke

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AHA/ASA GUIDELINE

Guidelines for the Management of Spontaneous Intracerebral Hemorrhage

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

J. Claude Hemphill, Steven M. Greenberg, Craig S. Anderson, Kyra Becker, Bernard R. Bendok, Mary Cushman, Gordon L. Fung, Joshua N. Goldstein, R. Loch Macdonald, Pamela H. Mitchell, Phillip A. Scott, Magdy H. Selim, Daniel Woo



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DOI <https://doi.org/10.1161/STR.0000000000000069>
Stroke. 2015;STR.0000000000000069
Originally published May 28, 2015

References

AHA/ASA Guideline

Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke **A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association**

Endorsed by the Society for Academic Emergency Medicine and The Neurocritical Care Society

Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons.

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References



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ORIGINAL ARTICLE

Rapid Blood-Pressure Lowering in Patients with Acute Intracerebral Hemorrhage

Craig S. Anderson, M.D., Ph.D., Emma Heeley, Ph.D., Yining Huang, M.D., Jiguang Wang, M.D., Christian Stapf, M.D., Candice Delcourt, M.D., Richard Lindley, M.D., Thompson Robinson, M.D., Pablo Lavados, M.D., M.P.H., Bruce Neal, M.D., Ph.D., Jun Hata, M.D., Ph.D., Hisatomi Arima, M.D., Ph.D., Mark Parsons, M.D., Ph.D., Yuechun Li, M.D., Jinchao Wang, M.D., Stephane Heritier, Ph.D., Qiang Li, B.Sc., Mark Woodward, Ph.D., R. John Simes, M.D., Ph.D., Stephen M. Davis, M.D., and John Chalmers, M.D., Ph.D., for the INTERACT2 Investigators*

N Engl J Med 2013; 368:2355-2365 | [June 20, 2013](#) | DOI: 10.1056/NEJMoa1214609

 [Comments](#) open through June 26, 2013

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ORIGINAL ARTICLE

Intensive Blood-Pressure Lowering in Patients with Acute Cerebral Hemorrhage

Adnan I. Qureshi, M.D., Yuko Y. Palesch, Ph.D., William G. Barsan, M.D., Daniel F. Hanley, M.D., Chung Y. Hsu, M.D., Renee L. Martin, Ph.D., Claudia S. Moy, Ph.D., Robert Silbergleit, M.D., Thorsten Steiner, M.D., Jose I. Suarez, M.D., Kazunori Toyoda, M.D., Ph.D., Yongjun Wang, M.D., Haruko Yamamoto, M.D., Ph.D., and Byung-Woo Yoon, M.D., Ph.D., for the ATACH-2 Trial Investigators and the Neurological Emergency Treatment Trials Network*

N Engl J Med 2016; 375:1033-1043 | [September 15, 2016](#) | DOI: 10.1056/NEJMoa1603460

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AHA/ASA SCIENTIFIC STATEMENT

Recommendations for the Management of Cerebral and Cerebellar Infarction With Swelling

A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

Eelco F. M. Wijdicks, Kevin N. Sheth, Bob S. Carter, David M. Greer, Scott E. Kasner, W. Taylor Kimberly, Stefan Schwab, Eric E. S. Rafael J. Tamargo, Max Wintermark

and on behalf of the American Heart Association Stroke Council



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DOI <https://doi.org/10.1161/01.str.0000441965.15164.d6>
Stroke. 2014;45:1222-1238
Originally published March 24, 2014

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Neurocrit Care (2016) 24:47–60
DOI 10.1007/s12028-015-0221-y



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REVIEW ARTICLE

Prophylaxis of Venous Thrombosis in Neurocritical Care Patients: An Evidence-Based Guideline: A Statement for Healthcare Professionals from the Neurocritical Care Society

Paul Nyquist¹ · Cynthia Bautista² · Draga Jichici³ · Joseph Burns⁴ ·
Sanjeev Chhangani⁵ · Michele DeFilippis⁶ · Fernando D. Goldenberg⁷ ·
Keri Kim⁸ · Xi Liu-DeRyke⁹ · William Mack¹⁰ · Kim Meyer¹¹

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Neurocrit Care (2016) 24:61–81
DOI 10.1007/s12028-015-0224-8



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REVIEW ARTICLE

The Insertion and Management of External Ventricular Drains: An Evidence-Based Consensus Statement

A Statement for Healthcare Professionals from the Neurocritical Care Society

Herbert I. Fried¹ · Barnett R. Nathan² · A. Shaun Rowe³ · Joseph M. Zabramski^{4,5} ·
Norberto Andaluz⁶ · Adarsh Bhimraj⁷ · Mary McKenna Guanci⁸ ·
David B. Seder^{9,10} · Jeffrey M. Singh¹¹

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Recommendations Evidence

Definitely

Probably

Consider

Don't

SIZE OF TREATMENT EFFECT

CLASS I

Benefit >>> Risk

Procedure/Treatment **SHOULD** be performed/administered

CLASS IIa

Benefit >> Risk

Additional studies with focused objectives needed

IT IS REASONABLE to perform procedure/administer treatment

CLASS IIb

Benefit ≥ Risk

Additional studies with broad objectives needed; additional registry data would be helpful

Procedure/Treatment **MAY BE CONSIDERED**

CLASS III No Benefit or CLASS III Harm

	Procedure/Test	Treatment
COR III: No benefit	Not Helpful	No Proven Benefit
COR III: Harm	Excess Cost w/o Benefit or Harmful	Harmful to Patients

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT

LEVEL A

Multiple populations evaluated*
Data derived from multiple randomized clinical trials or meta-analyses

- Recommendation that procedure or treatment is useful/effective
- Sufficient evidence from multiple randomized trials or meta-analyses

- Recommendation in favor of treatment or procedure being useful/effective
- Some conflicting evidence from multiple randomized trials or meta-analyses

- Recommendation's usefulness/efficacy less well established
- Greater conflicting evidence from multiple randomized trials or meta-analyses

- Recommendation that procedure or treatment is not useful/effective and may be harmful
- Sufficient evidence from multiple randomized trials or meta-analyses

LEVEL B

Limited populations evaluated*
Data derived from a single randomized trial or nonrandomized studies

- Recommendation that procedure or treatment is useful/effective
- Evidence from single randomized trial or nonrandomized studies

- Recommendation in favor of treatment or procedure being useful/effective
- Some conflicting evidence from single randomized trial or nonrandomized studies

- Recommendation's usefulness/efficacy less well established
- Greater conflicting evidence from single randomized trial or nonrandomized studies

- Recommendation that procedure or treatment is not useful/effective and may be harmful
- Evidence from single randomized trial or nonrandomized studies

LEVEL C

Very limited populations evaluated*
Only consensus opinion of experts, case studies, or standard of care

- Recommendation that procedure or treatment is useful/effective
- Only expert opinion, case studies, or standard of care

- Recommendation in favor of treatment or procedure being useful/effective
- Only diverging expert opinion, case studies, or standard of care

- Recommendation's usefulness/efficacy less well established
- Only diverging expert opinion, case studies, or standard of care

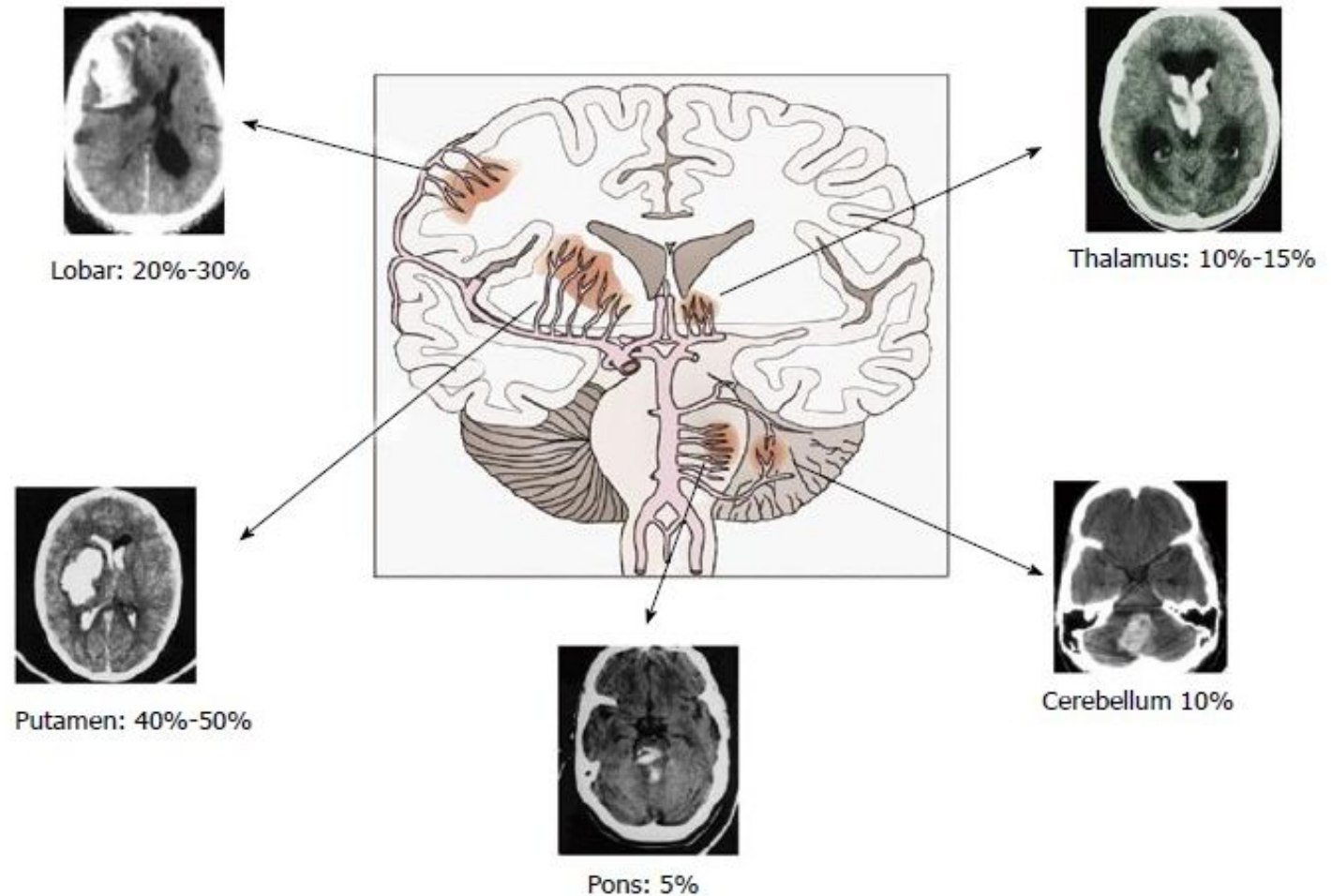
- Recommendation that procedure or treatment is not useful/effective and may be harmful
- Only expert opinion, case studies, or standard of care

Solid

Likely

Opinion
OR
Common
Sense

Intracerebral Hemorrhage ICH



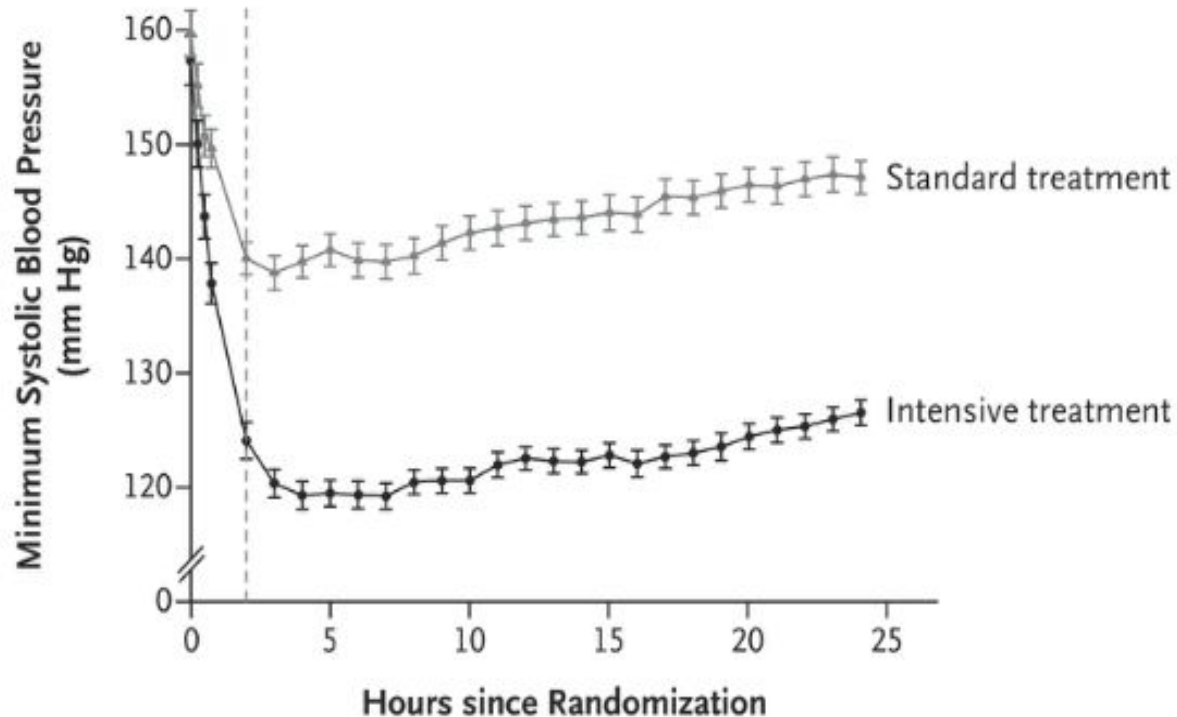
*Achieving an SBP goal of <140 is crucial
to prevent hematoma expansion and
improve outcomes in ICH...*

True or False?

BP Control Studies

ICH

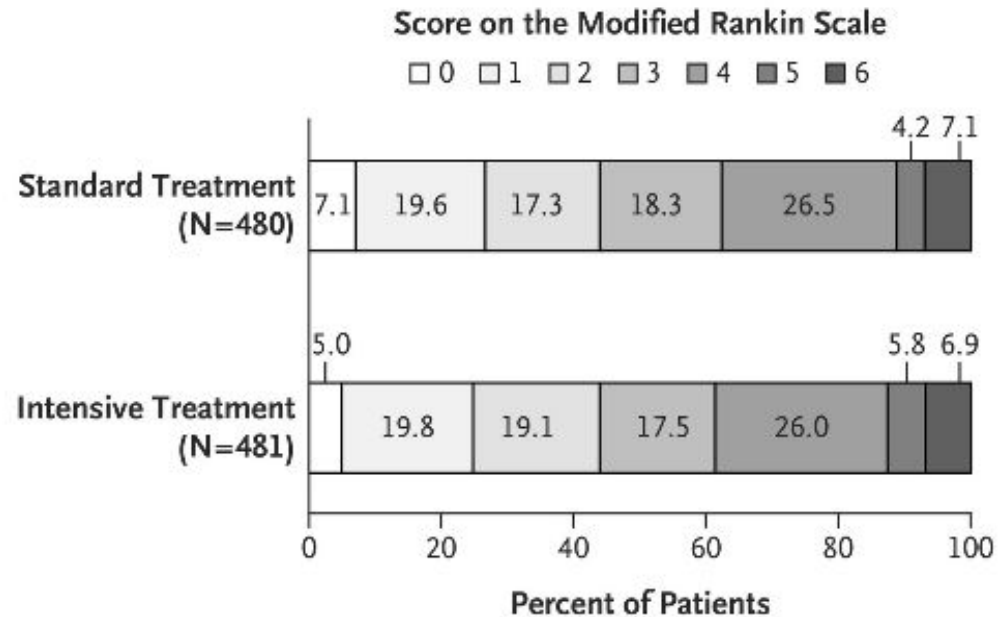
- **INTERACT2:** SBP <180 vs <140 w/ multidrug (2013)
- **ATACH-2:** SBP 110-139 vs 140-179 w/ Nicardipine (2016)



INTERACT2

ATACH-2

ICH



- Can safely lower
- No change in mortality
- Slightly better hematoma size (INTERACT2 only)
- Mildly better Rankin scores (INTERACT2 only)

BP Recommendations

ICH

- **SBP 150 - 220 mmHg and w/o contraindications**
 - acute lowering of SBP to 140 mmHg is safe (*Class I; LOE A*)
 - Can be effective for improving functional outcome (*Class IIa; LOE B*) (Revised)
- **SBP >220 mm Hg**
 - Reasonable to consider aggressive BP reduction by 25% with continuous intravenous infusion & frequent BP monitoring (*Class IIb; LOE C*)

Acute Ischemic Stroke

BP Management

AIS

- **Data is conflicting**
 - Early lowering shown detrimental
 - 48-72h lowering is safe
- **BP naturally decreases after 90 mins**
- **No guidance on agent choice**
- **Hypotension is rare (2.5%)**
 - R/o other causes
 - Volume and pressor support (neo/norepi) to maintain systemic perfusion (*Class I; LOE C*)

BP Recommendations

AIS

- **tPA Candidates**
 - Carefully lower SBP <185 mmHg & DBP <110 (*Class I; LOE B*)
 - Ensure BP is stabilized before tPA and then maintain < 180/105 (Unchanged)
- **Mechanical Thrombectomy Candidates**
 - <180/105 during & 24h after procedure (*Class IIab; LOE B*)
 - ESCAPE Protocol - SBP >150 while occluded
 - DAWN Protocol – SBP <140 reperfused

BP Recommendations

AIS

- **Non tPA Candidates**
 - **SBP <220/120:** Treatment at 48-72h is safe, but no benefit (*Class III; LOE A*)
 - **SBP >220/>120:** Lower by 15% during the first 24 hours after onset of stroke (*Class IIb; LOE C*)
- **Presence of medical comorbid conditions (ACS, ACHF, Ao Dissection, preeclampsia, etc)**
 - **Lowering by 15% emergently is reasonable** (*Class I; LOE C*)

BP Agents

- **Labetolol**
 - 10-20 mg slow IVP, may repeat frequently
 - Infusion 2-8 mg/min
- **Nicardipine**
 - 5-15 mg/hr titrated
- **Clevidipine**
 - Ultrashort acting, 1-21 mg/hr
- **Hydralazine**
 - 10-20 mg slow IVP, may repeat frequently
- **Nitroprusside**
 - Large swings, can increase ICP, out of favor

Common CVA Complications

0
↓
DAYS
↓
4

- Airway compromise
- Hyperthermia
- Hyperglycemia
- Hyponatremia
- Symptomatic ICH within 24h of tPA
- Hydrocephalus
- Intraventricular extension
- Seizures
- Cerebral Edema / Mass effect
- Infections
- VTE / PTE

A pCO₂ goal of 30 mmHg in an intubated pt decreases the likelihood of developing increased ICP...(AIS & ICH)

True or False?

Oxygenation Ventilation

- **Maintain normocarbia** (*Class IIa; LOE C*)
- **Intubate patients with decreased LOC resulting in poor oxygenation or impaired control of secretions** (*Class IIb; LOE C*)
- **Maintain SpO₂ of >94%** (*Class I; LOE C*)
- **Brief moderate hyperventilation (pCO₂ 30-34) as a bridge** (*Class IIa; LOE C*)
- **Prophylactic hyperventilation is NOT recommended** (*Class III; LOE C*)

Temperature Management

- **Maintain normothermia** (*Class I; LOE C*)
- **Hyperthermia should be treated**
 - Antipyretics
 - Cooling devices/strategies
- **Hypothermia should be offered in context of studies** (*Class IIb; LOE B*)

Tight glucose control (<110) has superior outcomes compared to 140-180, but has more hypoglycemic complications...(AIS & ICH)

True or False?

Glycemic Control

- **Hyperglycemia should be avoided, glucose levels of 140-180 mg/dL are recommended** (*Class I; LOE C*)
- **Tight glycemic control (glucose <110 mg/dL) is NOT indicated**
- **Utilize insulin infusions to avoid significant hyperglycemia** (*Class IIb; LOE C*)
- **Hypoglycemia should be avoided** (*Class I; LOE C*)
- **Enteral diet within 7 d** (*Class I; LOE B*)

Post tPA sICH

- Stop tPA
 - Labs (CBC, PT/PTT, Fibrinogen, T&C)
 - Emergent NC CT head
 - Cryoprecipitate 10 units over 10-30 min
 - Repeat for fibrinogen <200
 - Tranexamic acid 1000 mg over 10 min
- OR
- Aminocaproic acid 4-5g over 1h, then 1g/hr
 - Supportive Care Consults

(Class IIb; LOE C)

Post tPA

Angioedema

- **Stop tPA and hold ACEi**
- **Administer:**
 - IV methylprednisolone 125 mg
 - IV Diphenhydramine 50 mg
 - IV Ranitidine 50 mg
- **If refractive**
 - Epinephrine 0.3 mg SQ or 0.5 mg via neb
 - Icatibant 30 mg SQ (Bradykinin B antagonist)
 - Plasma Derived C1 Esterase Inhibitor (20 IU/kg)
- **Supportive Care**

(Class IIb; LOE C)

Hyponatremic Syndromes (35%)

- 2:1 more prevalent in ICH over AIS

- SIADH

- 24%

- CSWS

- 12%

Clinical manifestations to monitor	CSWS	SIADH
ECF volume (the primary way to differentiate SIADH from CSWS)	Decreased	Increased
Hematocrit	Increased	Normal
Albumin concentration	Increased	Normal
BUN/creatinine	Increased	Decreased
Potassium	Normal or Increased	Normal
Uric acid	Normal or decreased	Decreased
Treatment	Normal saline	Fluid restriction

- Outcomes with Hyponatremia due to CSWS are worse than SIADH

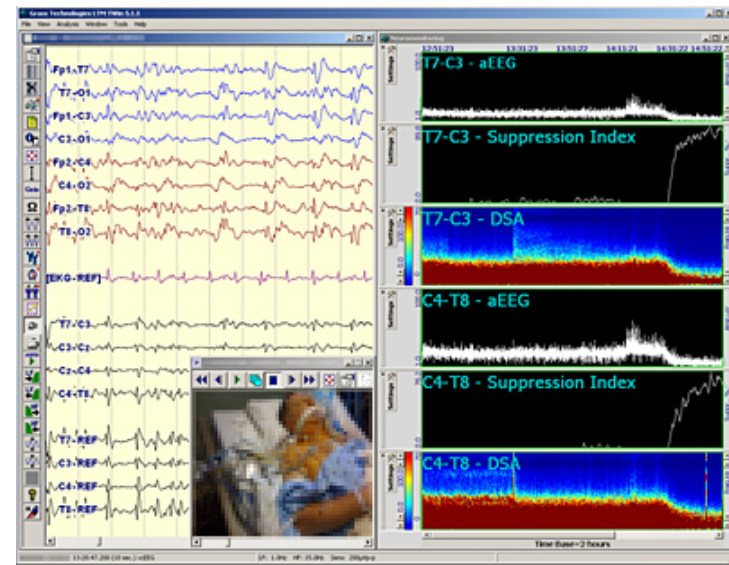
*Seizure prophylaxis is NOT
indicated in the absence of EEG or
clinical seizures...(AIS & ICH)*

True or False?

Seizures

EEG

- Treat clinical seizures with AEDs (10-15%) (*Class I; LOE C*)
- Electrographic seizures on EEG should be treated with AEDs (*Class I; LOE C*)
- Ppx AEDs are not recommended (*Class III; LOE B*)
- Continuous EEG monitoring in ICH pts with depressed MS out of proportion to injury (30%) is warranted (*Class IIa; LOE C*)



Hydrocephalus

EVDs

- **EVD placement for obstructive hydrocephalus is recommended, especially in patients with decreased LOC** *(Class I; LOE C) (revised)*
- **EVD placement for cerebellar AIS is appropriate** *(Class I; LOE C)*
- **Maintain a CPP of 50 to 70 mmHg** *(Class IIb; LOE C)*
- **Shunt wean rate in rapid (24h) vs gradual (4d) EVD weaning is NO different (except +3d LOS)...wean as quickly as feasible** *(NCS Consensus)*

Intraventricular Extension

CLEAR

- Intraventricular administration of tPA in IVH appears to have a fairly low complication rate, the efficacy and safety of this treatment are uncertain
(Class IIb; LOE B)

MISTIE

- The efficacy of endoscopic treatment of IVH is uncertain *(Class IIb; LOE B)*

Steroids are indicated in AIS & ICH if signs of increased ICP are present...

True or False?

Cerebral Edema

Increased ICP

↓
RESCUE
↓

- Positioning- HOB 30 degrees, neutral neck
- Brief hyperventilation- PaCO₂ 30-34 mmHg
- *Steroids* (Class III Harmful; LOE A)
- Hypertonic Saline/Mannitol (Class IIa; LOE C)
- Diuretics
- Intraventricular Drainage
- Paralysis
- *Barbiturate Coma, Hypothermia* (Class III NB; LOE B)
- Decompressive surgery

Decompressive Craniotomy ICH

- Deteriorating Cerebellar hemorrhage & infarct with brainstem compression and/or hydrocephalus from ventricular obstruction (*Class I; LOE B*)
- Supratentorial ICH, the usefulness of surgery is not well established (*Class IIb; LOE A*)
 - Early NOT clearly beneficial over only those in deterioration (*Class IIb; LOE A*)
 - In deteriorating patients may be life-saving (*Class IIb; LOE C*)
 - DC with or without hematoma evacuation may help in supratentorial ICH with coma, large hematomas w/ MLS , or refractive ICP (*Class IIb; LOE C*)

Decompressive Craniotomy AIS

- **Unilateral MCA infarctions worsening within 48h despite medical therapy**
 - <60 YO (*Class IIa; LOE A revised*)**
 - Mortality reduction 50%
 - 55% walking at 12 mos
 - 18% independent at 12 mos
 - >60 YO: (*Class IIb; LOE B revised*)**
 - Mortality reduction ~50% (76 vs 42%)
 - 11% walking at 12 mos
 - 0% independent at 12 mos
- **Cerebellar infarction failing med Rx & EVD (*Class I; LOE B*)**

Infectious Complications

- **CAUTI (15-60% of pts)**
 - Routine indwelling bladder catheters are **NOT recommended** (*Class III; LOE C*) (Unchanged)
- **Pneumonia**
 - Assessment per SLP of swallowing before intake or oral medications (*Class IIa; LOE C*)
 - Start NGT enteral feeds w/in 7d, PEG for anticipated prolonged dysphagia (>2-3 wks) (*Class IIa; LOE B*)
 - Routine prophylactic antibiotics **NOT** beneficial (*Class III; LOE B*)
 - Oral hygiene protocols reduces pneumonia (*Class IIb; LOE B*)

Chemical VTE prophylaxis should be withheld in ICH patients for at least 7 days...

True or False?

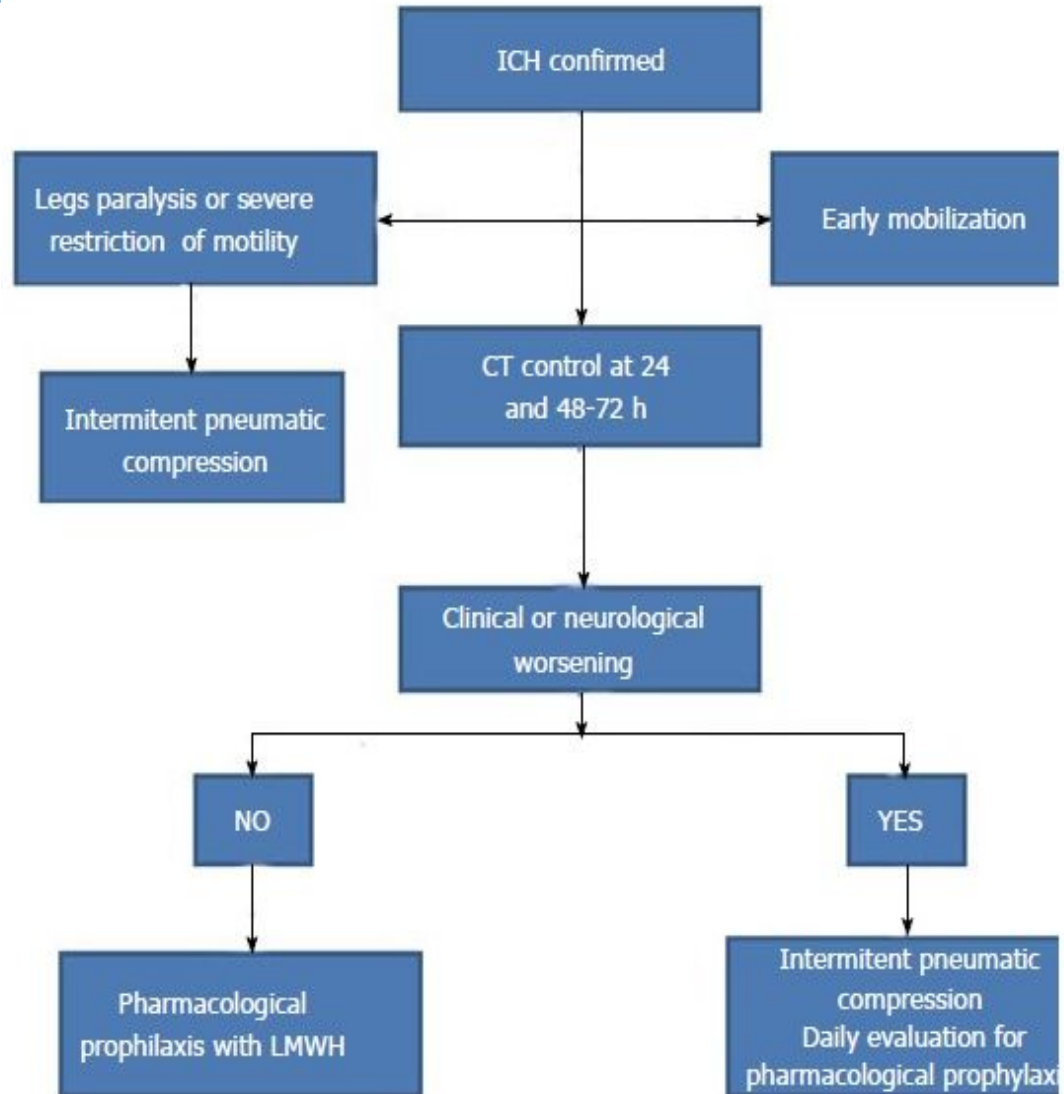
VTE/PTE

10% of deaths

- AIS and ICH pts should have SCDs for VTE prevention at admission (*Class I; LOE B*)
- AIS and ICH (after confirming bleeding cessation): low dose LMWH or UFH may be considered for VTE prevention in pts lacking mobility within 24h (AIS) and after 48-72h (ICH) (*Class IIb; LOE A/C*)
- Systemic anticoagulation or IVC filter for ICH patients with symptomatic DVT or PE (*Class IIa; LOE C*)
 - Choice depends on time from hemorrhage onset, hematoma stability, cause of hemorrhage, and overall condition (*Class IIa; LOE C*)
- Avoid Compression stockings (*Class III Harm; LOE B*)

VTE Initiation

ICH



Controversies & Misconceptions

- **DVT prophylaxis**
- **Empiric Osmotherapy**
- **Anticoagulation**

*Presence of an EVD is NOT a
contraindication for chemical VTE
prophylaxis...*

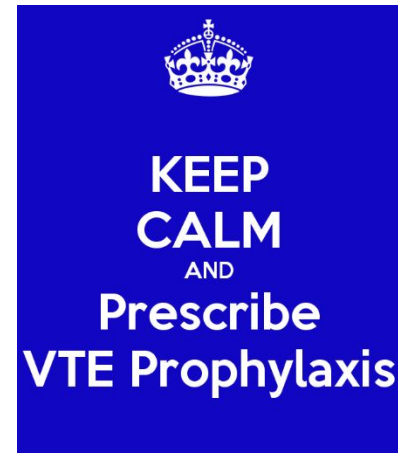
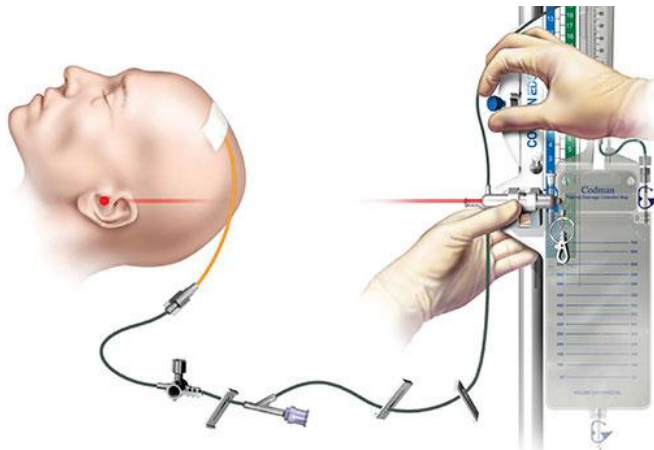
True or False?

DVT Prophylaxis

EVD

- In pts with EVD:

“Advancement of VTE prophylaxis may be considered when the risk of hemorrhage has been determined to be acceptably low, probably within the first 72 h (at the latest) if any existing hemorrhage is stable ” (Strong recommendation; low-quality evidence) (NCS Consensus)



*In the setting hypernatremia,
correct with hypotonic IVF, i e 1/2
NS... (AIS & ICH)*

True or False?

Empiric Osmotherapy

- **Use adequate fluid administration with isotonic fluids** (*Class IIb; LOE C*)
- **Hypotonic or hypo-osmolar fluids are NOT recommended** (*Class III; LOE C*)
- **Prophylactic osmotic diuretics before apparent swelling is NOT recommended** (*Class III; LOE C*)
- **Utilize osmotic therapy for clinical deterioration due to cerebral swelling** (*Class IIa; LOE C*)

ALS patients with a high grade carotid stenosis should NOT be systemically heparinized to prevent further emboli...

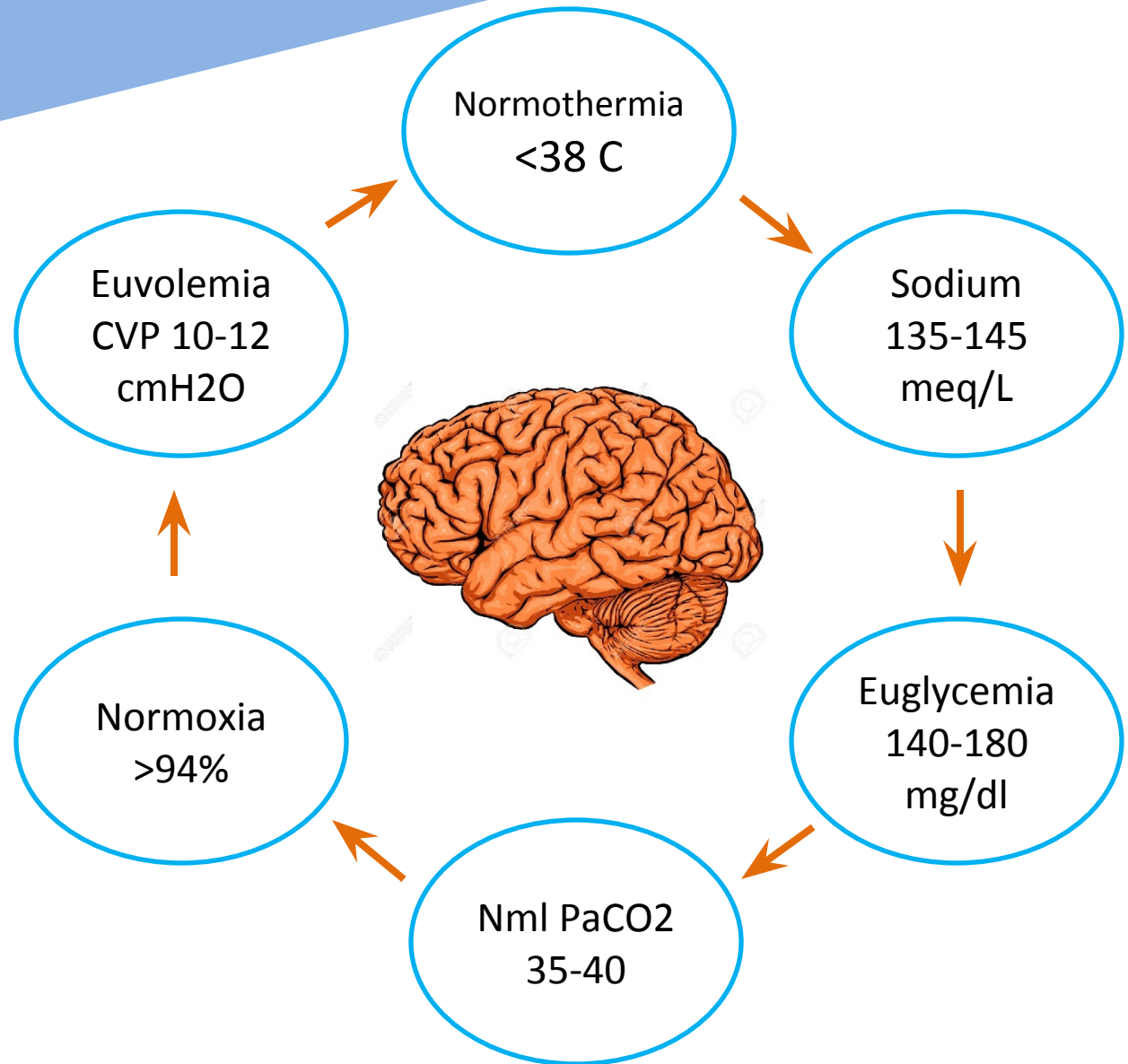
True or False?

Anticoagulation

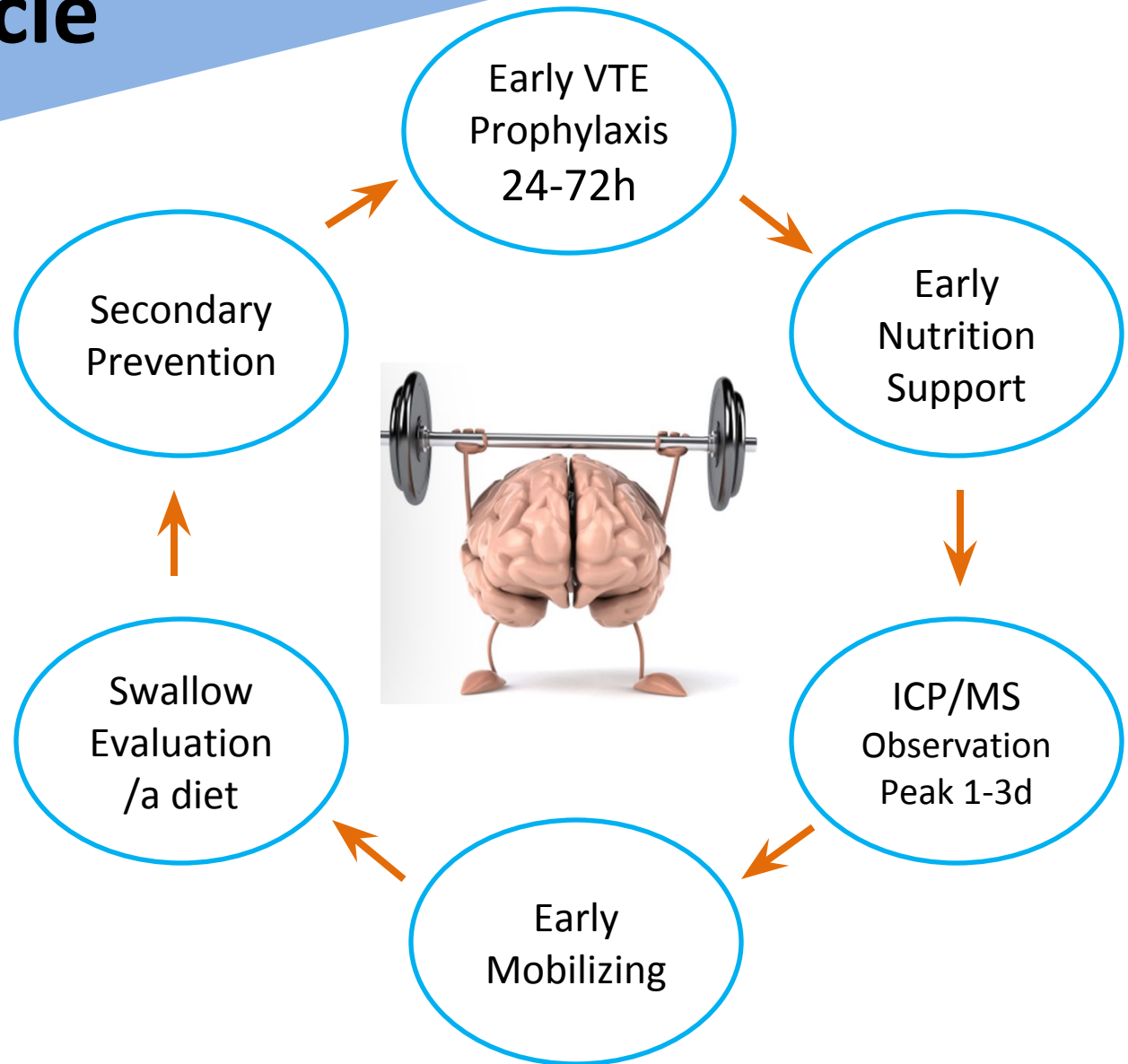
AIS

- **Oral aspirin 325 mg within 24 to 48 hours after stroke onset is recommended for most AIS patients** (*Class I; LOE A*)
- **Urgent anticoagulation to prevent early recurrent stroke, neurological worsening, improve outcomes or noncerebrovascular conditions after AIS is NOT recommended** (*Class III; LOE A*)
- **Initiation of anticoagulant therapy within 24 hours of treatment with IV tPA is NOT recommended** (*Class III; LOE B*)

CVA Acute Support Cycle



CVA Subacute Support Cycle



Questions?

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