



DESC de Réanimation Médicale
Besançon – 23 & 24 Mai 2017

HYPERTENSION INTRACRÂNIENNE

Dr Laurent CARTERON

Pôle Anesthésie – Réanimation Chirurgicale

Service de Réanimation Chirurgicale

CHRU de Besançon

Equipe d'accueil 3920

« Marqueurs pronostiques et facteurs de régulation des pathologies cardiaques et vasculaires »

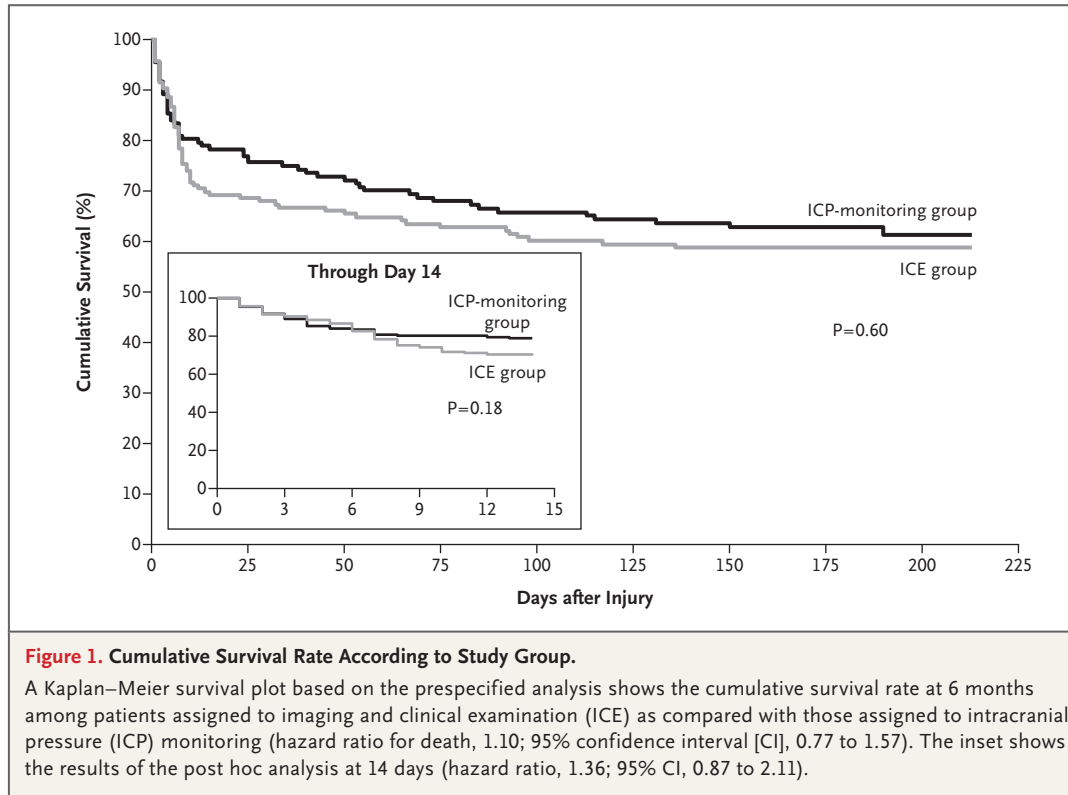
UFR des Sciences Médicales et Pharmaceutiques

Université de Franche Comté

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Faut-il mesurer la Pression IntraCrânienne?



A Trial of Intracranial-Pressure Monitoring in Traumatic Brain Injury



Quelques précisions...

These statements, which should be read in toto to properly reflect the group's consensus positions, conclude that this study:

- 1) **studied protocols**, not ICP- monitoring per se;
- 2) applies only to those protocols and specific study groups and should not be generalized to other treatment approaches or patient groups;
- 3) strongly calls for further research on ICP interpretation and use;
- 4) should be applied cautiously to regions with much different treatment milieu;
- 5) **did not investigate the utility of treating monitored ICP** in the specific patient group with established intracranial hypertension;
- 6) **should not change the practice** of those currently monitoring ICP; and
- 7) provided a protocol, used in non-monitored study patients, that should be considered when treating without ICP monitoring. Consideration of these statements can clarify study interpretation.

A Consensus-based Interpretation of the BEST TRIP ICP Trial

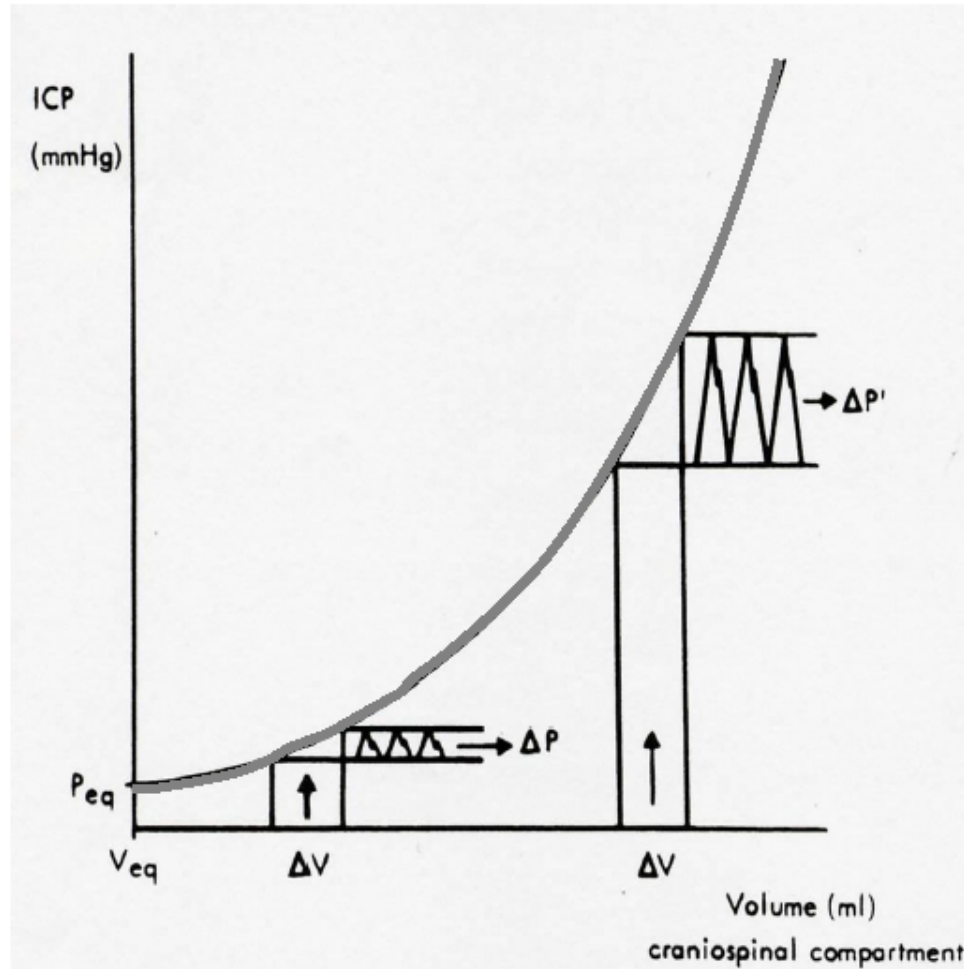
Running Title: Consensus Analysis of the BEST TRIP Trial

Randall M Chesnut^{1*}, Thomas P Bleck², Giuseppe Citerio³, Jan Classen⁴, D James Cooper⁵, William M Coplin⁶, Michael N Diringer⁷, Per-Olof Grände⁸, J Claude Hemphill III⁹, Peter J Hutchinson¹⁰, Peter Le Roux¹¹, Stephan A Mayer¹², David K Menon¹³, John A Myburgh¹⁴, David O Okonkwo¹⁵, Claudia S Robertson¹⁶, Juan Sahuquillo¹⁷, Nino Stocchetti¹⁸, Gene Sung¹⁹, Nancy Temkin^{1,20}, Paul M Vespa²¹, Walter Videtta²², Howard Yonas²³.

2015



Relation Pression Intracrânienne – Volume intracrânien

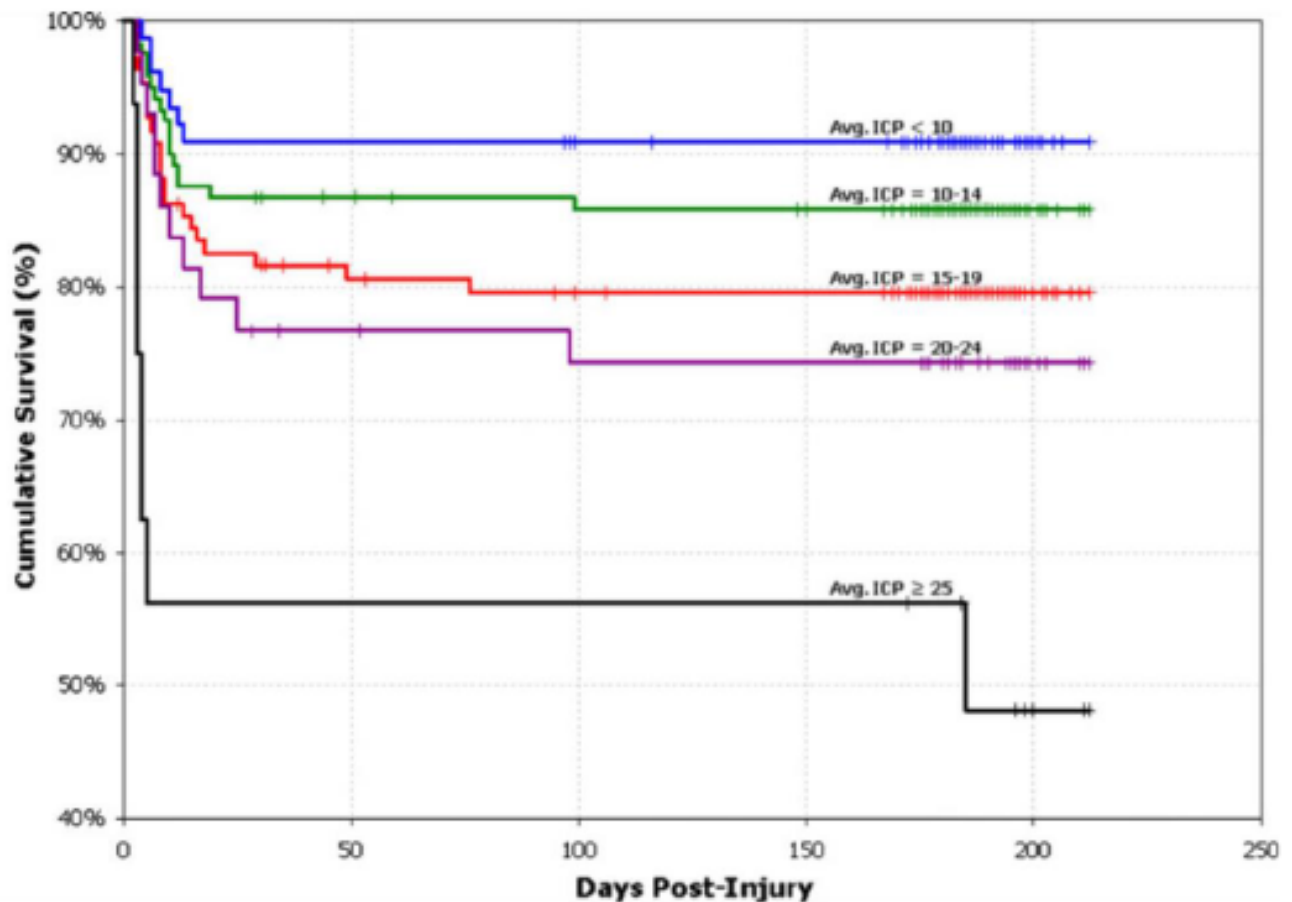


Langfitt, 1963

Mortality and long-term functional outcome associated with intracranial pressure after traumatic brain injury

Badri, *Intensive Care Med* 2012

Fig. 2 Kaplan–Meier survival curves stratified by categories of average ICP in the first 48 h of monitoring



Seuil de traitement de l'HTIC



Level I and II A

- There was insufficient evidence to support a Level I or II A recommendation for this topic.

Level II B

- **Treating ICP above 22 mm Hg is recommended** because values above this level are associated with increased mortality.

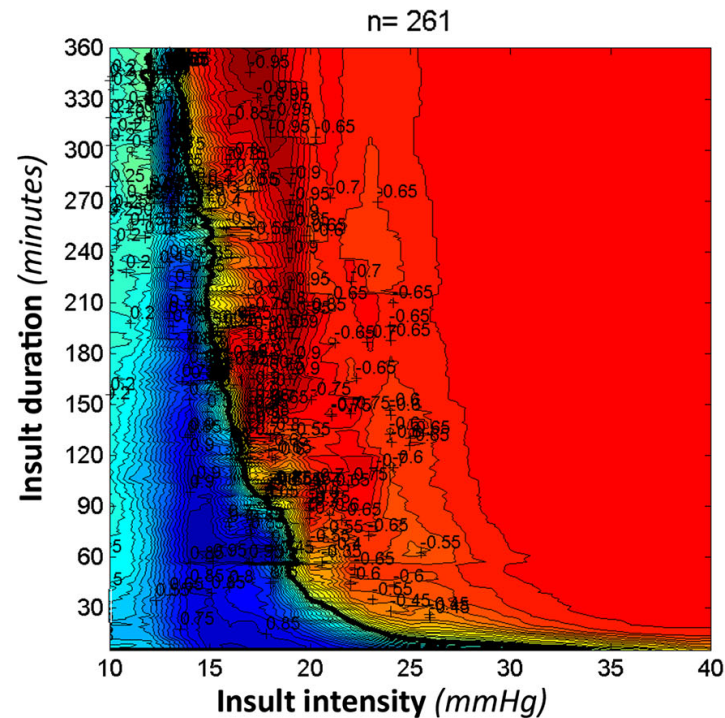
Level III

- A combination of ICP values and clinical and brain CT findings may be used to make management decisions.

*The committee is aware that the results of the RESCUEicp trial may be released soon after the publication of these Guidelines. The results of this trial may affect these recommendations and may need to be considered by treating physicians and other users of these Guidelines. We intend to update these recommendations after the results are published if needed. Updates will be available at <https://braintrauma.org/coma/>.

ICP Thresholds – « Dose de PIC »

Etude prospective multicentrique observationnelle, 261 patients – Mesure de la PIC toutes les minutes



Fabian Güiza
Bart Depreitere
Ian Piper
Giuseppe Citerio
Iain Chambers
Patricia A. Jones
Tsz-Yan Milly Lo
Per Enblad
Pelle Nilsson

Bart Feyen
Philippe Jorens
Andrew Maas
Martin U. Schuhmann
Rob Donald
Laura Moss
Greet Van den Berghe
Geert Meyfroidt

**Visualizing the pressure and time burden
of intracranial hypertension in adult
and paediatric traumatic brain injury**

icm THE OFFICIAL JOURNAL OF
ESCM
INTENSIVE CARE MEDICINE

2015

Pression de perfusion cérébrale

$$PPC = PAM - PIC$$

Mais...

L'important est le
DEBIT SANGUIN CEREBRAL

Autorégulation cérébrale

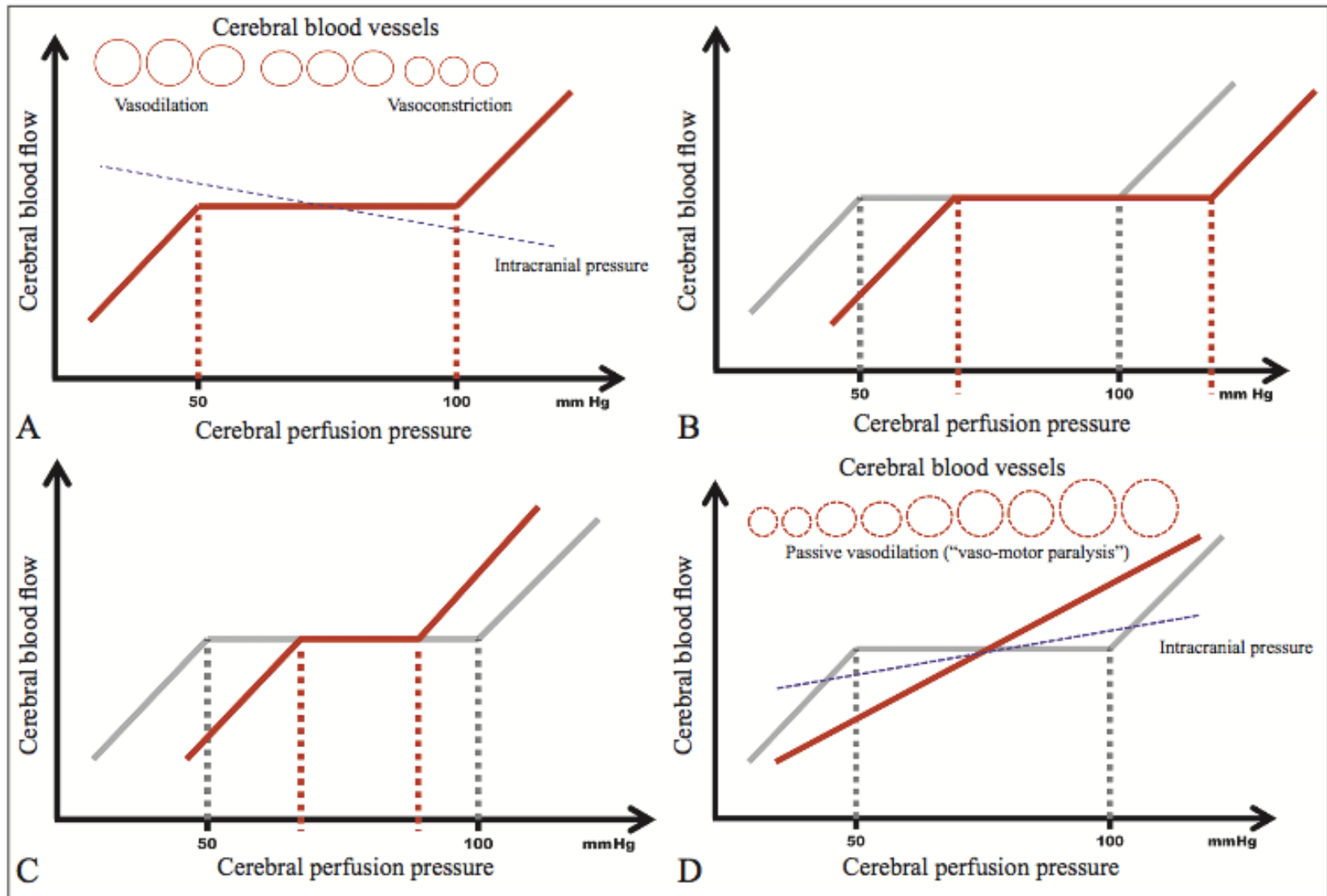
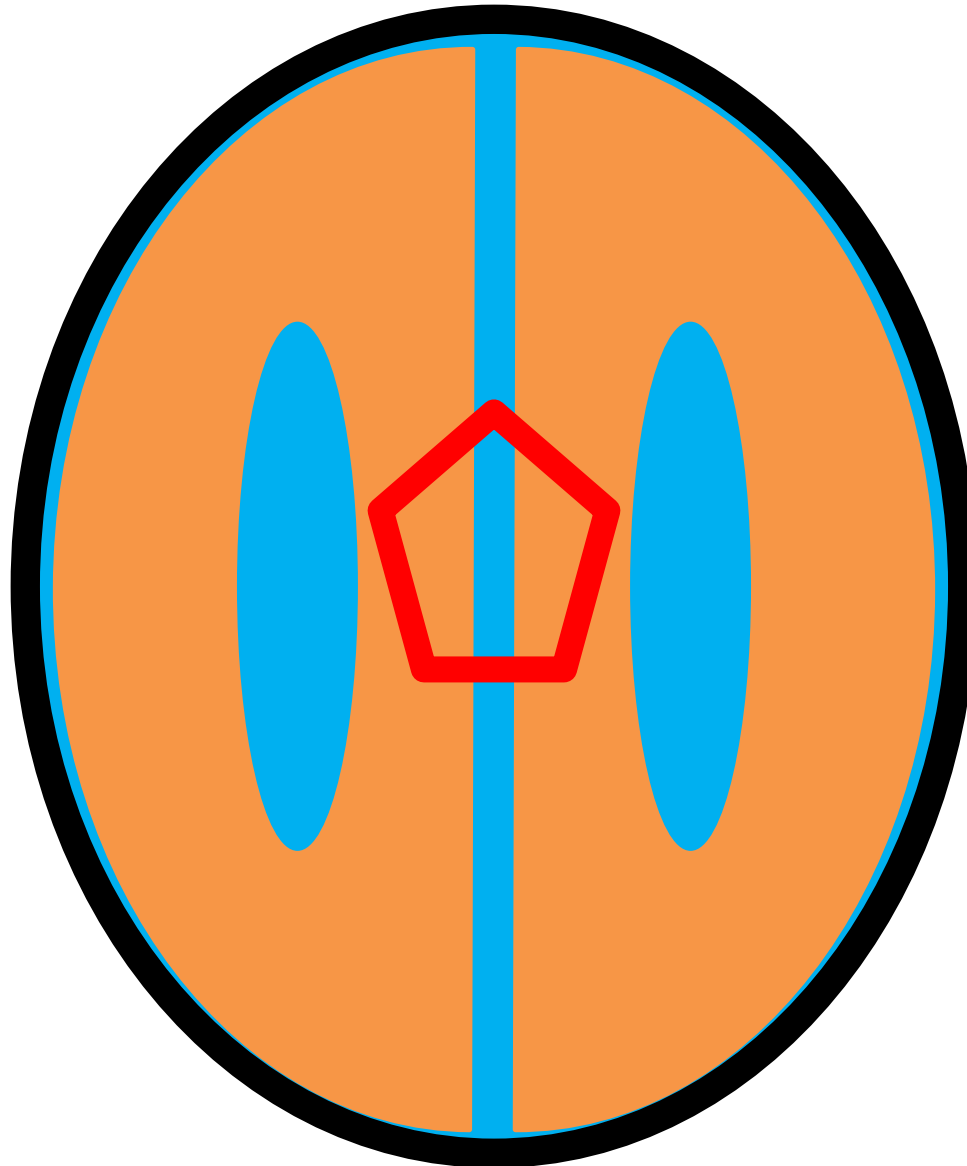


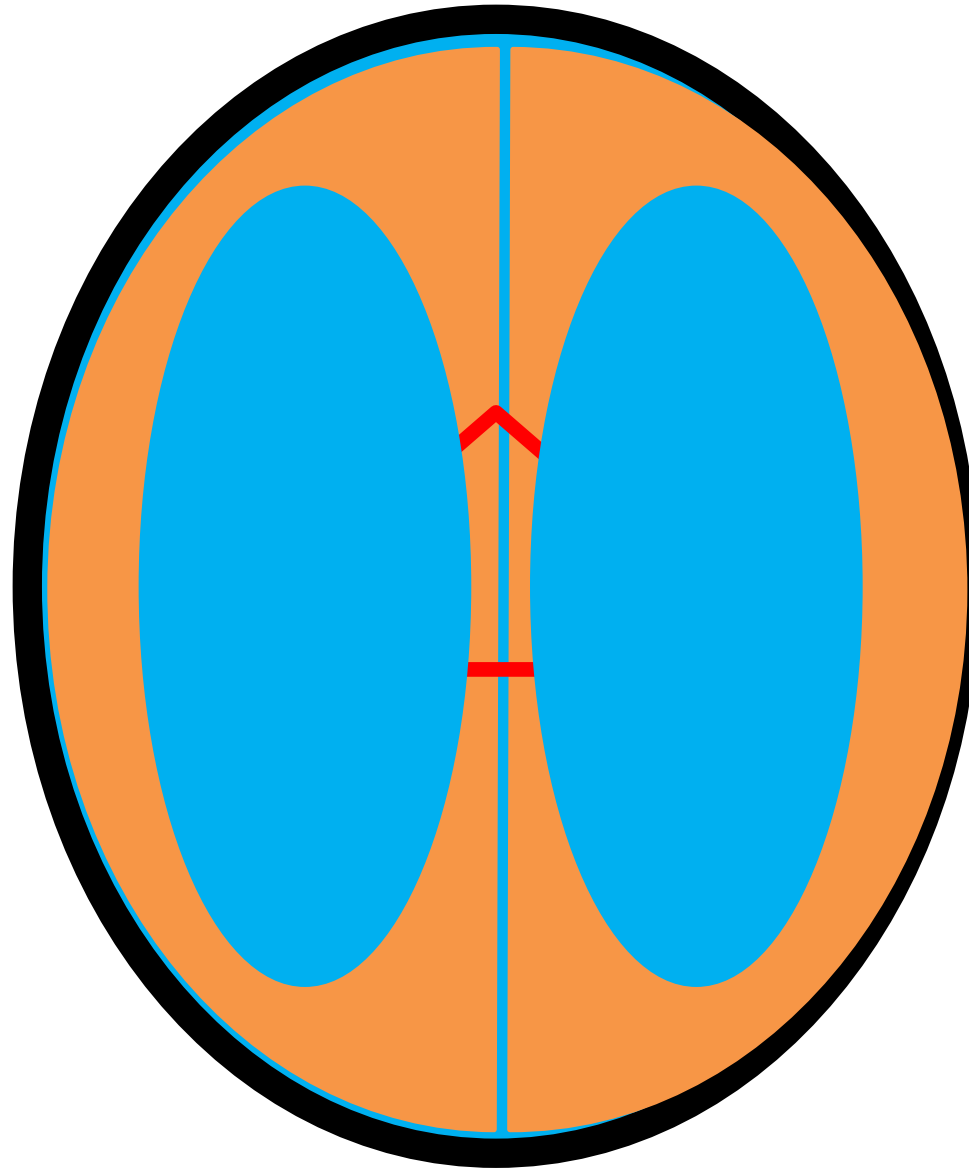
Figure 2.—Schematic view of cerebrovascular pressure autoregulation in normal (A) and pathological (B-D) conditions. Relationships of cerebral blood flow with cerebral perfusion pressure and intracranial pressure are depicted.

Doctrine de Monro - Kellie



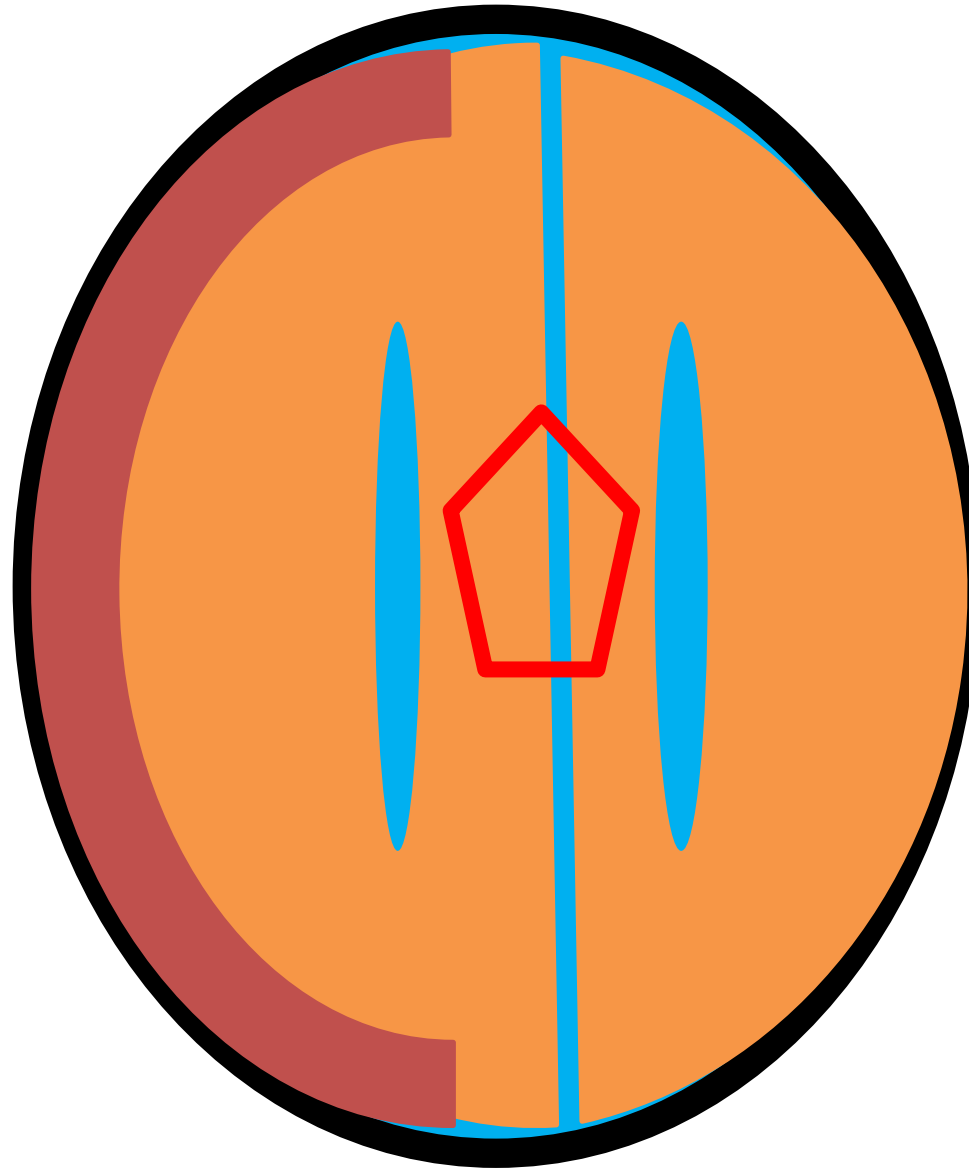
Doctrine de Monro – Kellie

HYDROCEPHALIE AIGUE



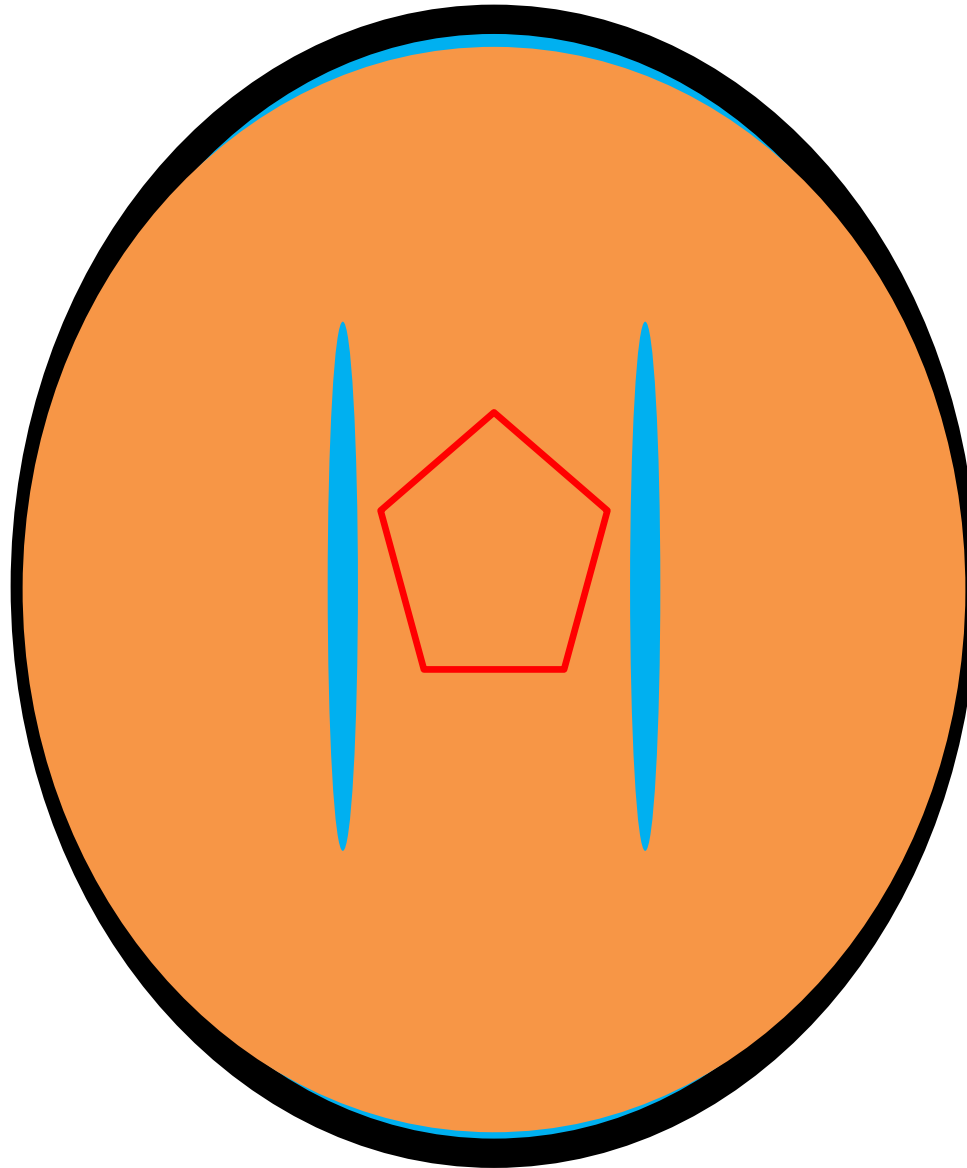
Doctrine de Monro – Kellie

PROCESSUS OCCUPANT DE L'ESPACE



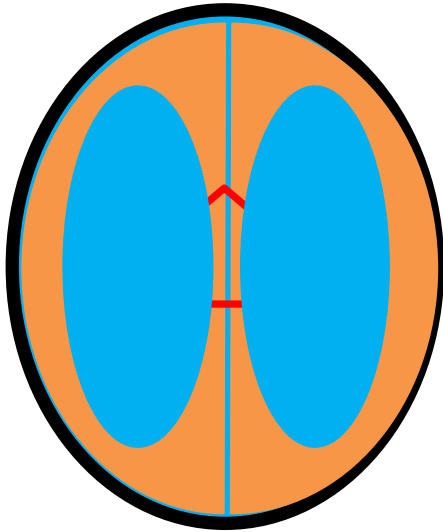
Doctrine de Monro – Kellie

OEDEME CEREBRAL

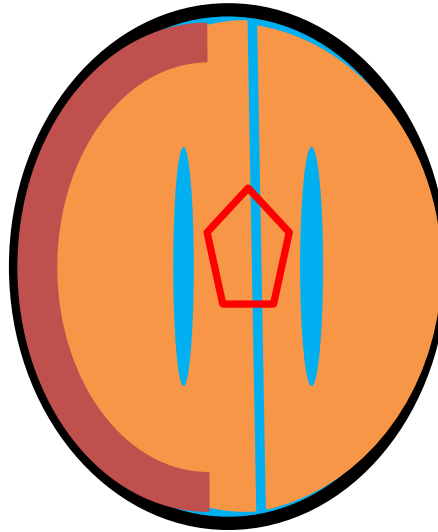


Doctrine de Monro – Kellie

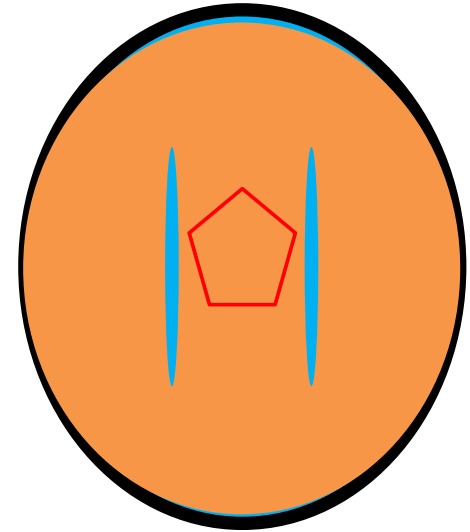
ÉTIOLOGIES DE L'HTIC & AXES THÉRAPEUTIQUES



Dérivation ventriculaire



Évacuation chirurgicale



Osmothérapie

+ Sédation?

+ Contrôle de la PaCO₂?

+ Gestion de la pression artérielle

+ Craniectomie décompressive?

+ Contrôle ciblé de la température?

Gestion de la pression artérielle

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Online version at <http://www.minervamedica.it>

Minerva Anestesiologica 2017 April;83(4):412-21
DOI: 10.23736/S0375-9393.16.11696-7

EXPERTS' OPINION

How to manage blood pressure after brain injury?

Laurent CARTERON^{1, 2}, Fabio S. TACCONE³, Mauro ODDO^{4 *}

¹Department of Anesthesiology and Intensive Care Medicine, Besançon University Hospital, Besançon, France; ²University of Franche-Comté, Besançon, France; ³Department of Intensive Care Medicine, Erasme Hospital, Free University of Brussels, Brussels, Belgium; ⁴Department of Intensive Care Medicine, Lausanne University Hospital, Centre Hospitalier Universitaire Vaudois (CHUV), Lausanne, Switzerland

*Corresponding author: Mauro Oddo, Department of Intensive Care Medicine, Lausanne University Hospital, Centre Hospitalier Universitaire Vaudois (CHUV), Rue du Bugnon 46, BH 08.623, CH-1011 Lausanne, Switzerland. E-mail: mauro.oddo@chuv.ch

Objectifs de Pression de Perfusion Cérébrale

R7.1 - Il faut probablement **individualiser** les objectifs de pression intracrânienne et de pression de perfusion cérébrale correspondant à la meilleure autorégulation cérébrale en se basant sur les données du monitoring multimodal.

(GRADE 2+) Accord FORT

R7.2 - En l'absence de monitoring multimodal, il faut probablement cibler la **pression de perfusion cérébrale entre 60 et 70 mmHg.**

(GRADE 2+) Accord FORT



Level I and II A

- There was insufficient evidence to support a Level I or II A recommendation for this topic.

Level II B

- The recommended target cerebral perfusion pressure (CPP) value for survival and favorable outcomes is **between 60 and 70 mm Hg**. Whether 60 or 70 mm Hg is the minimum optimal CPP threshold is unclear and may depend upon the patient's autoregulatory status.

Level III

- Maintaining **SBP at ≥ 100 mm Hg for patients 50 to 69 years old or at ≥ 110 mm Hg or above for patients 15 to 49 or over 70** years old may be considered to decrease mortality and improve outcomes.
- Avoiding aggressive attempts to maintain CPP above 70 mm Hg with fluids and pressors may be considered because of the risk of adult respiratory failure.



Sédation

AGENT IDÉAL?

- Diminution de la $CMRO_2$
- Respect de l'autorégulation cérébrale
- Respect de la réponse vasculaire au CO_2
- Respect du couplage débit/métabolisme
- Stabilité hémodynamique
- Action anti-épileptique, myorelaxante, analgésique
- Durée d'action courte et réversible, toxicité nulle
- Métabolisme indépendant du foie et du rein
- Faible coût

Abdenmour, AFAR 2008

Oddo et al. *Critical Care* (2016) 20:128
DOI 10.1186/s13054-016-1294-5

Critical Care

REVIEW

Open Access

Optimizing sedation in patients with acute brain injury



Mauro Oddo^{1,2*}, Ilaria Alice Crippa^{3,4,5}, Sangeeta Mehta⁶, David Menon⁷, Jean-Francois Payen⁸, Fabio Silvio Taccone⁵ and Giuseppe Citerio^{3,4}

Sédation - Analgésie

R5.1 - En dehors d'une hypertension intracrânienne ou d'un état de mal épileptique, les experts proposent d'appliquer aux traumatisés crâniens graves les **mêmes recommandations** pour le maintien et l'arrêt de la sédation-analgésie que pour les autres patients de réanimation.

Avis d'expert



Level I and II A

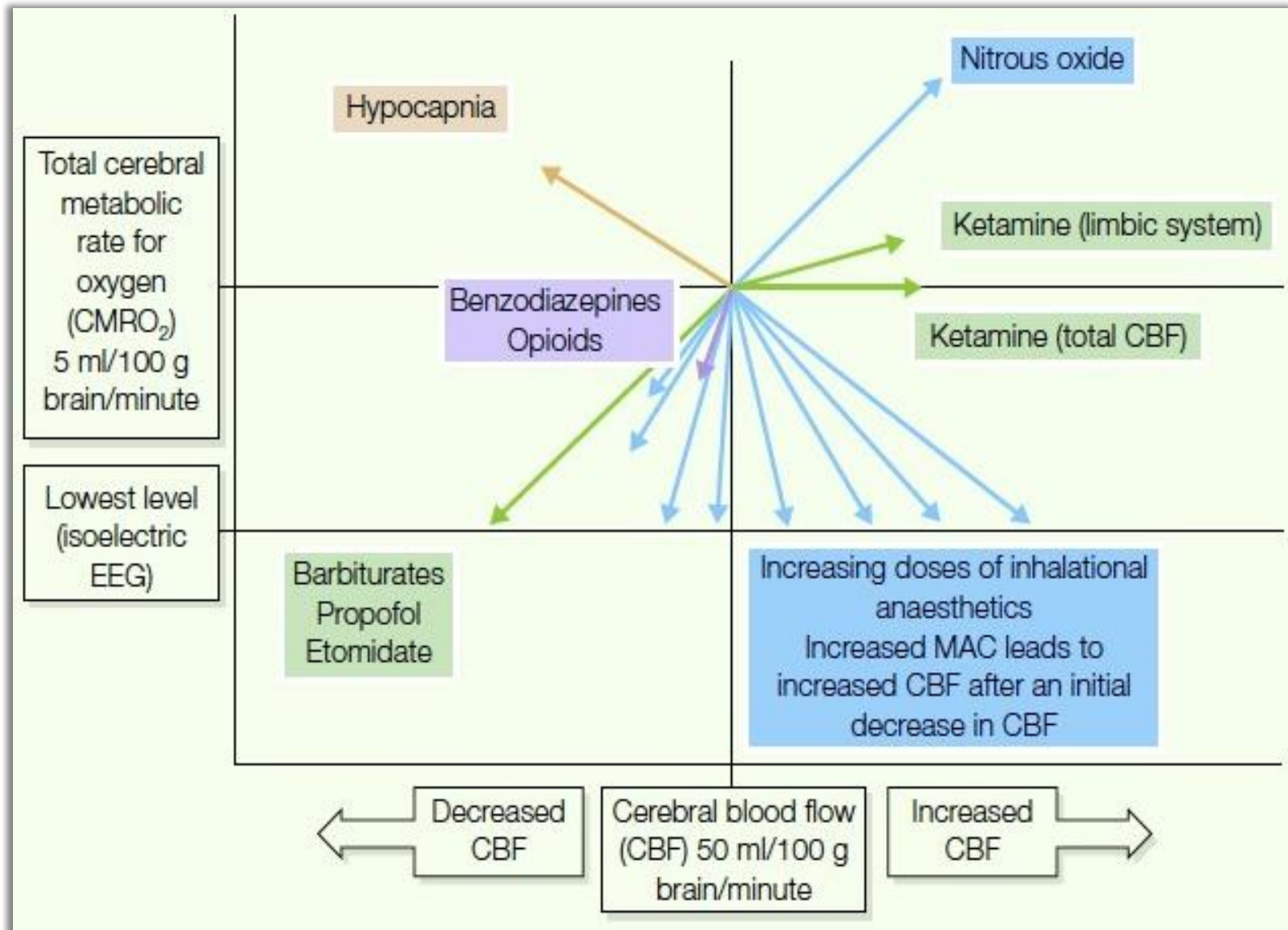
- There was insufficient evidence to support a Level I or Level IIA recommendation for this topic.

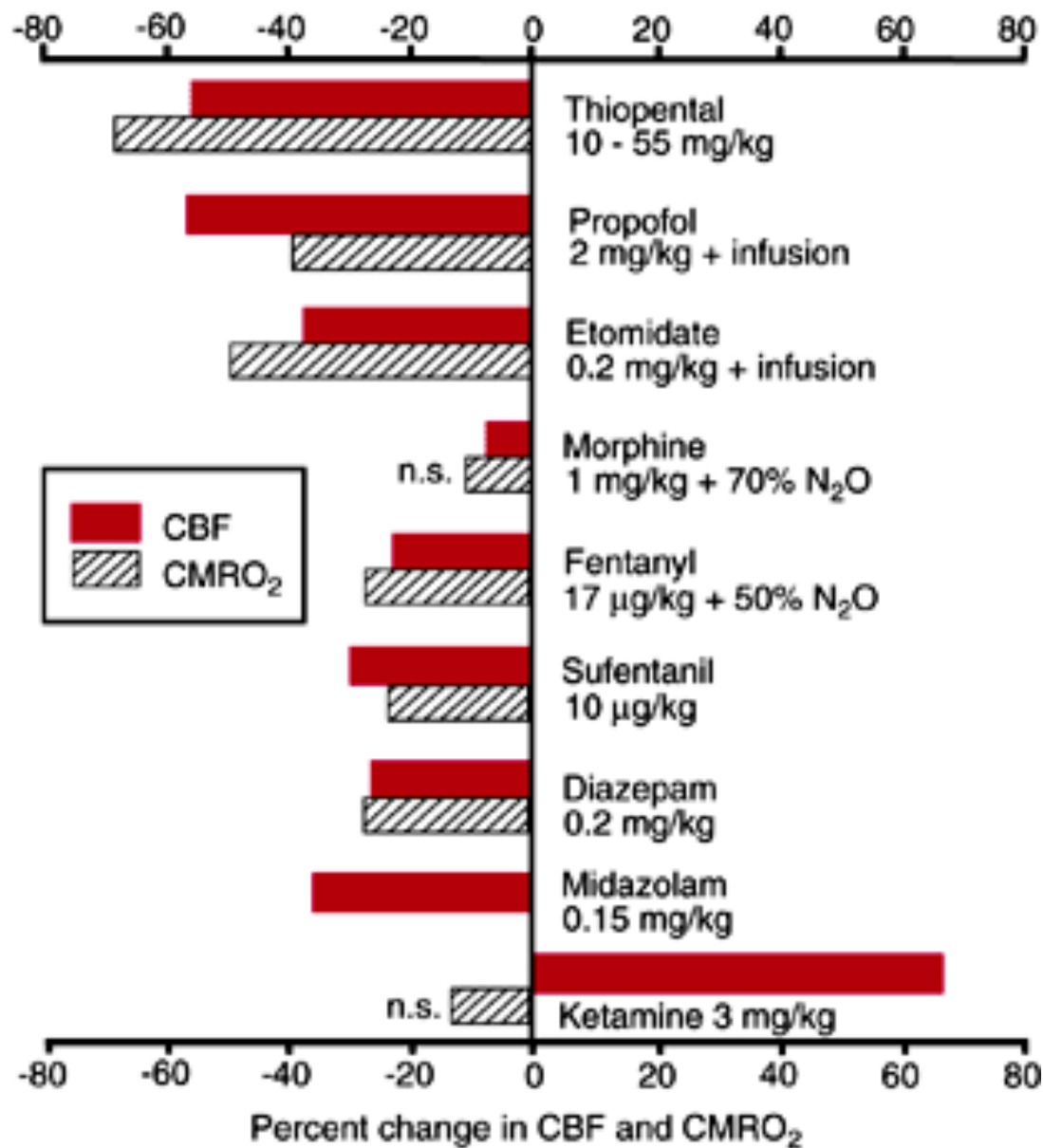
Level II B

- Administration of **barbiturates** to induce burst suppression measured by EEG **as prophylaxis** against the development of intracranial hypertension is **not recommended**.
- High-dose **barbiturate** administration is **recommended to control elevated ICP refractory** to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy.
- Although **propofol** is recommended for the control of ICP, it is **not recommended for improvement in mortality** or 6-month outcomes. Caution is required as high-dose propofol can produce significant morbidity.

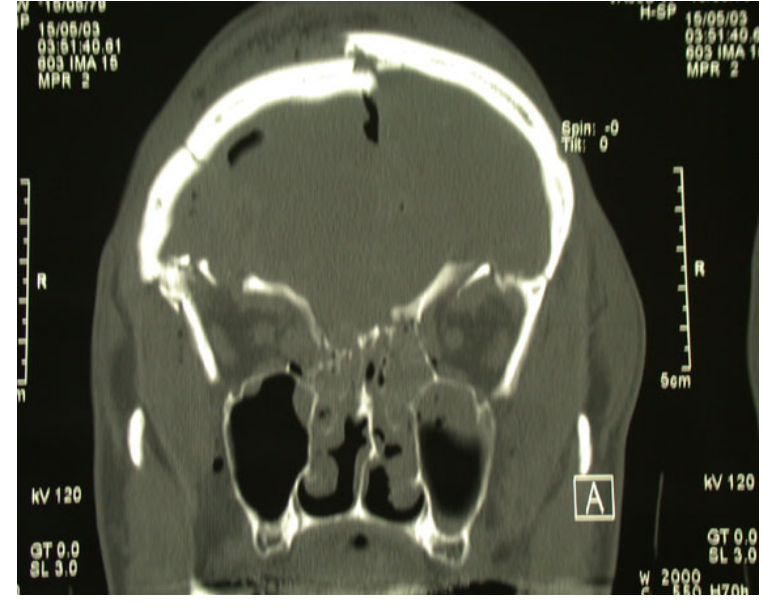


Couplage débit-métabolisme / Gestion de la sédation





Indication chirurgicales



Traumatisme crânien grave

Indications neurochirurgicales

R4.1 - Il faut probablement réaliser un **drainage ventriculaire externe** pour le contrôle de l'hypertension intracrânienne **après échec** d'un traitement comprenant l'optimisation des agressions cérébrales secondaires et de la sédation.

(GRADE 2+) Accord FORT

Les indications neurochirurgicales formelles à la phase précoce du TC grave sont :

- évacuation **la plus précoce possible** d'un hématome **extradural symptomatique** quelle que soit sa localisation,
- évacuation d'un hématome **sous-dural aigu significatif** (épaisseur supérieure à 5 mm avec déplacement de la ligne médiane supérieur à 5 mm),
- drainage d'une **hydrocéphalie aiguë**,
- parage et la fermeture immédiate des **embarrures ouvertes**.



Level I and II

- There was insufficient evidence to support a Level I or II recommendation for this topic.

Level III

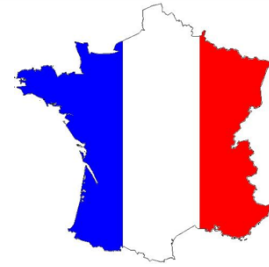
- An EVD system zeroed at the midbrain with continuous drainage of CSF may be considered to lower ICP burden more effectively than intermittent use.
- Use of CSF drainage to lower ICP in patients with an initial Glasgow Coma Scale (GCS) <6 during the first 12 hours after injury may be considered.

Traumatisme crânien grave

Craniectomie décompressive

R4.2- Il faut probablement réaliser une **craniectomie décompressive** pour contrôler la pression intracrânienne à la phase aiguë en cas d'hypertension intracrânienne réfractaire, dans le cadre d'une discussion multidisciplinaire.

(GRADE 2+) Accord FORT



Level I

- There was insufficient evidence to support a Level I recommendation for this topic.

Level II A

- **Bifrontal DC is not recommended to improve outcomes** as measured by the Glasgow Outcome Scale–Extended (GOS-E) score at 6 months post-injury in severe TBI patients with diffuse injury (without mass lesions), and with ICP elevation to values >20 mm Hg for more than 15 minutes within a 1-hour period that are refractory to first-tier therapies. However, this procedure has been demonstrated to reduce ICP and to minimize days in the intensive care unit (ICU).
- A **large frontotemporoparietal** DC (not less than 12 x 15 cm or 15 cm diameter) is recommended over a small frontotemporoparietal DC for reduced mortality and improved neurologic outcomes in patients with severe TBI.

*The committee is aware that the results of the RESCUEicp trial may be released soon after the publication of these Guidelines. The results of this trial may affect these recommendations and may need to be considered by treating physicians and other users of these Guidelines. We intend to update these recommendations after the results are published if needed. Updates will be available at <https://braintrauma.org/coma/guidelines>.



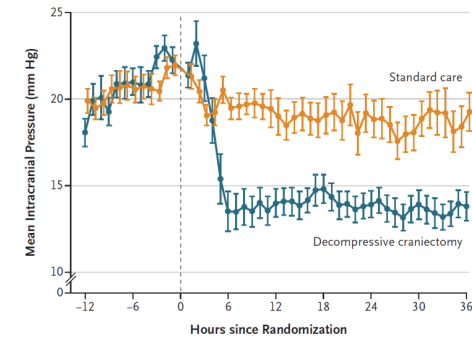
Traumatisme crânien grave

Craniectomie décompressive

Etude prospective randomisée, 155 patients - Mortalité à 6 mois identique, morbidité importante

Table 2. Primary and Secondary Outcomes.*

Outcome	Decompressive Craniectomy (N=73)	Standard Care (N=82)	P Value†
Intracranial pressure and cerebral perfusion pressure			
Intracranial pressure after randomization — mm Hg	14.4±6.8	19.1±8.9	<0.001
No. of hr of intracranial pressure >20 mm Hg — median (IQR)	9.2 (4.4–27.0)	30.0 (14.9–60.0)	<0.001
Intracranial hypertension index — median (IQR)‡	11.5 (5.9–20.3)	19.9 (12.5–37.8)	<0.001
Cerebral hypoperfusion index — median (IQR)§	5.7 (2.5–10.2)	8.6 (4.0–13.8)	0.03
Duration of hospital intervention			
Days of mechanical ventilation — median (IQR)	11 (8–15)	15 (12–20)	<0.001
Days of ICU stay — median (IQR)	13 (10–18)	18 (13–24)	<0.001
Days of hospitalization — median (IQR)	28 (21–62)	37 (24–44)	0.82
Extended Glasgow Outcome Scale			
Score — no. (%)			
1 (dead)	14 (19)	15 (18)	
2 (vegetative state)	9 (12)	2 (2)	
3 (lower severe disability)	18 (25)	17 (21)	
4 (upper severe disability)	10 (14)	8 (10)	
5 (lower moderate disability)	13 (18)	20 (24)	
6 (upper moderate disability)	6 (8)	13 (16)	
7 (lower good recovery)	2 (3)	4 (5)	
8 (upper good recovery)	1 (1)	3 (4)	
Median score (IQR)	3 (2–5)	4 (3–5)	0.03
Unfavorable score of 1 to 4 — no. (%)	51 (70)	42 (51)	0.02



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*

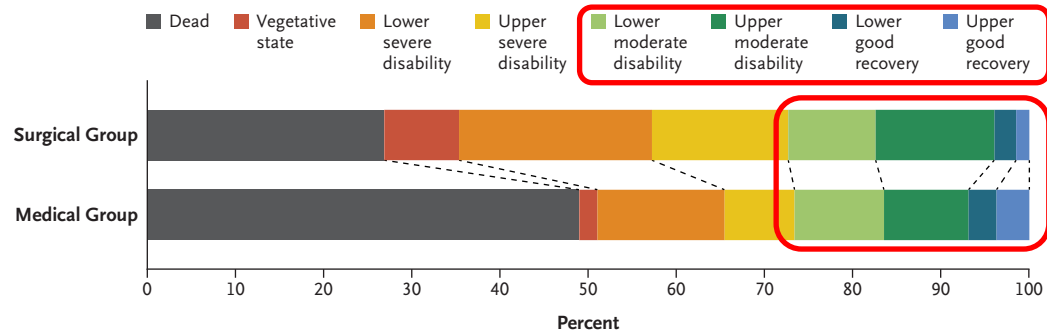


Traumatisme crânien grave

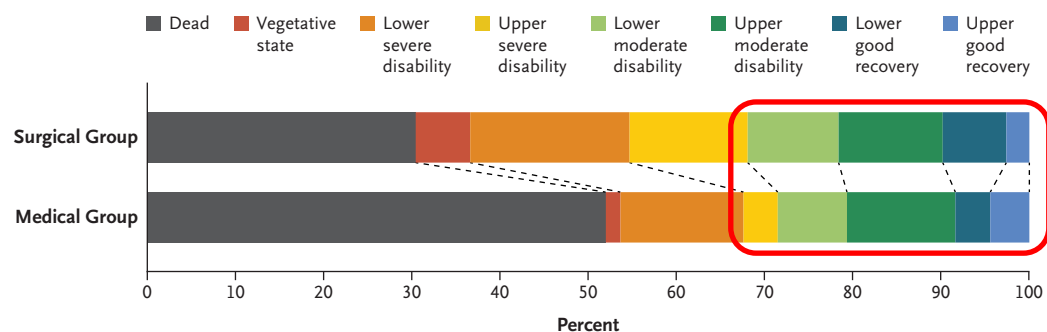
Craniectomie décompressive

Etude prospective randomisée, 408 patients - Mortalité diminuée, morbidité augmentée

A GOS-E Results at 6 Mo (primary end point)



B GOS-E Results at 12 Mo (secondary end point)



Trial of Decompressive Craniectomy for Traumatic Intracranial Hypertension

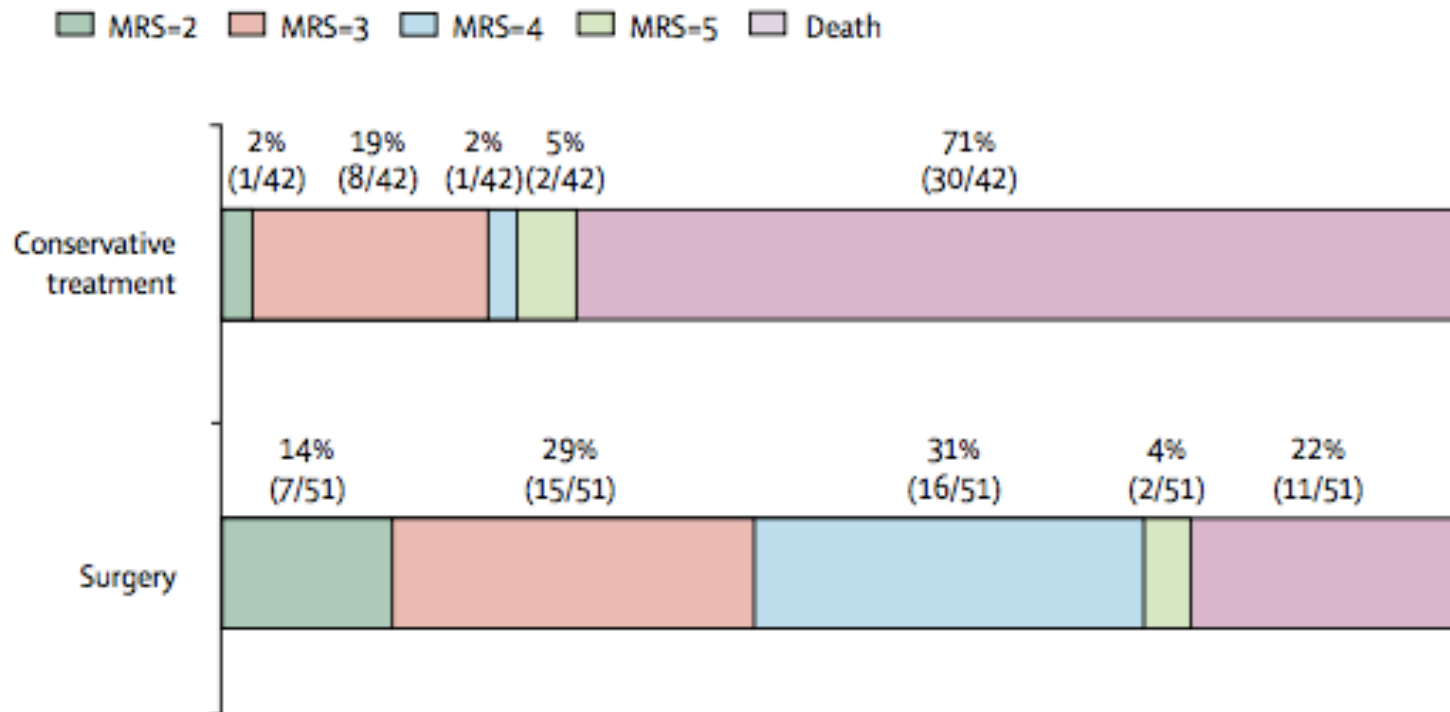
P.J. Hutchinson, A.G. Kolas, I.S. Timofeev, E.A. Corteen, M. Czosnyka, J. Timothy, I. Anderson, D.O. Bulters, A. Belli, C.A. Eynon, J. Wadley, A.D. Mendelow, P.M. Mitchell, M.H. Wilson, G. Critchley, J. Sahuquillo, A. Unterberg, F. Servadei, G.M. Teasdale, J.D. Pickard, D.K. Menon, G.D. Murray, and P.J. Kirkpatrick, for the RESCUEicp Trial Collaborators*



AVC ischémique

Craniectomie décompressive

Analyse poolée, 3 études prospectives randomisées, 93 patients, dans les 48h - Mortalité à 12 mois diminuée



Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials

THE LANCET

Katayoun Vahedi, Jeannette Hofmeijer, Eric Juettler, Eric Vicaut, Bernard George, Ale Algra, G Johan Amelink, Peter Schmiedeck, Stefan Schwab, Peter M Rothwell, Marie-Germaine Bousser, H Bart van der Worp, Werner Hacke, for the DECIMAL, DESTINY, and HAMLET investigators

2007

Osmothérapie

R7.3 – Il faut administrer du **mannitol 20% ou du sérum salé hypertonique (250 mosmol)** en 15 à 20 minutes en traitement d'urgence d'une hypertension intracrânienne sévère ou de signes d'engagement, après contrôle des agressions cérébrales secondaires.

(GRADE 1+) Accord FORT



Level I, II, and III

- Although hyperosmolar therapy may lower intracranial pressure, there was **insufficient evidence about effects on clinical outcomes to support a specific recommendation**, or to support use of any specific hyperosmolar agent, for patients with severe traumatic brain injury.

Recommendations from the Prior (3rd) Edition Not Supported by Evidence Meeting Current Standards

- Mannitol is effective for control of raised intracranial pressure (ICP) at doses of 0.25 g/kg to 1 g/kg body weight. Arterial hypotension (systolic blood pressure <90 mm Hg) should be avoided.
- Restrict mannitol use prior to ICP monitoring to patients with signs of transtentorial herniation or progressive neurological deterioration not attributable to extracranial causes.

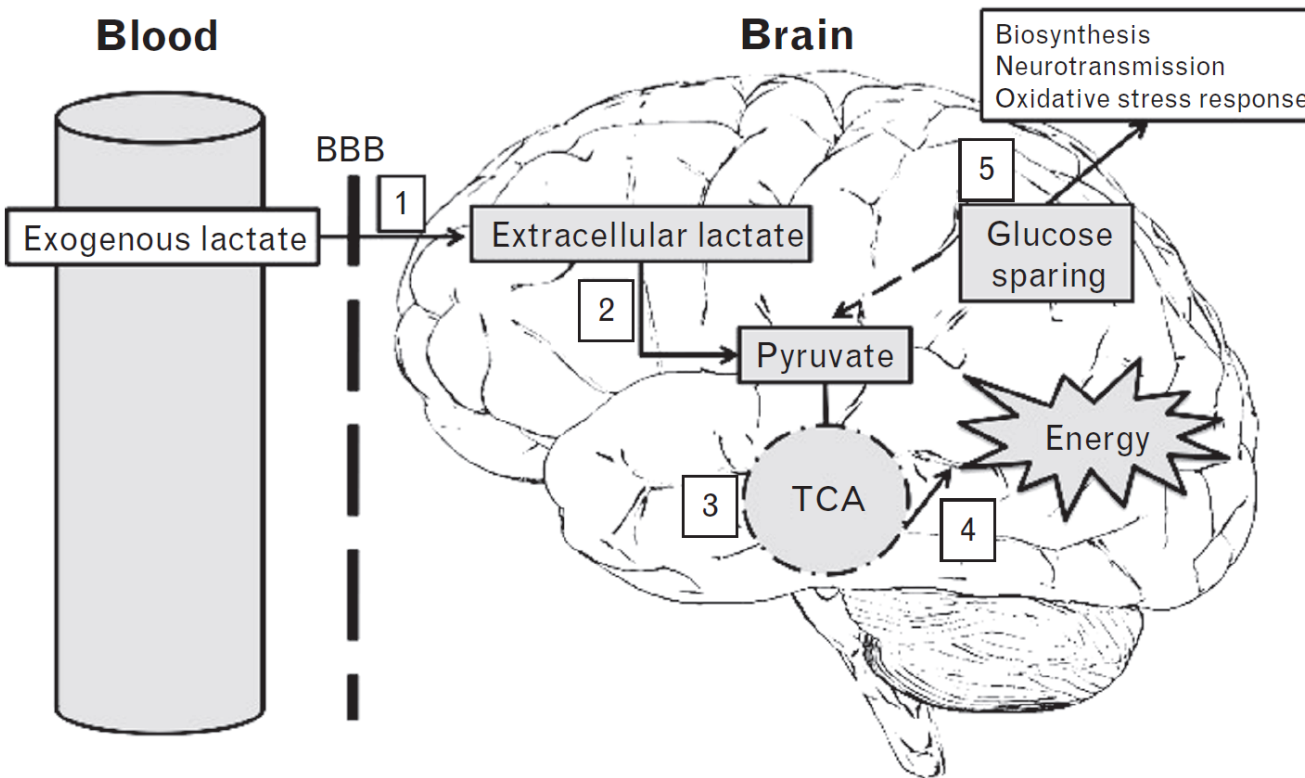


Osmothérapie



- **Mannitol** : 0,2 gr/mL
 - 0,5 à 1 g/kg sur 15 à 20 minutes +++
 - Effet hémodynamique, rhéologique et osmotique
 - Effets secondaires : diurétique +++, hyponatrémie (de dilution), acidose, hypotension
 - Compensation des pertes urinaires par sérum physio isotonique
- **Sérum salé hypertonique** :
 - De 3 à 24%...
 - Souvent associé à colloïde pour maintien de l'effet
 - 3-4 ml/kg de SSH 7,5%, surveillance de la natrémie et de l'osmolarité
 - Effets secondaires : insuffisance rénale aiguë, hyperchlorémie, hypernatrémie (transitoire)

Rationnel pour l'utilisation de lactate hypertonique



- Apport supplémentaire d'énergie au cerveau
- Diminue d'œdème cérébral et améliore la perfusion cérébrale
- Evite l'acidose hyperchlorémique

Lactate and the injured brain: friend or foe?

Pierre Bouzat^{a,b} and Mauro Oddo^a

Current Opinion in
Critical Care

Contrôle ciblé de la température



R12.1–Chez les patients traumatisés crâniens graves, il faut probablement pratiquer un CCT entre 35 et 37°C dans le but de prévenir l’hypertension intracrânienne.

(GRADE 2+) Accord FORT

R12.2 – Chez les patients traumatisés crâniens graves, il faut probablement pratiquer un CCT entre 35 et 37°C dans le but d’améliorer la survie avec bon pronostic neurologique.

(GRADE 2+) Accord FORT

R12.3 – Chez les patients traumatisés crâniens avec hypertension intracrânienne malgré un traitement médical bien conduit, il faut probablement pratiquer un CCT entre 32 et 35 °C dans le but de faire baisser la pression intracrânienne.

(GRADE 2+) Accord FORT

R12.4– Chez les patients traumatisés crâniens, il faut probablement adapter la durée et la profondeur du CCT en fonction de l’hypertension intracrânienne.

Avis d’experts

R12.5 –Chez l'enfant traumatisé crânien grave, il faut faire un CCT visant à maintenir une normothermie.

Avis d’experts

R12.6 –Chez l'enfant traumatisé crânien grave, il ne faut pas induire de CCT avec pour but d’obtenir une hypothermie thérapeutique (32-34°C) pour améliorer le pronostic ou pour contrôler l’HTIC.

(GRADE 1-) Accord FORT

Targeted Temperature Management



Level I and II A

- There was insufficient evidence to support a Level I or II A recommendation for this topic.

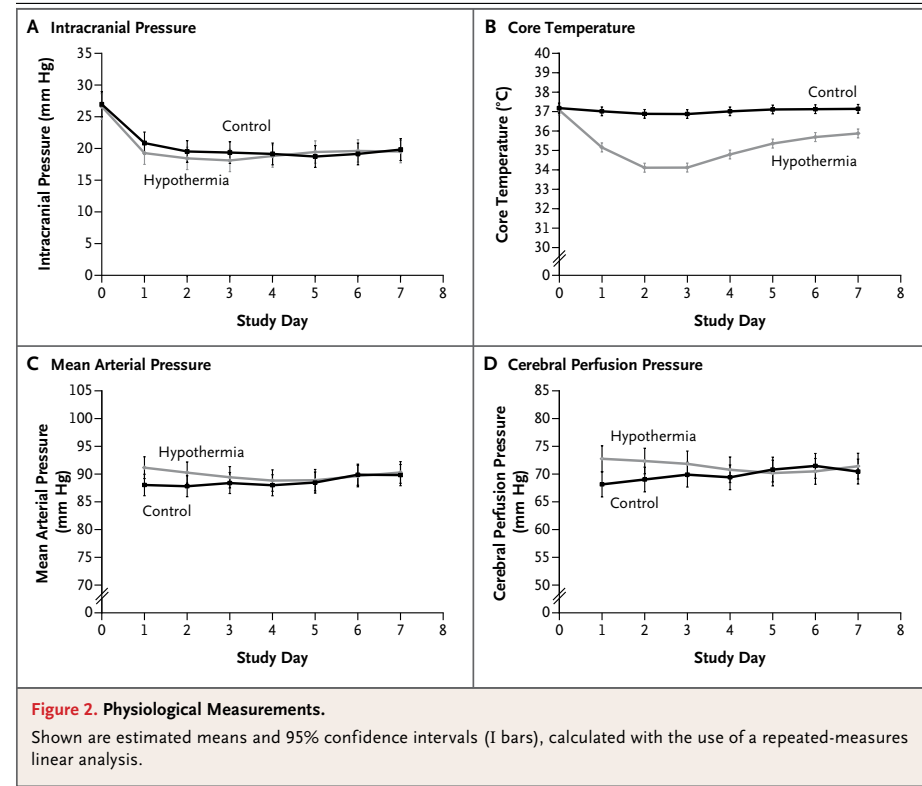
Level II B

- Early (within 2.5 hours), short-term (48 hours post-injury) prophylactic hypothermia is **not recommended** to improve outcomes in patients with diffuse injury.

Intérêt de l'hypothermie profonde?

Essai contrôlé randomisé (47 centres, 18 pays)
387 patients en HTIC
Traitement standard vs. Hypothermie 32-35°C

Arrêt prématuré pour sur-mortalité dans le groupe hypothermie



Hypothermia for Intracranial Hypertension after Traumatic Brain Injury

Peter J.D. Andrews, M.D., M.B., Ch.B., H. Louise Sinclair, R.G.N., M.Sc.,
Aryelly Rodriguez, M.Sc., Bridget A. Harris, R.G.N., Ph.D.,
Claire G. Battison, R.G.N., B.A., Jonathan K.J. Rhodes, Ph.D., M.B., Ch.B.,
and Gordon D. Murray, Ph.D., for the Eurotherm3235 Trial Collaborators*



Hypothermie thérapeutique

Randomized Controlled Trial of Long-term Mild Hypothermia for Severe Traumatic Brain Injury (LTH-I)

This study is currently recruiting participants. (see [Contacts and Locations](#))

Verified January 2014 by RenJi Hospital

Sponsor:

RenJi Hospital

Collaborators:

First Affiliated Hospital of Zhejiang University
West China Hospital

ClinicalTrials.gov Identifier:

NCT01886222

First received: June 17, 2013

Last updated: January 21, 2014

Last verified: January 2014

[History of Changes](#)

The Prophylactic Hypothermia Trial to Lessen Traumatic Brain Injury (POLAR-RCT)

This study is currently recruiting participants. (see [Contacts and Locations](#))

Verified April 2012 by Australian and New Zealand Intensive Care Research Centre

Sponsor:

Australian and New Zealand Intensive Care Research Centre

Collaborators:

Australian and New Zealand Intensive Care Society Clinical Trials Group
National Health and Medical Research Council, Australia
Victorian Transport Accident Commission
Monash University
Délégation à la Recherche Clinique et à l'Innovation (DRCI) CHU Besançon

ClinicalTrials.gov Identifier:

NCT00987688

First received: September 29, 2009

Last updated: January 1, 2014

Last verified: April 2012

[History of Changes](#)

Homéostasie biologique

R10.1 – Il ne faut **probablement pas induire une hyponatrémie prolongée** pour contrôler la pression intracrânienne chez le traumatisé crânien grave.

(GRADE 2-) Accord FORT

R10.2 – Il ne faut **pas administrer des glucocorticoïdes à forte dose** après un traumatisme crânien grave.

(GRADE 1-) Accord FORT

R10.3 – Il faut surveiller étroitement la glycémie et réaliser un **contrôle glycémique** ciblant des valeurs comprises **entre 8 mM/L (1,4 g/L) et 10-11 mM/L(1,8-2 g/L)** chez le traumatisé crânien grave (adulte et enfant).

(GRADE 1+) Accord FORT



Le CO2



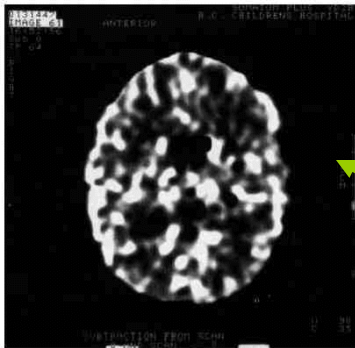
Pas de neuro-réanimation sans monitoring de l' EtCO2

« L'hypocapnie est transitoire, ses effets sont définitifs »

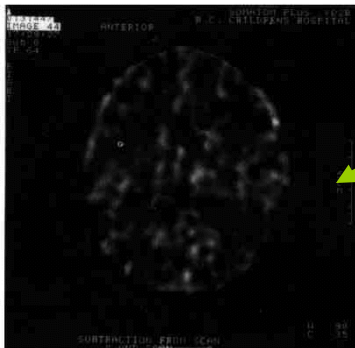
D. Payen JMT SFAR 2006



!!! Vasoconstriction à besoins constants en O2 !!!



PCO2=45mmHg, PIC=44mmHg, PPC=54mmHg, DSC global=59ml/min/100g



PCO2=30mmHg, PIC=15mmHg, PPC=82mmHg, DSC global=14ml/min/100g avec des débits régionaux <10ml/min/100g = seuil d'ischémie irréversible

D'où l'intérêt du monitoring multimodal

Skippen and all CCM 1997

NORMOCAPNIE +++ dans la souffrance cérébrale

Prise en charge médicale de l'HTIC

R7.4 – Il ne faut **probablement pas faire d'hypocapnie** comme traitement d'une hypertension intracrânienne.

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R7.5– Il ne faut **probablement pas administrer d'albumine à 4%** comme soluté de remplissage chez les traumatisés crâniens graves.

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Indications et modalités du monitoring cérébral

R6.1 - Il faut probablement **avoir recours** à un monitoring systématique de la pression intracrânienne après traumatisme crânien grave afin de détecter une hypertension intracrânienne dans les cas suivants :

- 1- Signe(s) **d'hypertension intracrânienne** sur l'imagerie.
- 2- **Chirurgie périphérique urgente** (hors risque vital engagé).
- 3- **Evaluation neurologique impossible.**

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R6.2 - Il ne faut probablement **pas avoir recours** à un monitoring systématique de la pression intracrânienne afin de détecter une hypertension intracrânienne dans le cadre d'un traumatisme crânien grave isolé **si la tomodensitométrie initiale est normale, en l'absence de critères de gravité clinique et/ou d'anomalies au Doppler transcrânien.**

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Indications et modalités du monitoring cérébral

R6.3 - Il faut probablement avoir recours à un monitoring systématique de la pression intracrânienne après évacuation d'un hématome intracrânien post-traumatique (sous-dural, extra-dural ou intraparenchymateux) si (1 seul critère suffit) :

- Le score de **Glasgow moteur préopératoire était inférieur ou égal à 5.**
- Il existait une **anisocorie** ou une **mydriase bilatérale** préopératoire.
- Un épisode **d'instabilité hémodynamique** est survenu en préopératoire.
- Des **signes de gravité** existaient sur l'imagerie préopératoire (disparition des citernes de la base, déviation de la ligne médiane supérieure ou égale à 5 mm, existence d'autre(s) lésion(s) intracrâniennes).
- Il existait un **œdème cérébral peropératoire.**
- De **nouvelles lésions intracrâniennes** sont apparues sur l'imagerie post-opératoire.

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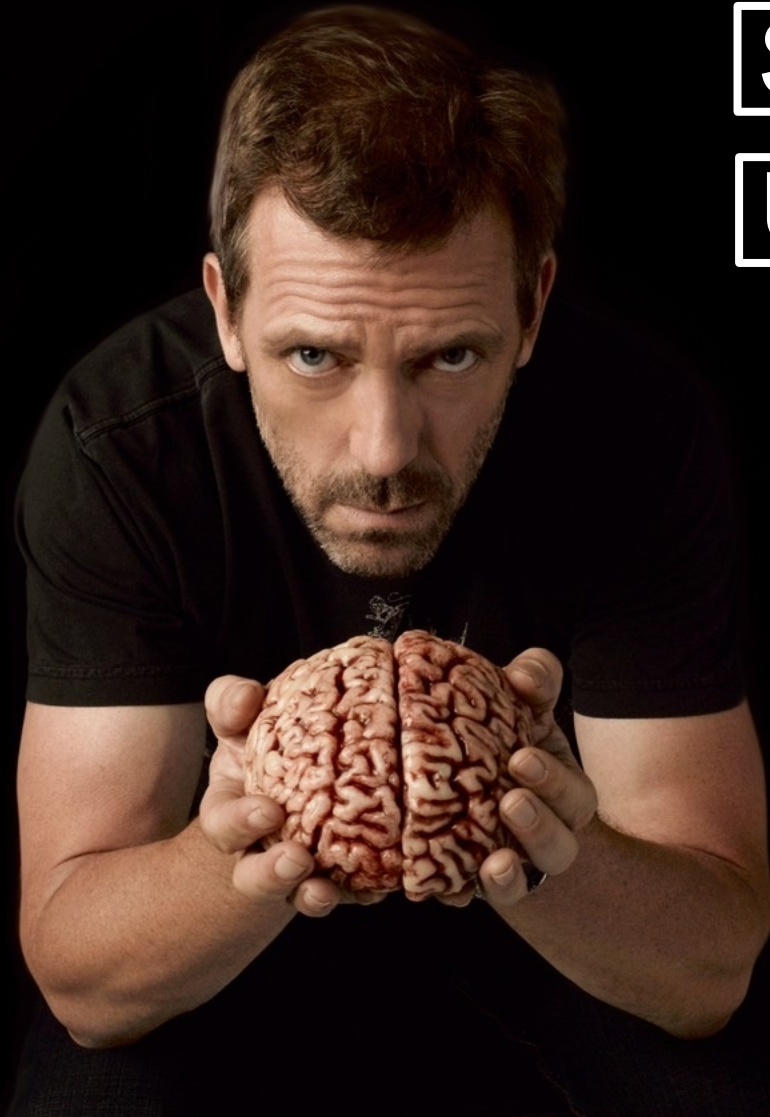
Indications et modalités du monitoring cérébral

R6.4- Les experts proposent d'avoir recours à un **monitorage multimodal** (Doppler transcrânien et/ou pression tissulaire cérébrale en oxygène) pour optimiser le débit sanguin cérébral et l'oxygénation cérébrale chez les traumatisés crâniens graves.

Avis d'expert

Proposition de prise en charge de l'HTIC (d'après Stocchetti et al.)

Therapy Steps	Levels of Evidence	Treatment	Risk
8	Not reported	Decompressive craniectomy	Infection or delayed hematoma Subdural effusion Hydrocephalus and syndrome of the trephined
7	Level II	Metabolic suppression (barbiturates)	Hypotension and increased number of infections
6	Level III	Hypothermia	Fluid and electrolyte disturbances and infection
5	Level III	Induced hypocapnia	Excessive vasoconstriction and ischemia
4	Level II	Hyperosmolar therapy Mannitol or hypertonic saline	Negative fluid balance Hypernatremia Kidney failure
3	Not reported	Ventricular CSF drainage	Infection
2	Level III	Increased sedation	Hypotension
1	Not reported	Intubation Normocarbic ventilation	Coughing, ventilator asynchrony, ventilator-associated pneumonia



SAVE THEIR BRAINS:

USE YOUR BRAIN