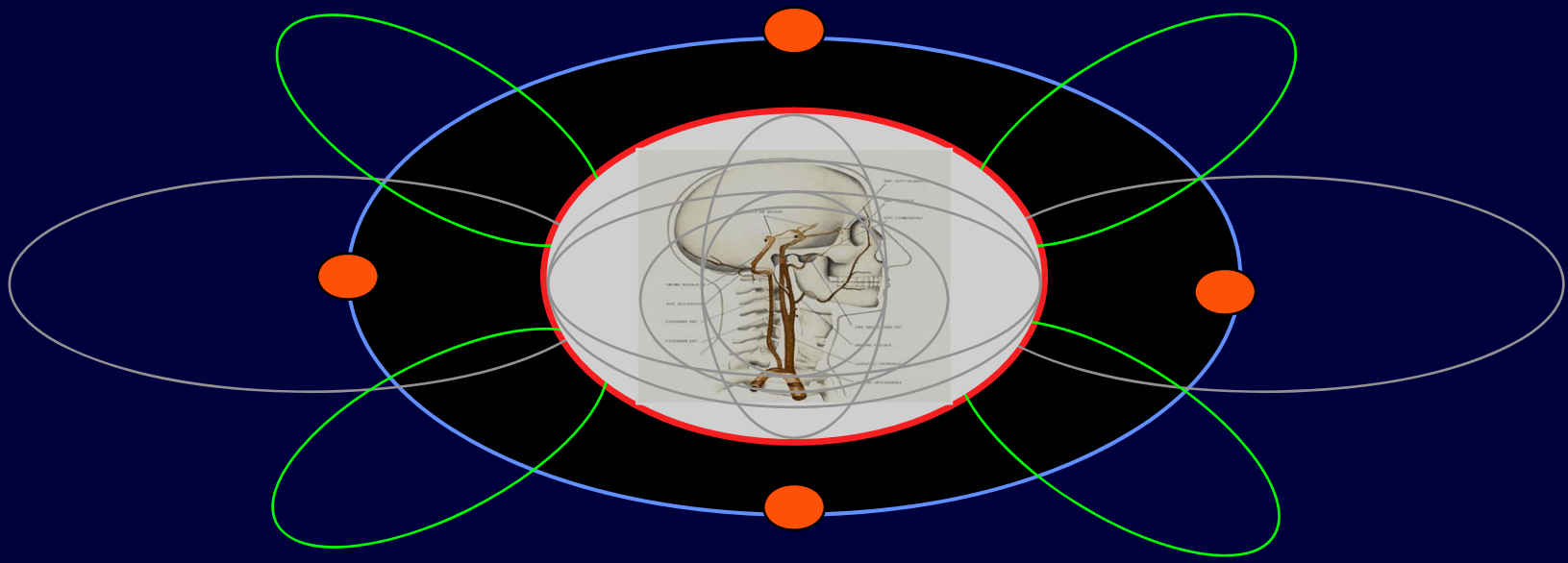
颅 高 压 危 象



刘 励 军
苏州大学附属第二医院急诊医学科

提纲

1. 颅高压危象定义与形成机制
2. 颅高压危象临床表现与预测
3. 颅高压危象的治疗

一、颅高压危象定义与形成机制

颅高压危象

- 颅高压危象：各种原因引起颅内压增高>20mmHg 的基础上，出现以下危及患者生命的征象：

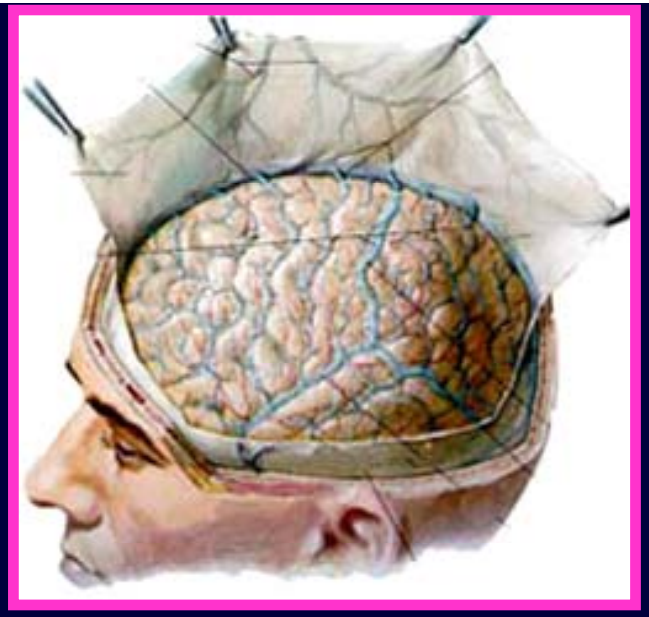
✓神经系统：剧烈头痛、意识障碍（如烦躁不安、嗜睡、昏迷等）

✓循环系统：血压升高、晚期血压下降、心动过速、或心动过缓

✓呼吸系统：呼吸节律慢而深、或不规则，甚至呼吸暂停等

✓内环境严重紊乱：高热、尿崩症、高钠血症等

ICP
5 - 13 mmHg



脑组织

脑脊液

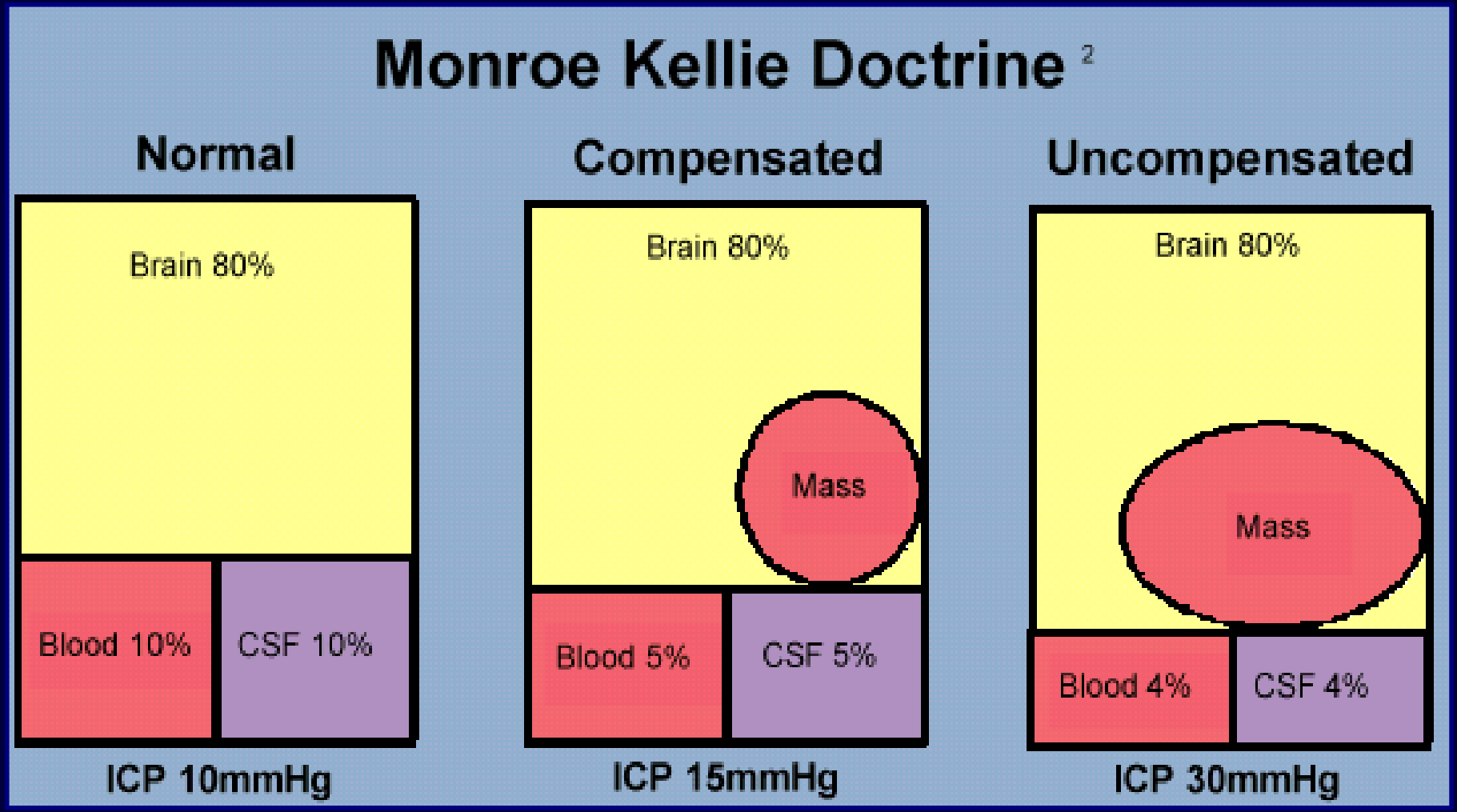
脑血流

80 %

10 %

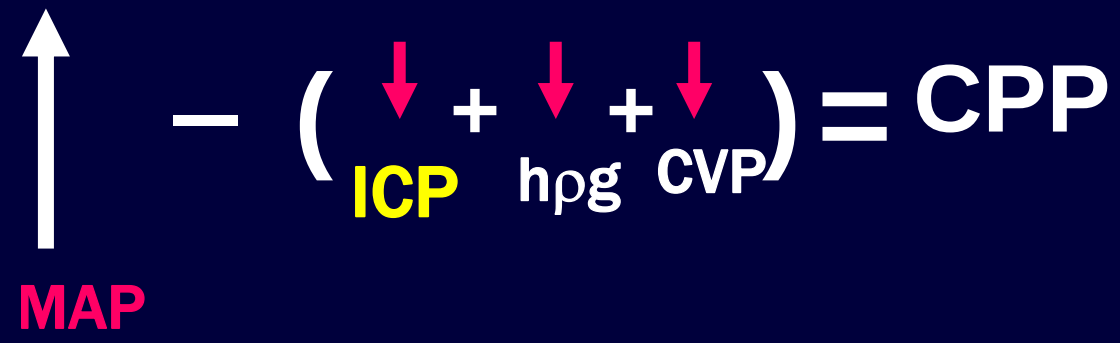
10%

形成机制

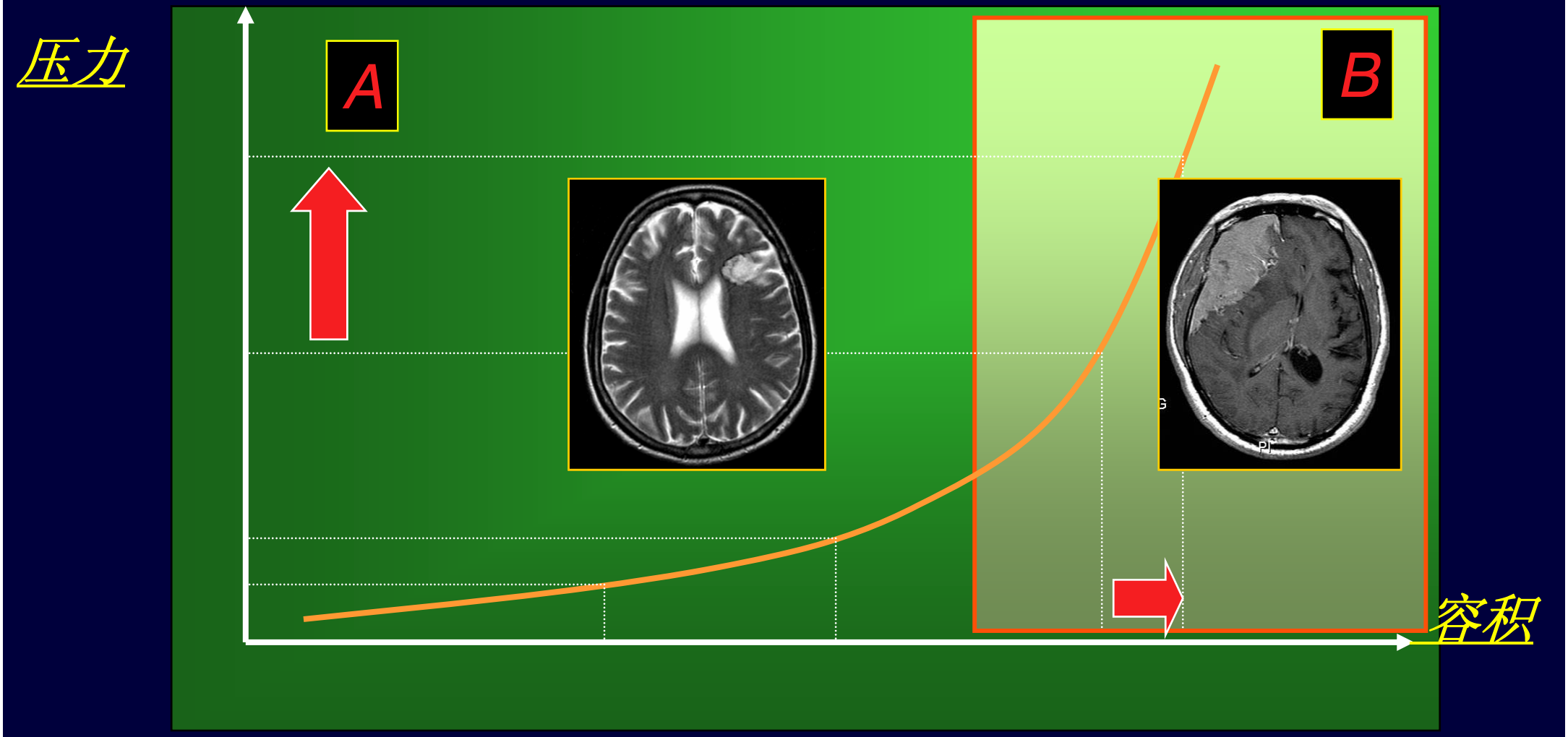

Monroe Kellie Doctrine 2
Normal
Brain 80%
Blood 10%
CSF 10%
ICP 10mmHg
Compensated
Brain 80%
Mass
Blood 5%
CSF 5%
ICP 15mmHg
Uncompensated
Brain 80%
Mass
Blood 4%
CSF 4%
ICP 30mmHg

形成机制

脑灌注压（CPP）：



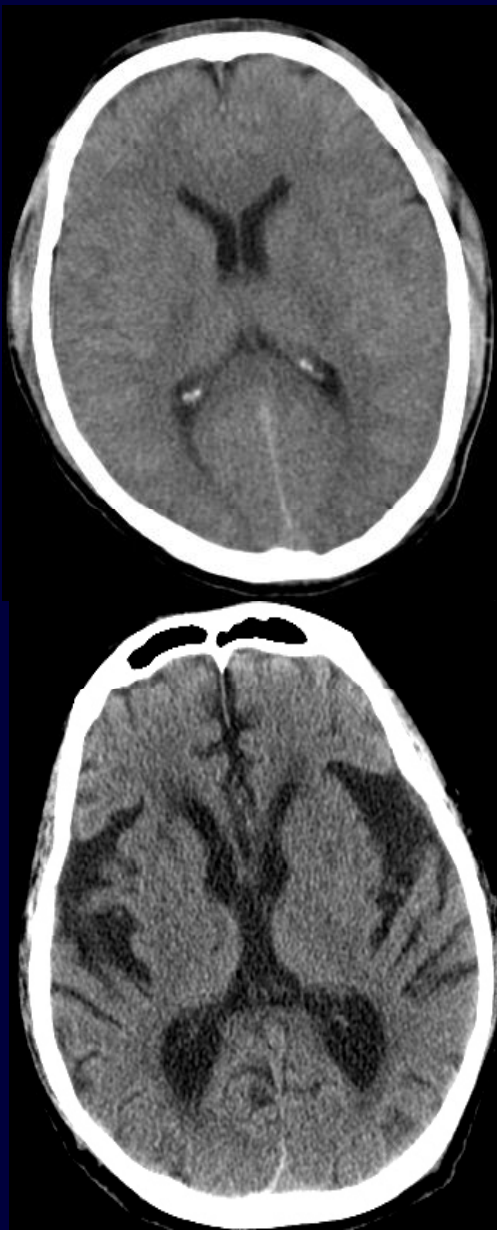
颅 内 高 压
I.C.H



颅 内 高 压
I.C.H

颅内压力的增加与下列因素相关：

- 年龄
- 脑组织体积增加的大小
- 脑组织体积增大的速度
- 机体代偿



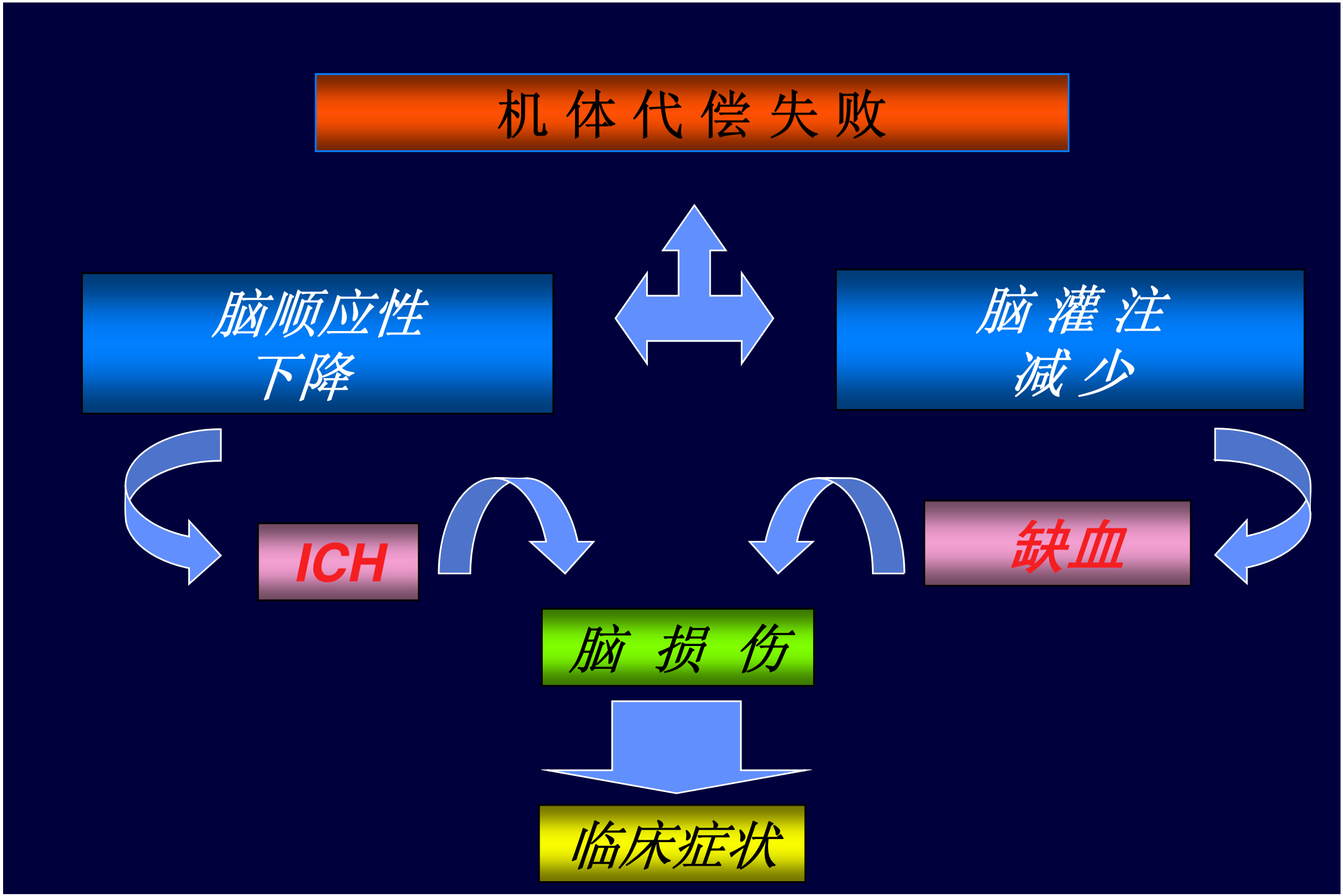
机体代偿

血流动力学调整

- 血压增高
- 血管收缩

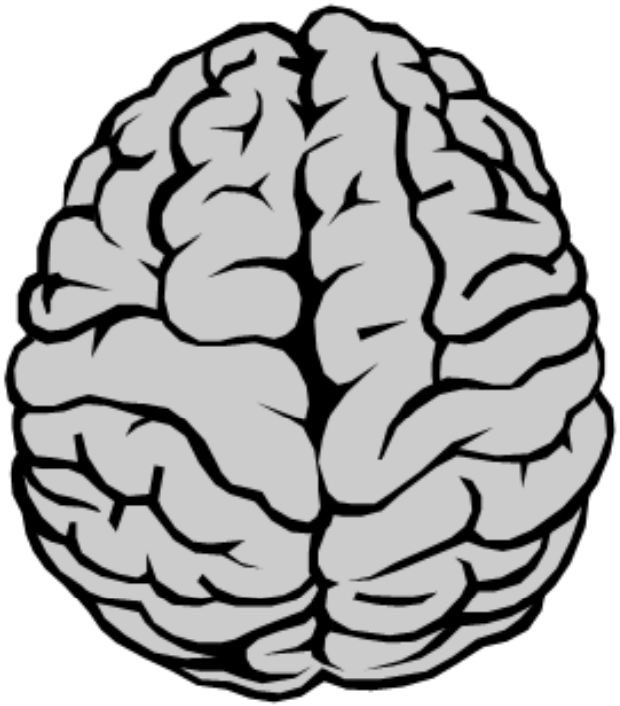
脑室系统调整

- 脑脊液重分布
- 脑脊液生成 ↘


机体代偿失败
脑顺应性下降
脑灌注减少
ICH
缺血
脑损伤
临床症状

Secondary Injury

- O_2 ↓
- C.B.F ↓
- I.C.P. ↑



Brief Episodes of Intracranial Hypertension and Cerebral Hypoperfusion Are Associated With Poor Functional Outcome After Severe Traumatic Brain Injury

Deborah M. Stein, MD, MPH, Peter F. Hu, MS, Megan Brenner, MD, MS, Kevin N. Sheth, MD, Keng-Hao Liu, MS, Wei Xiong, MS, Bizhan Aarabi, MD, and Thomas M. Scalea, MD

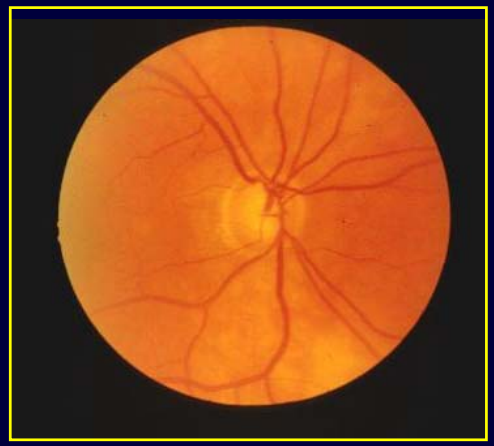
Conclusions: This study demonstrates that the number of brief 5-minute episodes of ICH and CH is predictive of poor outcome after severe TBI. This finding has important implications for management paradigms which are currently targeted to treatment rather than prevention of ICH and CH. This study demonstrates that these brief episodes may play a significant role in outcome after severe TBI.

(*J Trauma.* 2011;71: 364–374)

二、颅高压危象临床表现与预测

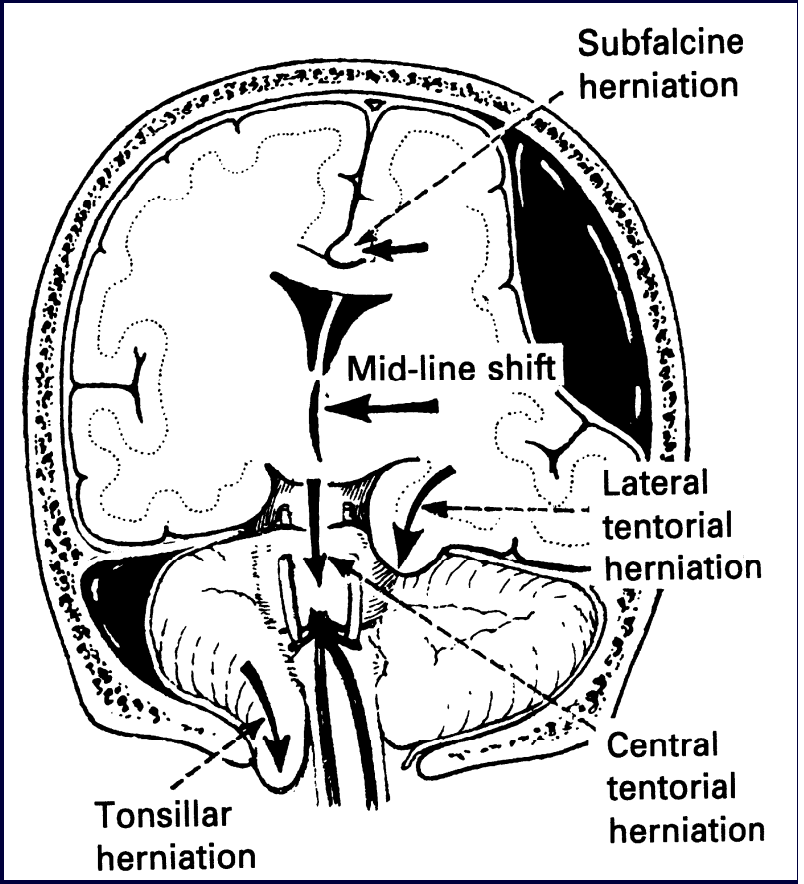
颅高压危象临床表现

- 头痛
- 恶心,呕吐
- 视力障碍
- 运动异常
- 瞳孔扩大
- cushing氏反应
  - 心率减慢
  - 呼吸减慢
  - 血压增高
- 视乳头水肿
  - 特异性强
  - 出现时间早
  - 没有视乳头水肿不能排除颅内高压



后颅窝的特殊性：
枕骨大孔疝
小脑幕切迹疝

- 容积小 - 顺应性低
- 压迫中脑导水管形成脑积水
- 压迫脑干
- 临床表现早
- 机体代偿能力小
- 常危及生命



需 要 紧 急 处 理

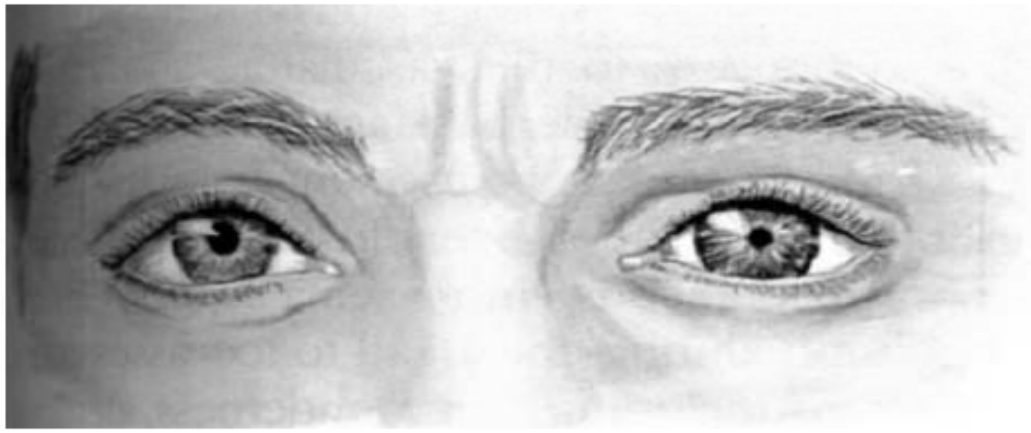
颅高压危象的预测

① 早期临床表现

② 监测：瞳孔仪、TCD、颅内压

Neurological Deterioration

- GCS ⇓
- Pupil size ⇑
- Headache ⇑
- Unilateral weakness



颅高压危象的预测

- **昏迷或镇静治疗患者：**

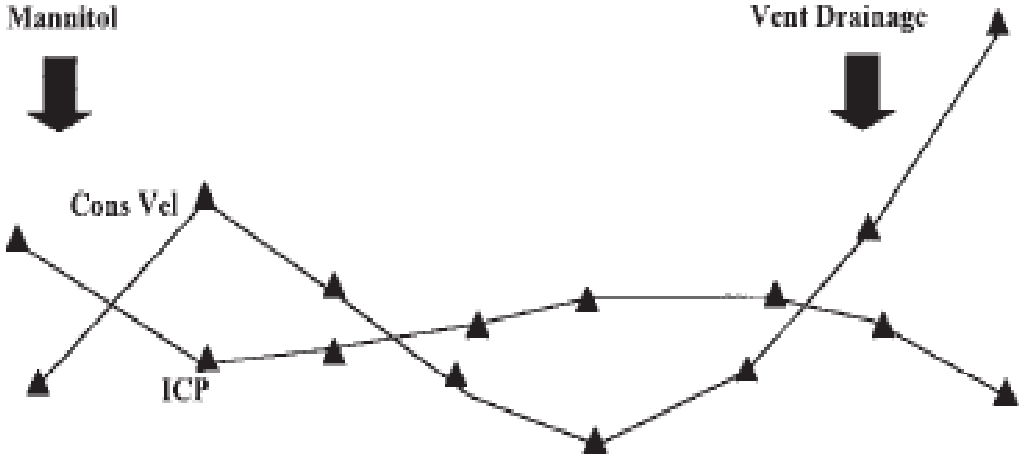
✓ 动态观察瞳孔的变化

✓ 镇静深度的评价

✓ 脑干、深浅反射等

Quantitative pupillometry, a new technology: normative data and preliminary observations in patients with acute head injury

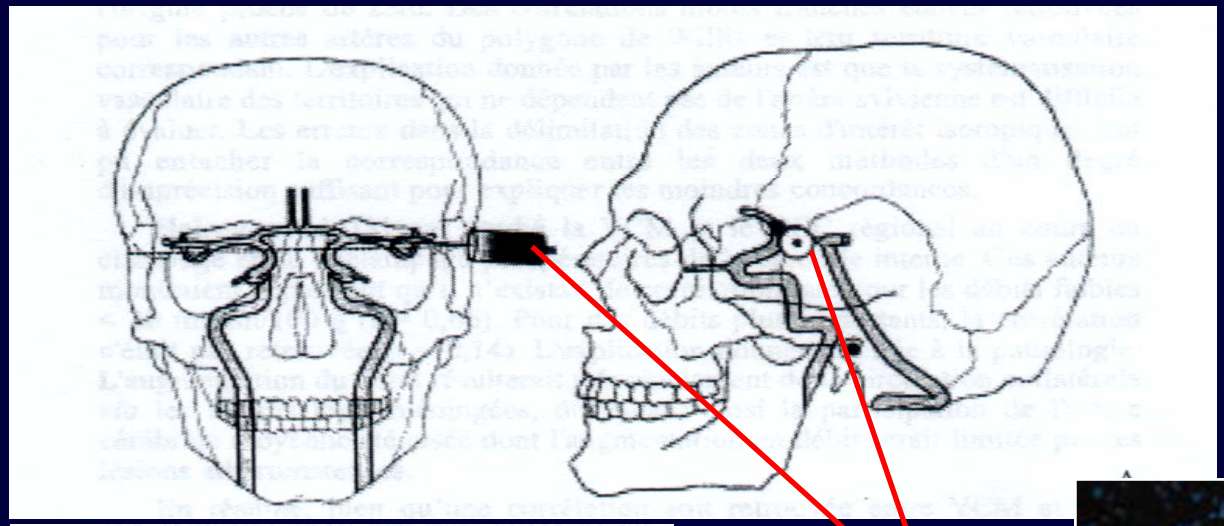
13:19	13:40	13:59	14:17	14:32	14:41	14:46	14:50
MaxA 1.8mm	1.7mm	1.9mm	1.8mm	1.6mm	1.7mm	1.8mm	1.5mm
MinA 1.7mm Reduction 5%	1.5mm 11%	1.8mm 4%	1.7mm 4%	1.5mm 4%	1.4mm 13%	1.5mm 12%	1.3mm 14%
Latency 0.2sec	0.12sec	0.20sec	0.24sec	0.36sec	0.32sec	0.24sec	0.20sec
C.vel -0.19 mm/sec	-0.51 mm/sec	-0.32 mm/sec	-0.11 mm/sec	-0.005 mm/sec	-0.14 mm/sec	-0.43 mm/sec	-0.73 mm/sec
ICP 32mmHg	17mmHg	17mmHg	19mmHg	22mmHg	22mmHg	Open	15mmHg
R eye	R eye	R eye	R eye	R eye	R eye	R eye	R eye

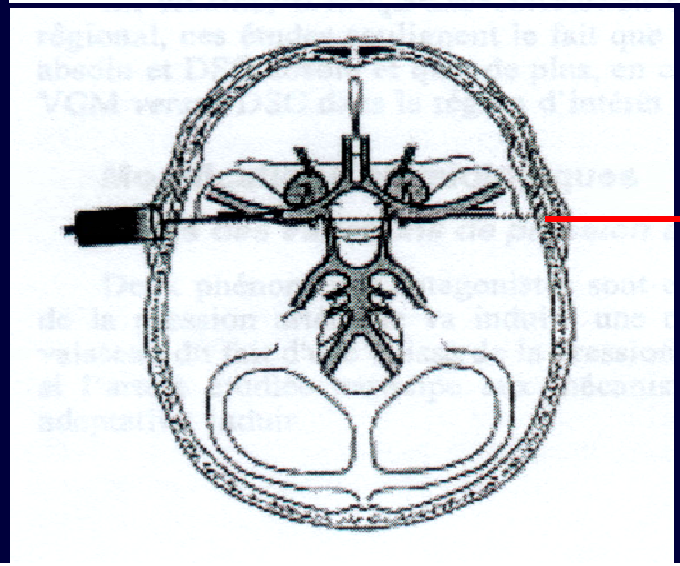


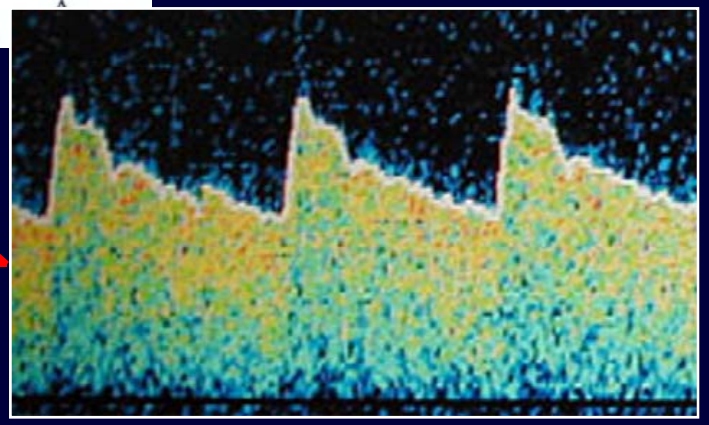
J Neurosurg 98:205–213, 2003

便携式经颅超声多谱勒（TCD）

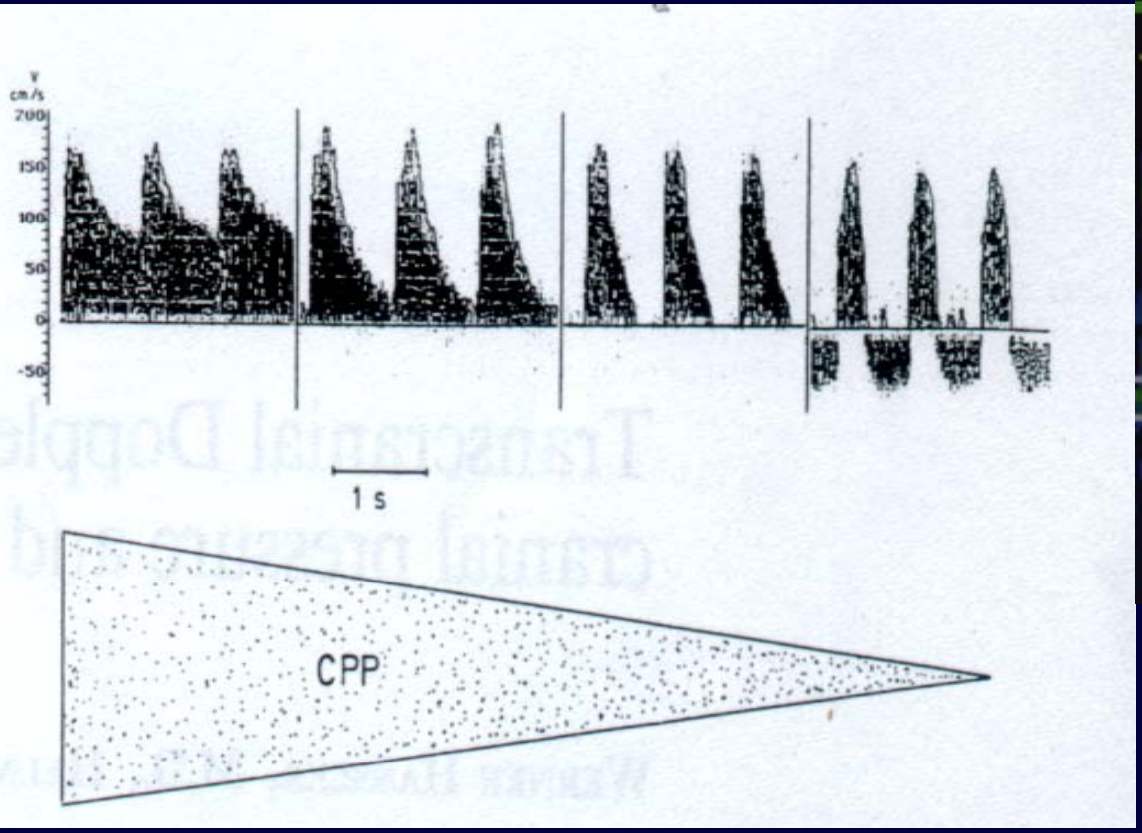
便携式经颅超声多谱勒（TCD）

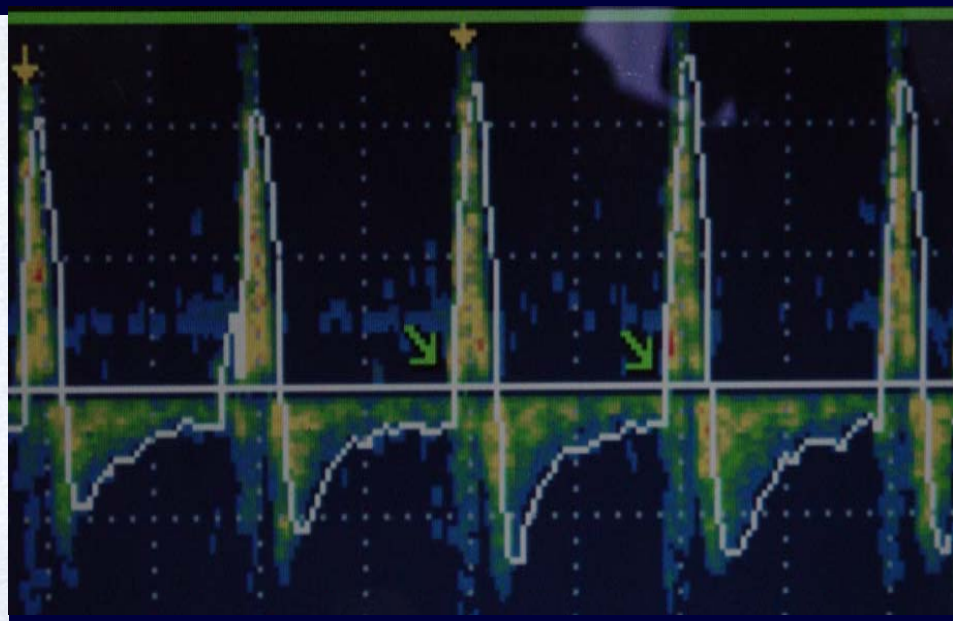






便携式经颅超声多谱勒（TCD）





便携式经颅超声多谱勒（TCD）

- CPP ＝ VDmx / Vmxy × mABP ＋ 14
- ICP ＝ mABP － CPP
- ICP ＝ mABP - (VDmx / Vmxy × mABP ＋ 14)

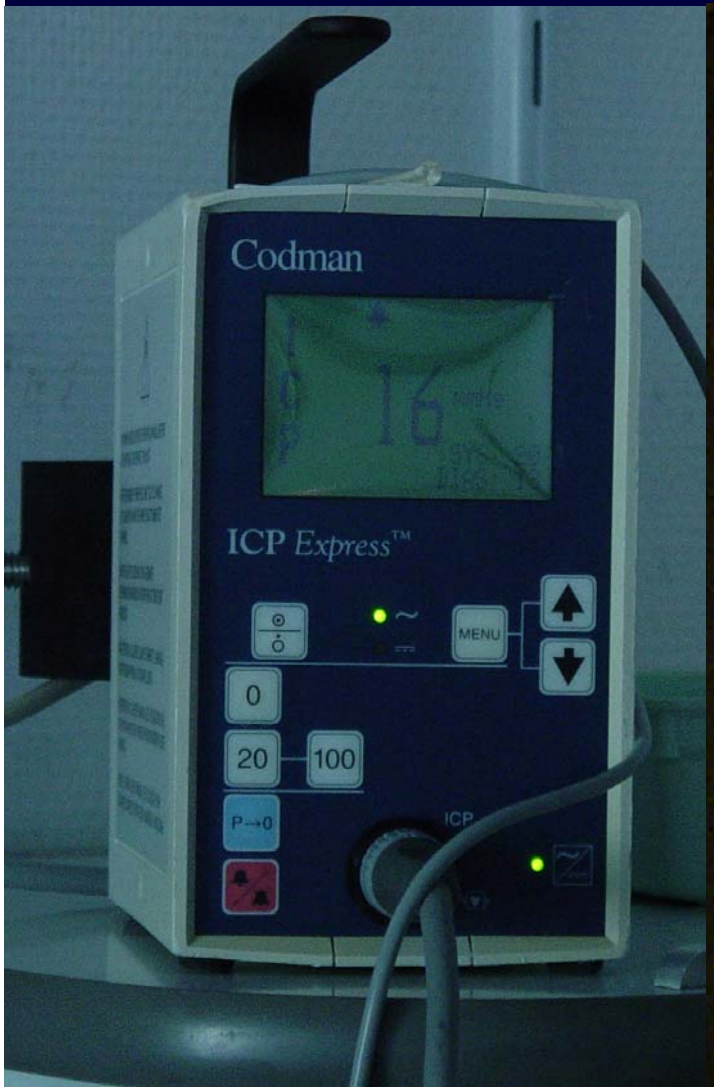
VDmx:舒张期血流速度， cm/s

Vmxy:平均血流速度， cm/s

Czosnyka M,et al. J Neurosurg, 1998,88:802-808

李跃伟，等. 中国血液流变学 2006；16

颅内压的监测


Codman
ICP Express™
MENU
0
20
100
P→0
ICP


LIT 12 Adulte 20 DEC 06 10:05
II
Pas d'enregistrement sur alarme.
FC
74
Mode non-stimulé
POULS 74
ST1
00
1mV
II
1mV
PA
126
60
PA
127/69 (90)
PIC
28
PIC
(12)
PLETH
SpO2
100
PERF.
02
105 SpO2

颅内压的监测

- **目的：**
  - ① 早期诊断颅内高压
  - ② 调整（或停用）抗颅内高压药物
  - ③ 及时判断手术时机
  - ④ 判断预后：
    - ICP≥ 25mmHg时，重残率增高
    - 颅内压≥40mmHg时，病死率增加
    - 颅内压≥60mmHg时，药物难以控制时，死亡常难以避免

颅内压的监测：适应证

Box 2: Indications for ICP Monitoring

GCS Score: 3–8 (after resuscitation)

1. Abnormal Admission Head CT Scan
    a. Hematoma
    b. Contusion
    c. Edema
    d. Herniation
    e. Compressed basal cisterns
2. Normal Admission Head CT Scan PLUS 2 or more of the following
    a. Age > 40 years
    b. Motor posturing
    c. Systolic blood pressure < 90 mm Hg

颅内压的监测

- **治疗目标：**

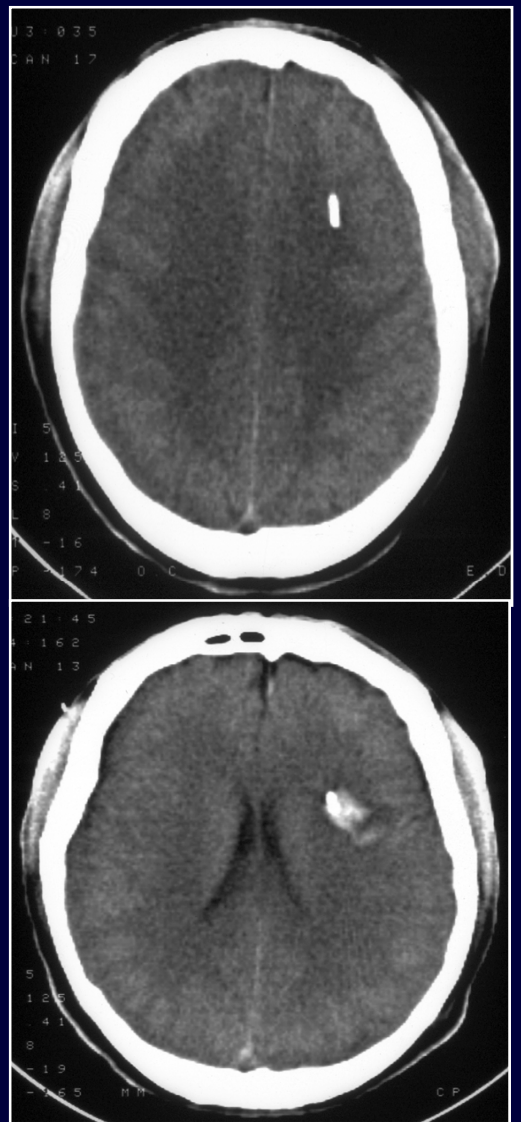
  ICP ＜ 20-25 mmHg

  CPP ＞ 70-80 mmHg

- **并发症：**

  出血：脑实质内＝脑室 1～2%

  感染：脑室 ＞＞ 脑实质内



颅内压的监测

颅内压监测＋脑室外引流

三、颅高压危象的处理

方 法

First-tier therapies

① 一般治疗
② 病因治疗
③ 过度通气治疗
④ 脑脊液引流
⑤ 渗透治疗
⑥ 诱导性高血压

Second-tier therapies

① 亚低温治疗
② 巴比妥昏迷疗法
③ 去骨板减压术

颅内高压的治疗

目标 ：

- 降低颅内压
- 维持脑灌注
- 防止继发脑损害

CIP < 20 mm Hg
CPP = 60 -70 mm Hg

1. 一般治疗

（1）头部抬高

✓30° 和颈部中位

（2）呼吸支持

✓SpO_2 > 92 %

✓$PaCO_2$ = 35 - 40 mm Hg

（3）循环支持

✓调整MAP： 脑灌注压= 60 - 70 mm Hg

✓纠正贫血：Hb >= 10g / 100 ml

1.一般治疗

（4）维持内环境稳定

- ✓Na^+ 140 - 150 mmol / L
- ✓血浆渗透压 290 - 320 mosm / kg
- ✓酸碱平衡 .....

（5）纠正凝血功能异常

（6）防止和治疗癫痫发作

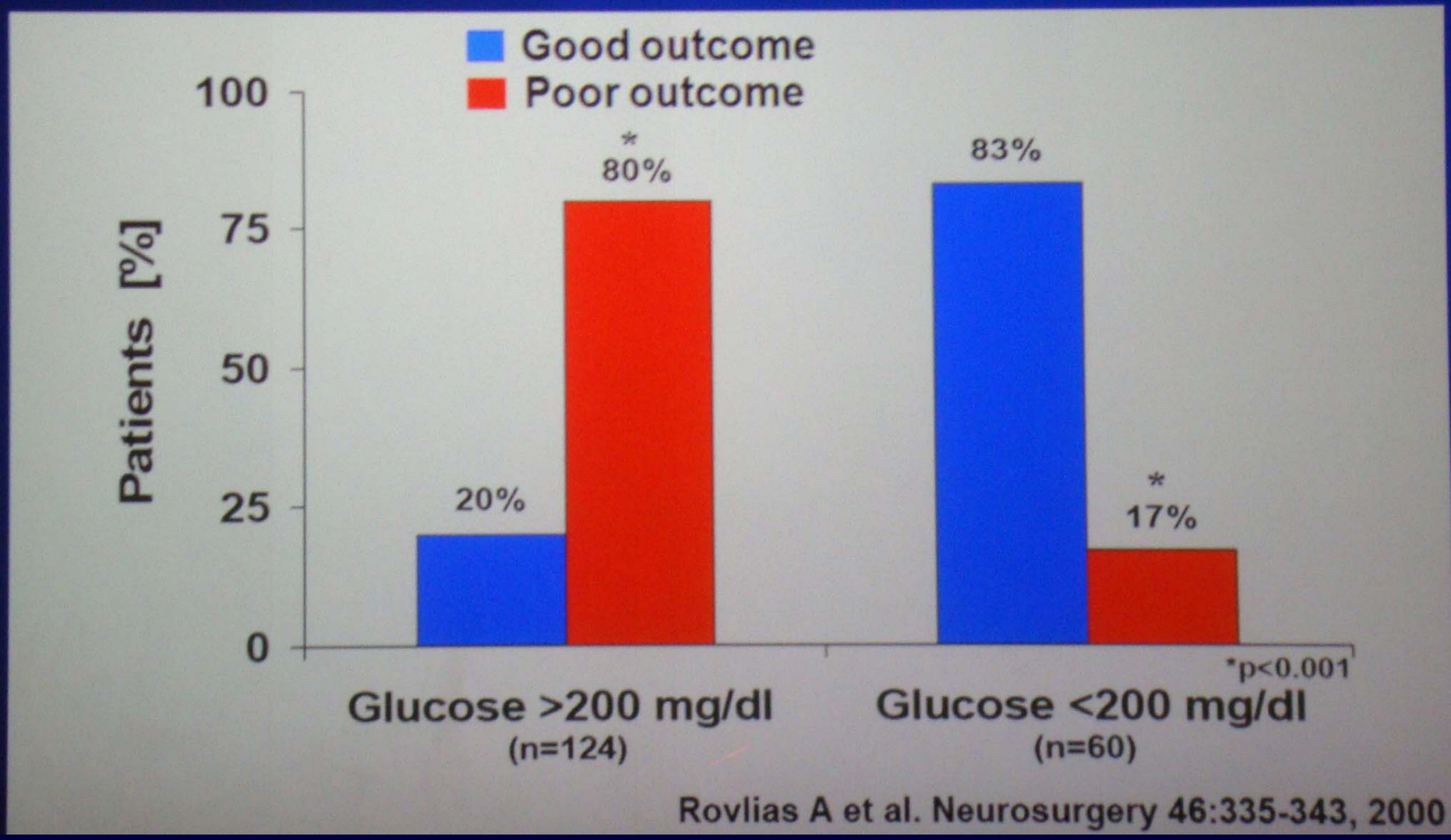
1.一般治疗

（7）控制体温（核心温度≤37.5℃）

（8）避免高血糖症（Glu<10mmol/L）

Glycaemic control

30th ISICEM



Rovlias A et al. Neurosurgery 46:335-343, 2000

1.一般治疗

（9）镇静

- 降低脑代谢
- 增加人机协调

以下情况推荐使用肌松剂：

- 人机对抗持续，并排除其他可排除的病理性因素
- 严重肺损伤 (ARDS)
- 亚低温治疗 (避免寒战): 维库溴铵

2. 病因治疗

缺血性卒中的溶栓治疗

颅内血肿的清除

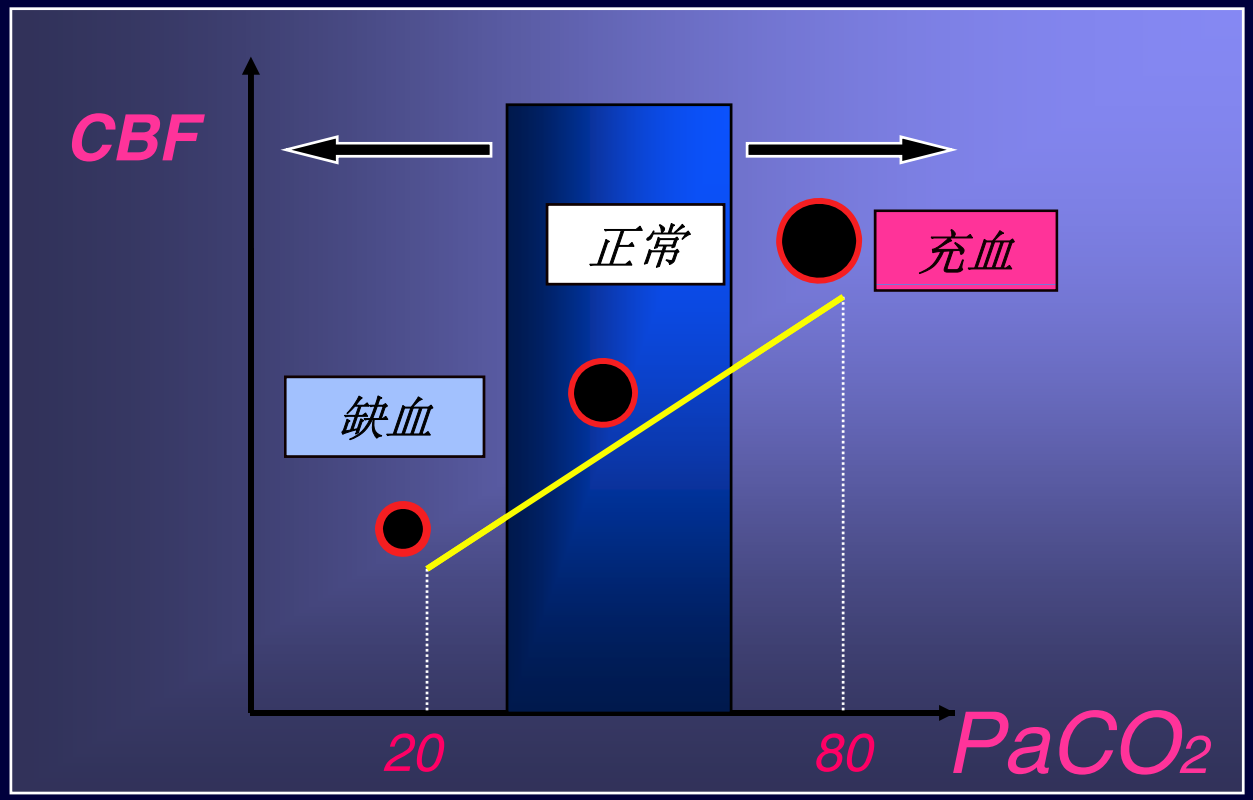
解除凹陷性骨折

●●●●●●

3. 过度通气治疗

仅是暂时增加颅内顺应性的一项权宜之计

正常情况下$PaCO_2$在20~80mmHg之间时，
CBF与$PaCO_2$ 呈线性相关

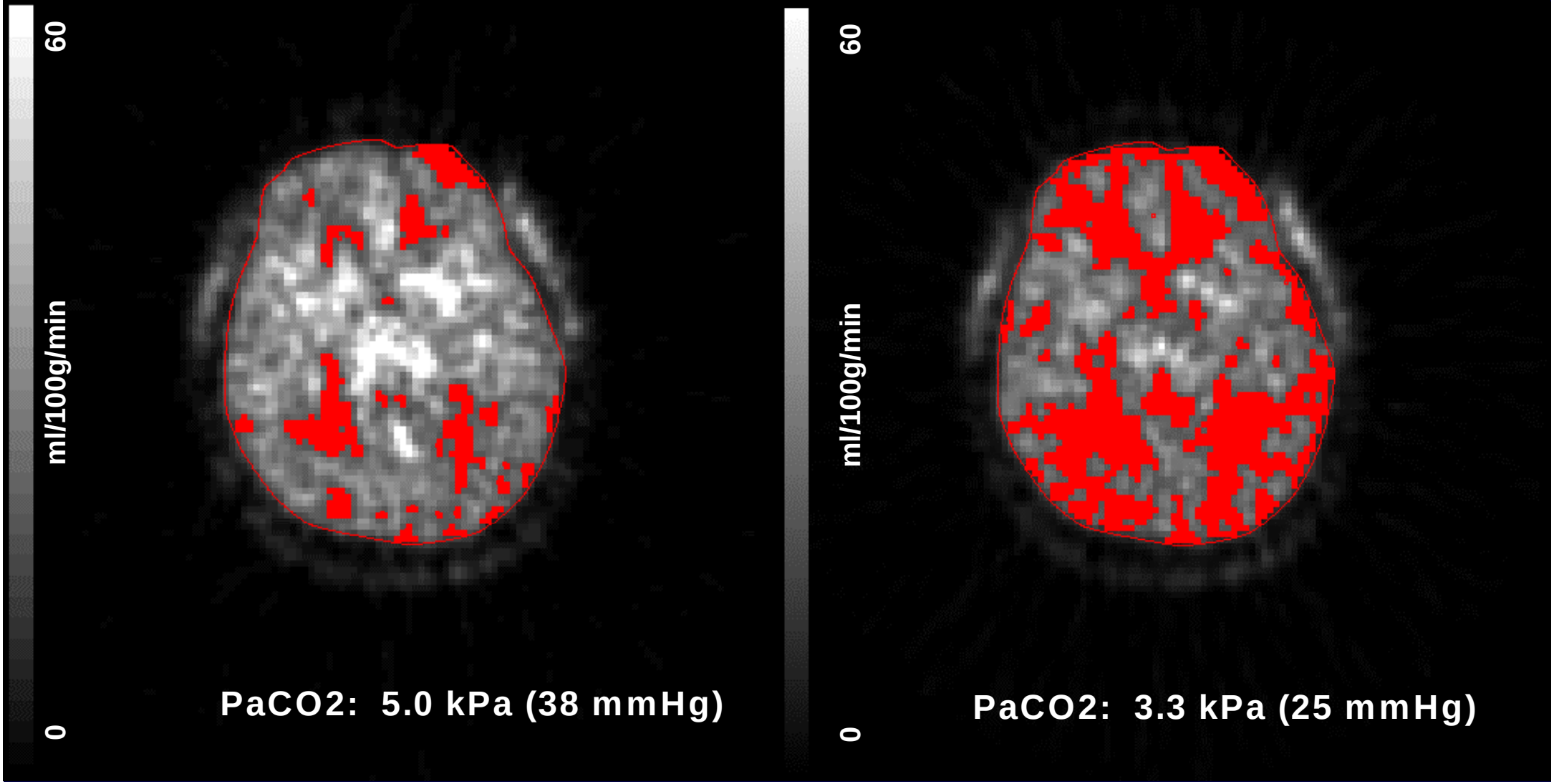


Wolfson Brain Imaging Centre
University of Cambridge

Acute head injury (6 hrs post impact)

Areas in red show regions with rCBF ≤ 20 ml/100g/min)

(Coles et al. Crit Care Med. 2002)



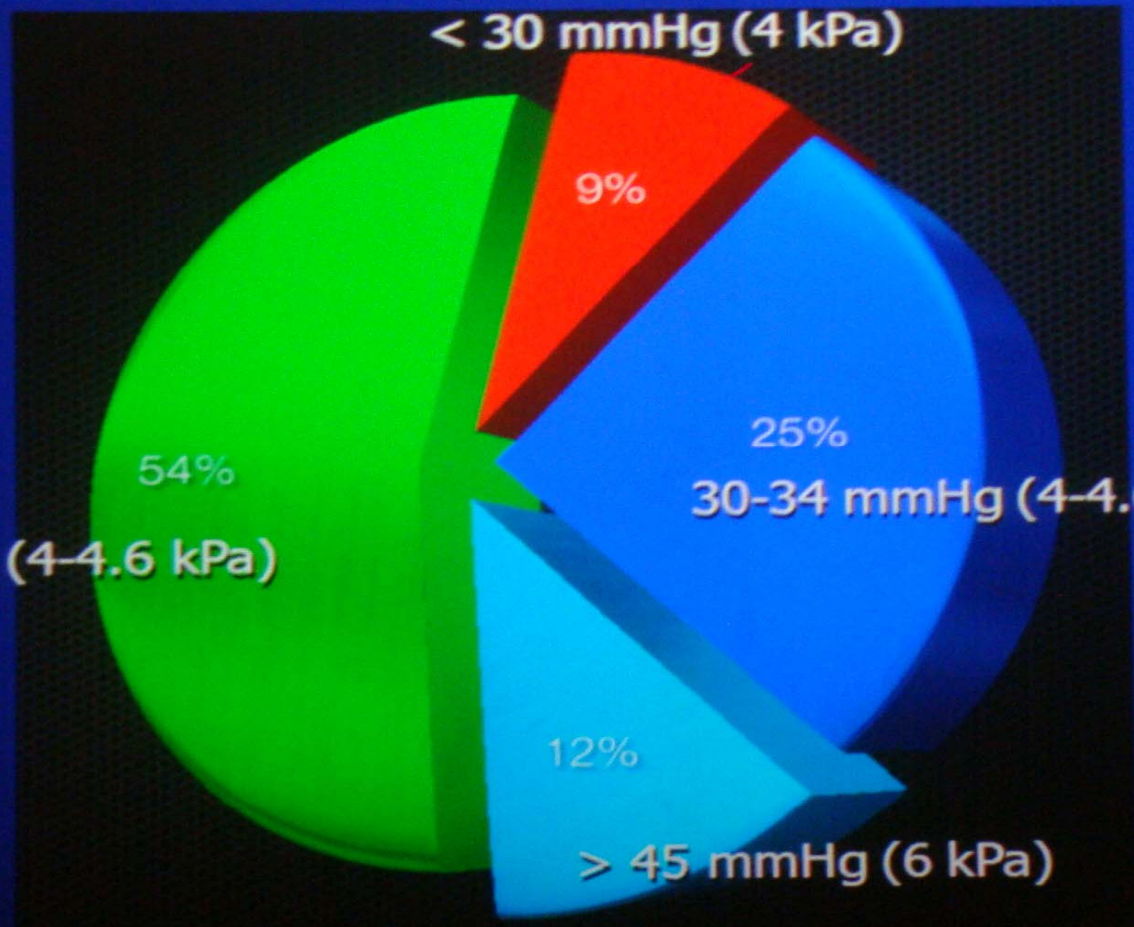
良好控制 $PaCO_2$ —— 是一个挑战！

Incidence of iatrogenic dyscarbia during mild therapeutic hypothermia after successful resuscitation from out-of-hospital cardiac arrest☆

Patrik Falkenbach[a], Antti Kämäräinen[a], Antti Mäkelä[a], Jouni Kurola[b], Tero Varpula[c], Tero Ala-Kokko[d], Juha Perttilä[e], Jyrki Tenhunen[a,*]

Acta Anaesthesiol Scand 2009; 53: 926–934

30th ISICEM



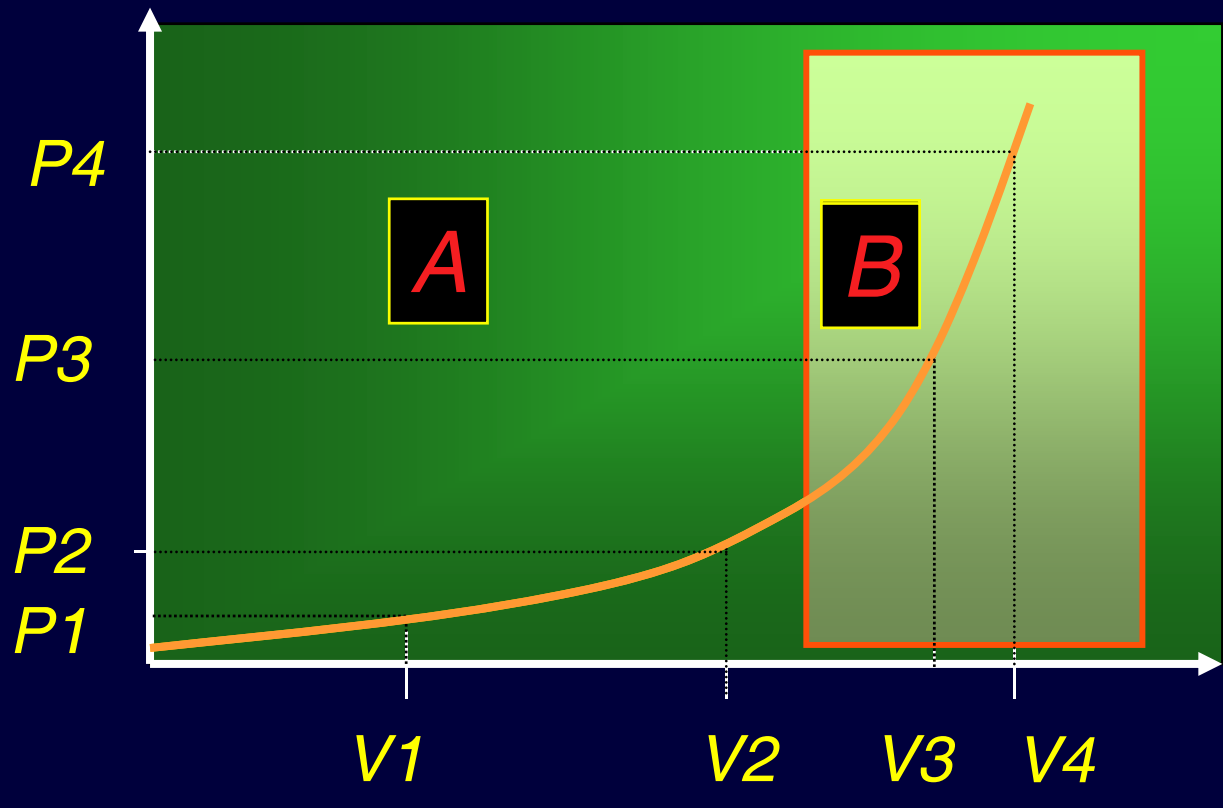
PaCO2 of 122 pts
(1627 measurements)

Acta Anaesthesiol Scand 2009; 53: 926–93

4. 脑脊液引流

- 直接引流，减轻肿胀脑组织的压力
  - 监测颅内压力
  - 如果**ICP > 20 mmHg**,打开导管引流

当脑顺应性极低时
很小的容积减小
将引起颅内压力明显降低
*(见曲线**B**部分)*



5. 渗透治疗

① 20 %的甘露醇

② 7.5 % ～20%的高张生理盐水

20 %甘露醇

- 剂量 = 0.25 至1g/kg in 30 min
- 即刻作用
  - ✓ 正常脑组织血管收缩 (zone saine)
  - ✓ ↗缺血区域脑血流
  - ✓ ↗ 血容量, ↗ 脑灌注压

20 %甘露醇

- 脱水作用 **15’ – 30’**
  - ✓ 持续时间：**5 ~6h，40 min**作用高峰
  - ✓ 减少脑组织含水量

- 副反应
  - ✓ 心功能不全
  - ✓ 加重血容量不足
  - ✓ 电解质紊乱
  - ✓ 加重损伤脑组织的水肿**?!**

20 %的高张生理盐水

- 剂量 = 40 ml (在30分钟内输液泵泵入)
- 作用
  - ✓ 使细胞内和间质内水分进入血管腔内
  - ✓ ↗ 脑血流
  - ✓ ↘ 脑血流阻力
- 副反应
  - ✓ 可致心源性肺水肿
  - ✓ 血钠水平波动等内环境紊乱
- 禁忌证 Na^+ > 150 mmol/L, 渗透压 > 320 mosm/L

（100ml 7.5%NaCl）治疗效果的评价

渗透治疗副作用

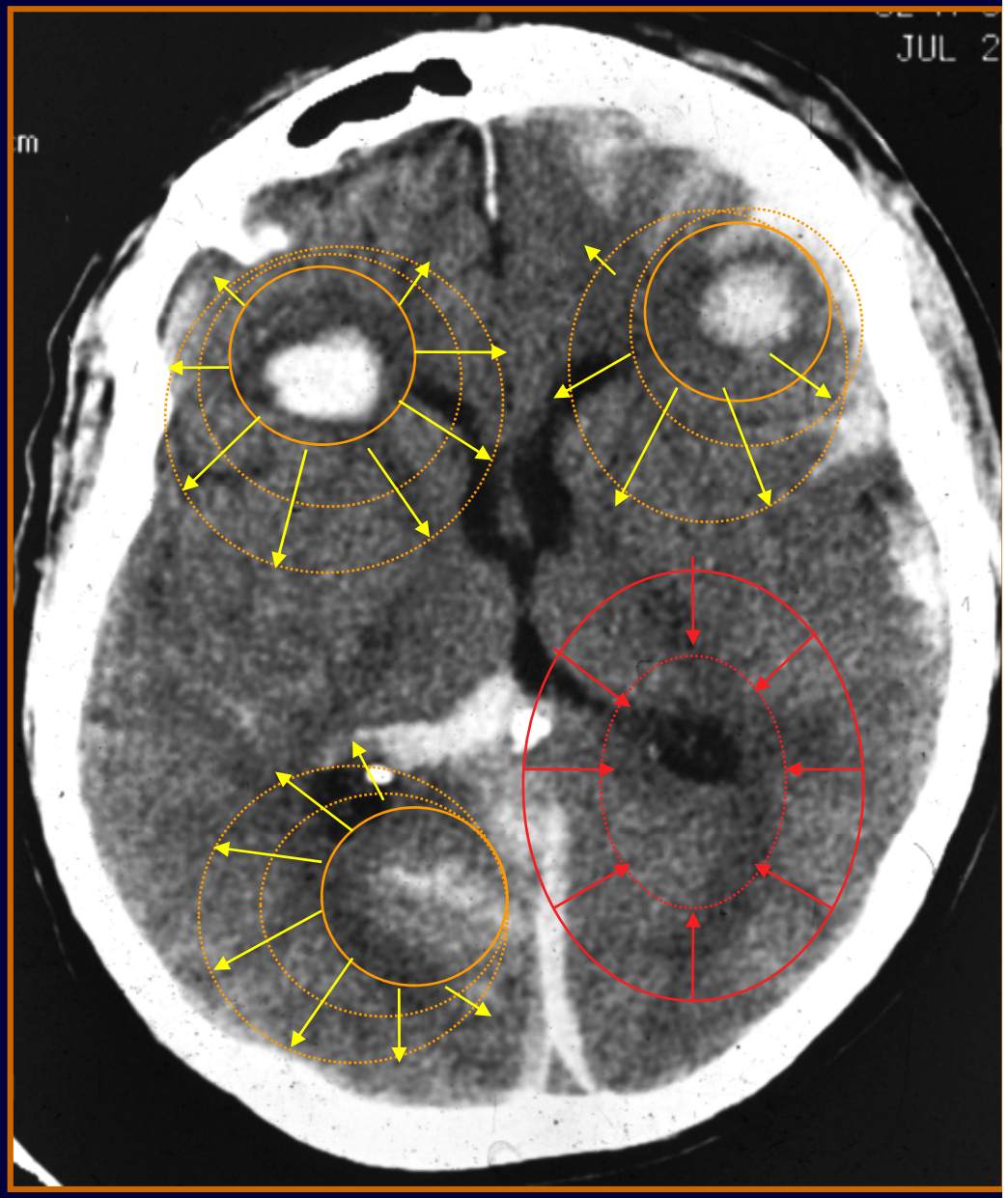
正常组织 = 血脑屏障无损伤

减少脑组织含水量

受损组织 = 血脑屏障异常

加重脑水肿

治疗效果与BBB
破坏范围相关



6.诱导性高血压

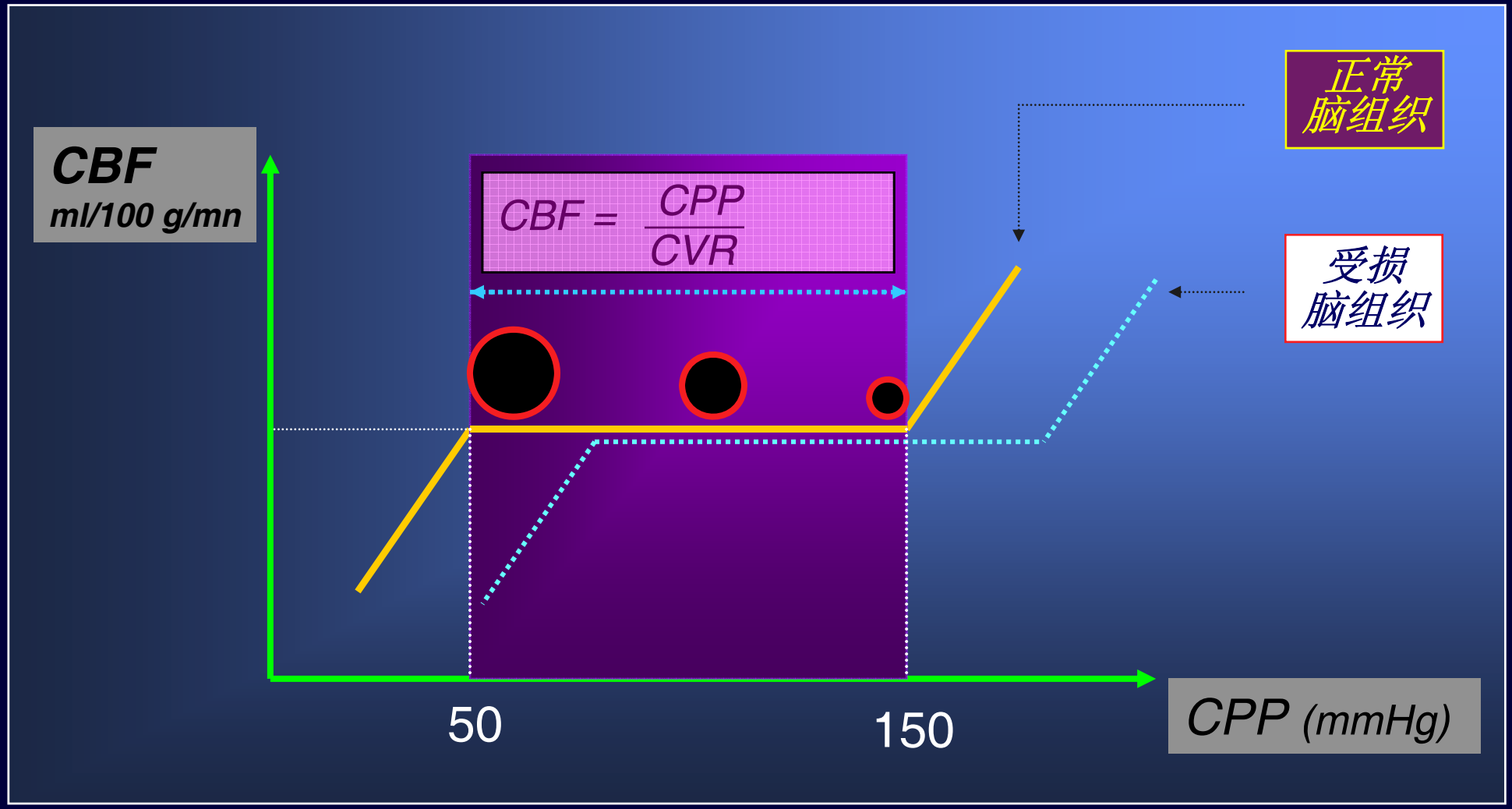
ROSNER学说

- 增加体循环血压（**MAP**）而增加脑灌注压（**CPP**）
- 必要条件：脑血流自动调节功能存在!
- 如果血脑屏障受损范围广，则会增加颅内压

CPP> 70 mm Hg

诱导性高血压

CBF = CPP / CVR



二线疗法：巴比妥昏迷疗法

作用机制

↘ $CMRO_2$ ⇒ ↘ CBF ⇒ ↘ ICP
↘减少钙离子的内流
↘脂质过氧化
↗颅内血管张力（收缩）

适应证

上述一线治疗效果不佳者

并发症

- ↘ 血压
- 免疫抑制
- 无法监测病情变化
- 治疗负荷高

二线疗法：人工亚低温治疗

目标 = 核心温度为 34 至36°C之间

方法 =

- 无创方法
- 有创方法

常需联合使用肌松剂防止寒颤发生

人工亚低温治疗

Figure 1. Cooling Device Used in the Hypothermia after Cardiac Arrest Study, Which Operates by Circulating Cool Air over the Patient.

人工亚低温治疗

人工亚低温治疗

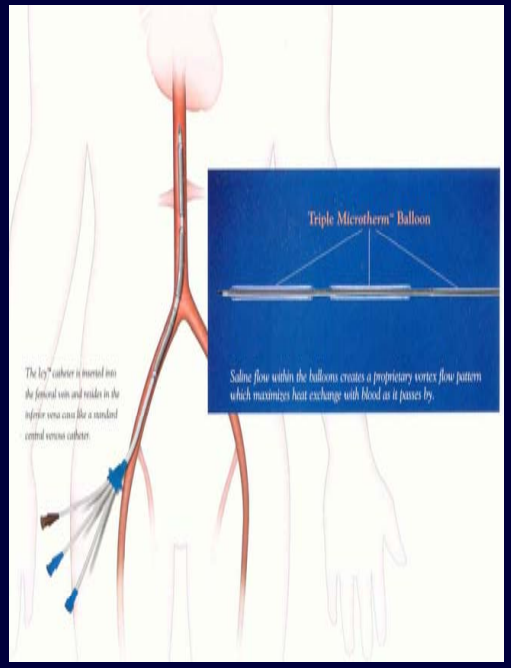


Figure 1. The Reprieve Endovascular Temperature Management System.

Neurology 2004;63:312-317

人工亚低温治疗

- ⇩脑代谢率
- ⇩自由基的产生
- ⇩兴奋性氨基酸的释放
- ⇩促炎症因子的生成
- ……

人工亚低温治疗

- 2001年，在美国完成的一项多中心(11个大学中心医院)的MHT治疗GCS在3～8的TBI患者的研究（NABIS: Hypothermia），却得出了总体上MHT治疗严重TBI无效的结果。

Lack of effect of induction of hypothermia after acute brain injury.（see next）

Clifton GL, et al. N Engl J Med; 2001; 344: 556-563.

TABLE 4. RATES OF POOR OUTCOME AND DEATH SIX MONTHS AFTER SEVERE BRAIN INJURY IN PATIENTS TREATED WITH INDUCTION OF HYPOTHERMIA OR NORMOTHERMIA.

TREATMENT GROUP	TOTAL NO.	NO. (%) WITH POOR OUTCOME*	RELATIVE RISK (95% CI)†	P VALUE	NO. (%) WHO DIED	RELATIVE RISK (95% CI)†	P VALUE
All patients‡	368		1.0 (0.8–1.2)	0.99		1.0 (0.7–1.4)	0.79
Hypothermia	190	108 (57)			53 (28)		
Normothermia	178	102 (57)			48 (27)		
Patients with Glasgow coma scores of 3–4 on admission	87		1.1 (0.8–1.4)	0.64		1.4 (0.4–2.4)	0.35
Hypothermia	50	39 (78)			22 (44)		
Normothermia	37	27 (73)			13 (35)		
Patients with Glasgow coma scores of 5–8 on admission	281		0.9 (0.7–1.2)	0.55		1.0 (0.6–1.5)	0.71
Hypothermia	140	69 (49)			30 (21)		
Normothermia	141	75 (53)			32 (23)		
Patients >45 years old	52		1.3 (1.0–1.7)	0.08		1.0 (0.3–2.0)	1.00
Hypothermia	26	23 (88)			10 (38)		
Normothermia	26	18 (69)			10 (38)		

*Poor outcome was defined as severe disability, vegetative state, or death and was adjusted for age and Glasgow coma score on admission.

†Values indicate the relative risk in the hypothermia group as compared with the normothermia group. CI denotes confidence interval.

‡Data are presented for 368 patients because outcome data were missing for 7 patients and Glasgow coma score on admission, age, or both were missing for 17 patients.

N Engl J Med 2001; 344: 556-563.

人工亚低温治疗

MTH治疗TBI真的无效 

① 亚低温的程度？

② 亚低温的持续时间？

③ 亚低温后的复温速度？

④ TBI的基本治疗？

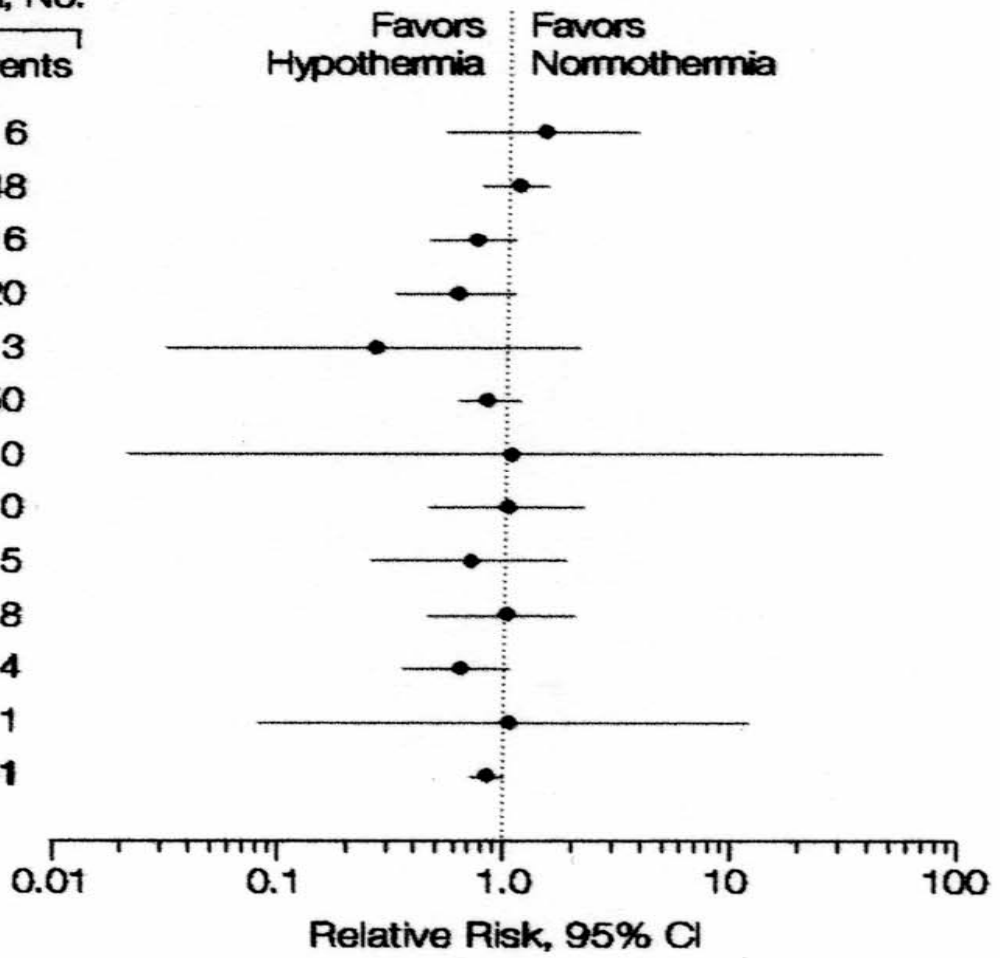
⑤ TBI患者与MTH的联合治疗（颅内压的控制、脑灌注压的维持、过度通气的应用等）？

12RCTs的系统回顾（截至2002年9月）

McIntyre,et al. JAMA.2003;289:2992-2999

Figure 2. Mortality in Therapeutic Hypothermia

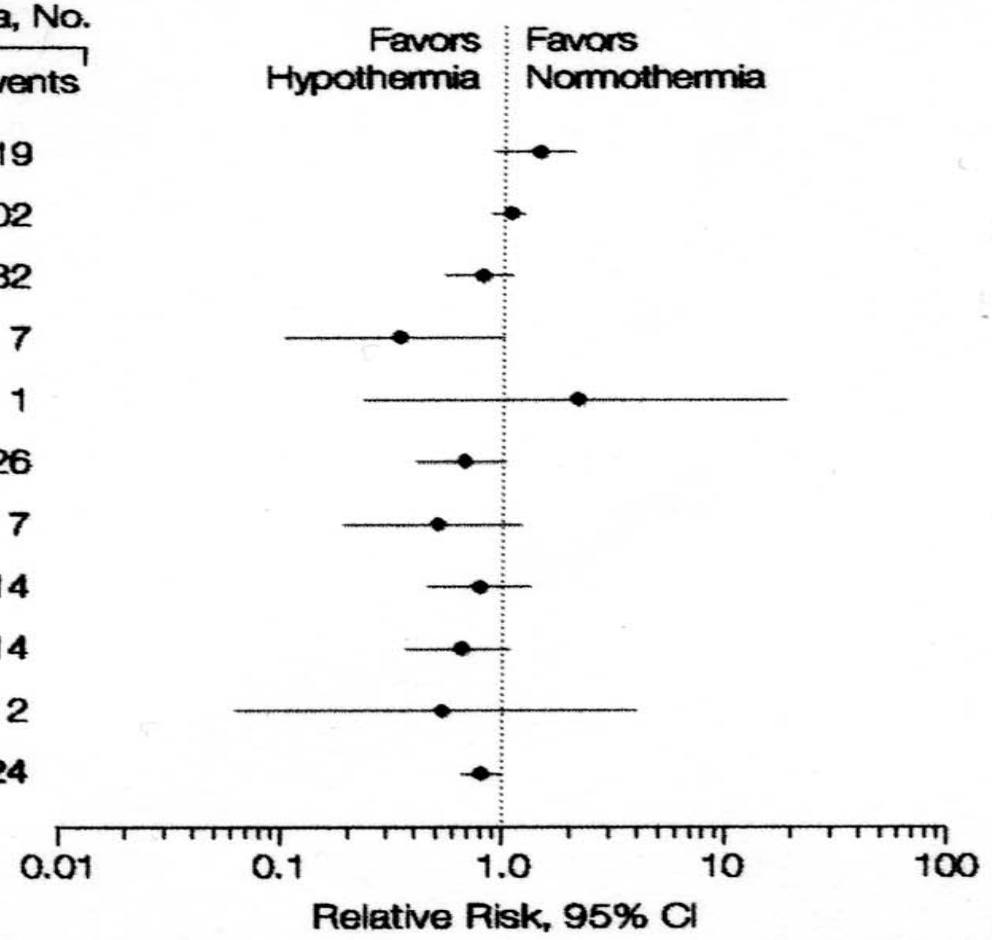
Study	Hypothermia, No. Patients	Hypothermia, No. Events	Normothermia, No. Patients	Normothermia, No. Events
Shiozaki et al,[47] 2001	45	8	46	6
Clifton et al,[34] 2001	190	53	178	48
Yan and Tang,[52] 2001	24	13	20	16
Jiang et al,[48] 2000	43	11	44	20
Aibiki et al,[50] 2000	15	1	11	3
Zhang and Wang,[53] 2000	123	41	123	50
Shiozaki et al,[49] 1999	8	0	8	0
Marion et al,[11] 1997	39	9	42	10
Hirayama et al,[51] 1994	12	4	10	5
Clifton et al,[32] 1993	23	8	22	8
Shiozaki et al,[33] 1993	16	8	17	14
Clifton et al,[12] 1992	5	1	5	1
Total	**543**	**157**	**526**	**181**



MTH对于神经功能不良预后的影响

Figure 4. Poor Neurologic Outcome for Therapeutic Hypothermia*

Study	Hypothermia, No. Patients	Hypothermia, No. Events	Normothermia, No. Patients	Normothermia, No. Events
Shiozaki et al,[47] 2001	45	24	46	19
Clifton et al,[34] 2001	190	108	178	102
Jiang et al,[48] 2000	43	23	44	32
Aibiki et al,[50] 2000	15	3	11	7
Shiozaki et al,[49] 1999	8	2	8	1
Marion et al,[11] 1997	39	15	42	26
Hirayama et al,[51] 1994	12	4	10	7
Clifton et al,[32] 1993	23	11	22	14
Shiozaki et al,[33] 1993	16	8	17	14
Clifton et al,[12] 1992	5	1	5	2
Total	**396**	**199**	**383**	**224**



*Poor neurologic outcome is defined as severe disability or vegetative state or death according the Glasgow Outcome Scale score.

总体研究结果和存在问题

总体结果：

① MTH使死亡风险下降19％；

② MTH使神经功能不良预后的风险下降22％；

③ MTH应使核心温度在32-33℃ ， 持续时间≥ 48小时 ， 复温时间≤ 24小时。

存在问题：

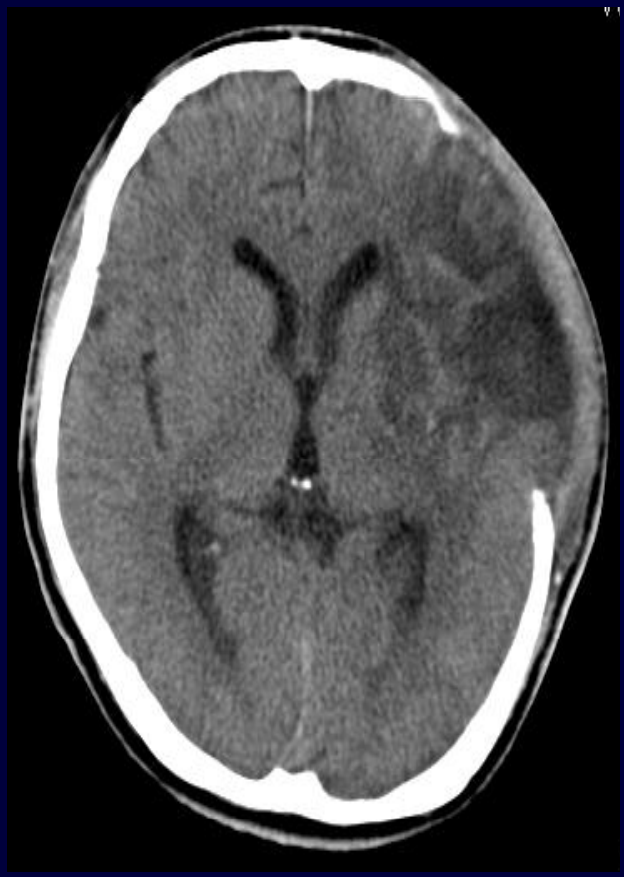
① TBI的基本治疗方案和护理质量；

② TBI患者与MTH的联合治疗（颅内压的控制、脑灌注压的维持、过度通气的应用等）。

二线治疗：去骨板减压术

适应证：

- ★ 年龄 < 40 岁
- ★ 弥漫性脑水肿，但未见占位病灶
- ★ 无脑疝或脑疝时间较短
- ★ 颅内压经前述方法未得到有效控制



The NEW ENGLAND JOURNAL of MEDICINE

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*

D. James et al , The New England Journal of Medicine,2011

去骨板减压术

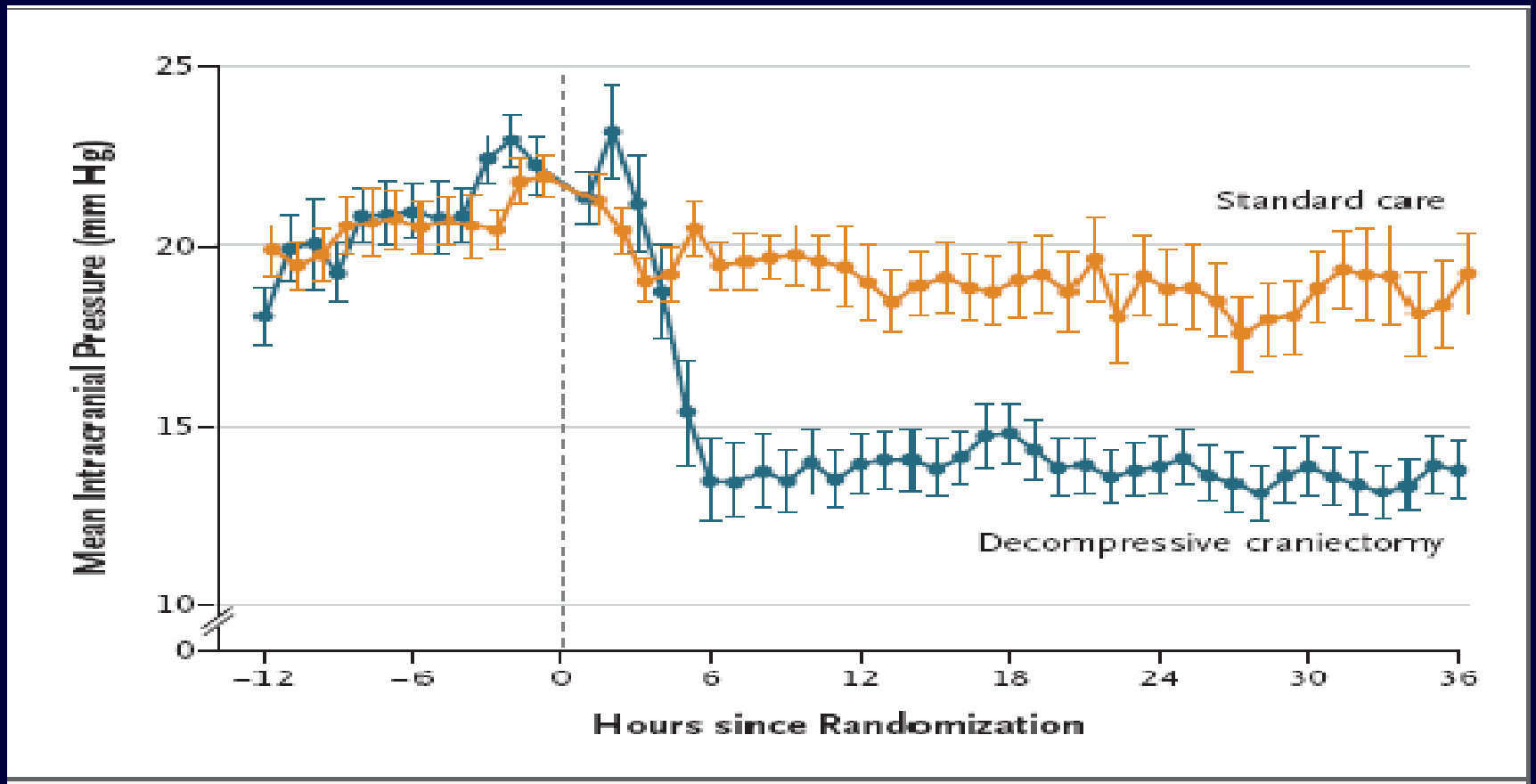


Figure 1. Intracranial Pressure before and after Randomization.
Shown are the mean measurements of intracranial pressure in the two study groups during the 12 hours before and the 36 hours after randomization. The I bars indicate standard errors.

D. James et al , The New England Journal of Medicine,2011

去骨板减压术

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

D. James et al , The New England Journal of Medicine,2011

去骨板减压术

Outcome	Decompressive Craniectomy (N=73)	Standard Care (N=82)	P Value†
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

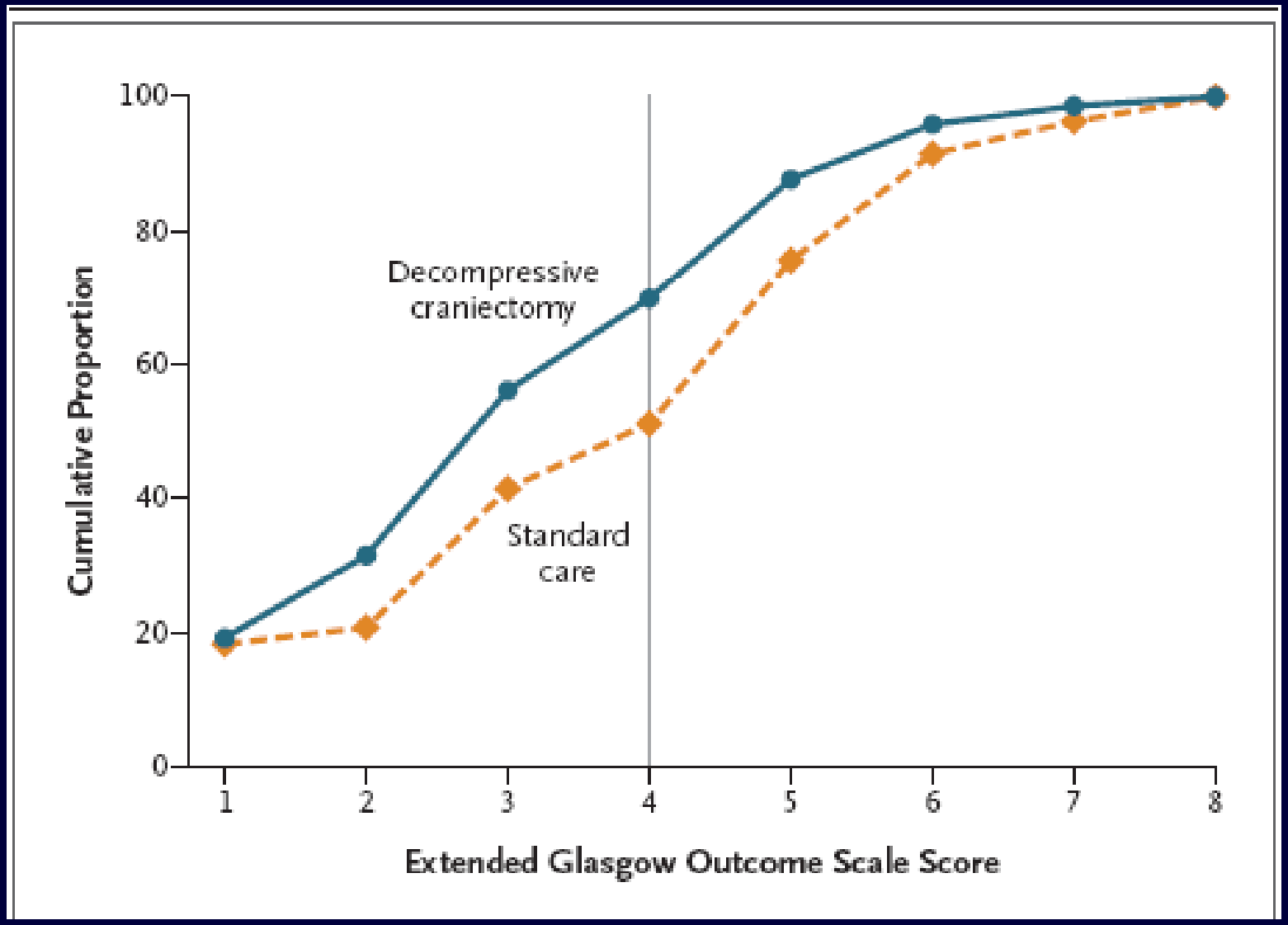
D. James et al , The New England Journal of Medicine,2011

去骨板减压术

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

D. James et al , The New England Journal of Medicine,2011

去骨板减压术



D. James et al , The New England Journal of Medicine,2011

小　结

颅内高压危象

颅内压监测
ICP>20mmHg

CT/MRI显示血肿等病灶
立即手术切除

ICP持续升高

脑积液引流

- 一般治疗
- 渗透治疗
- 过度通气
- 诱导高血压
- 亚低温
- 巴比妥昏迷

去骨瓣减压？？

综合考量治疗手段

Thanks for your attention !