Intracerebral Hemorrhage (ICH)

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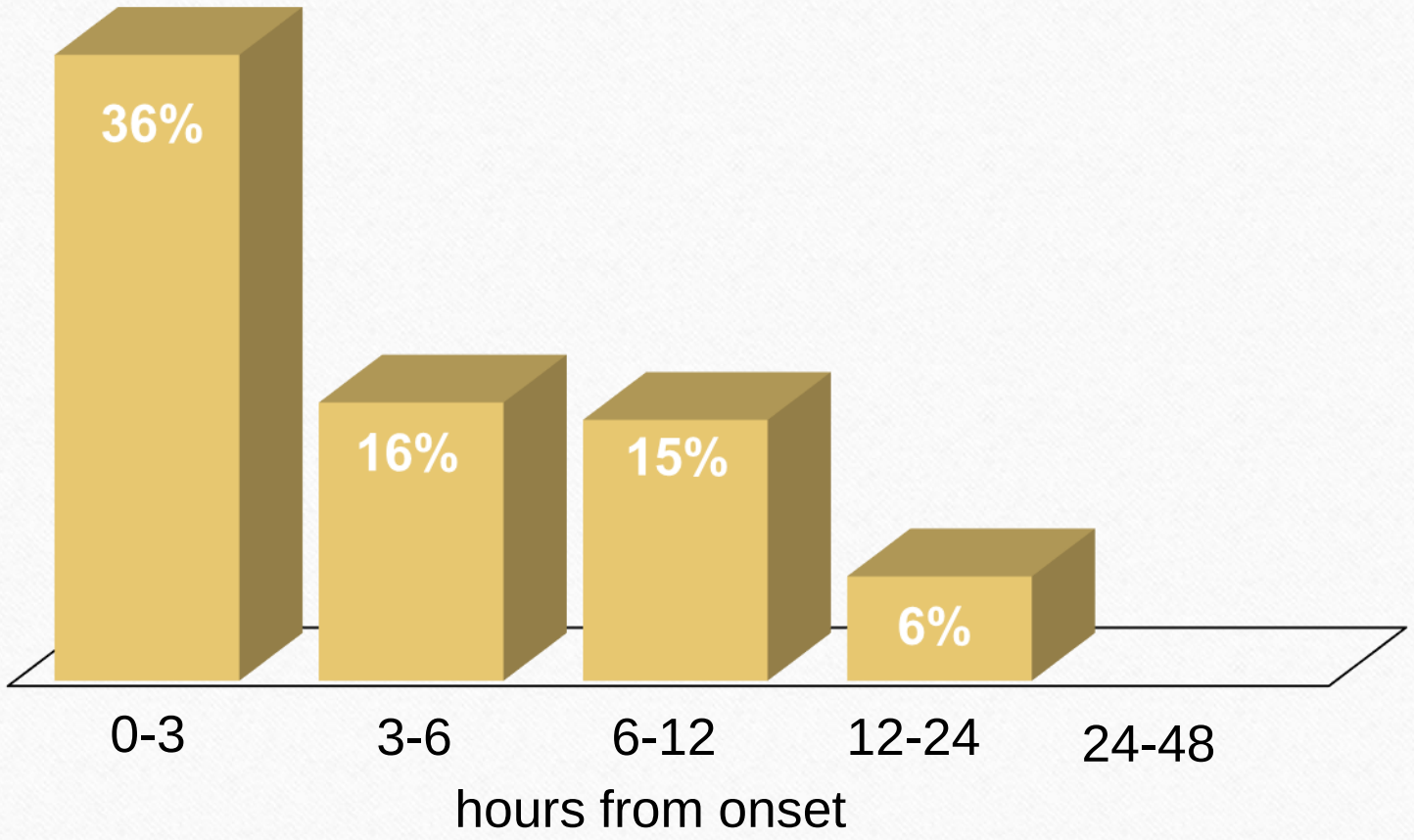
Acute Management of ICH

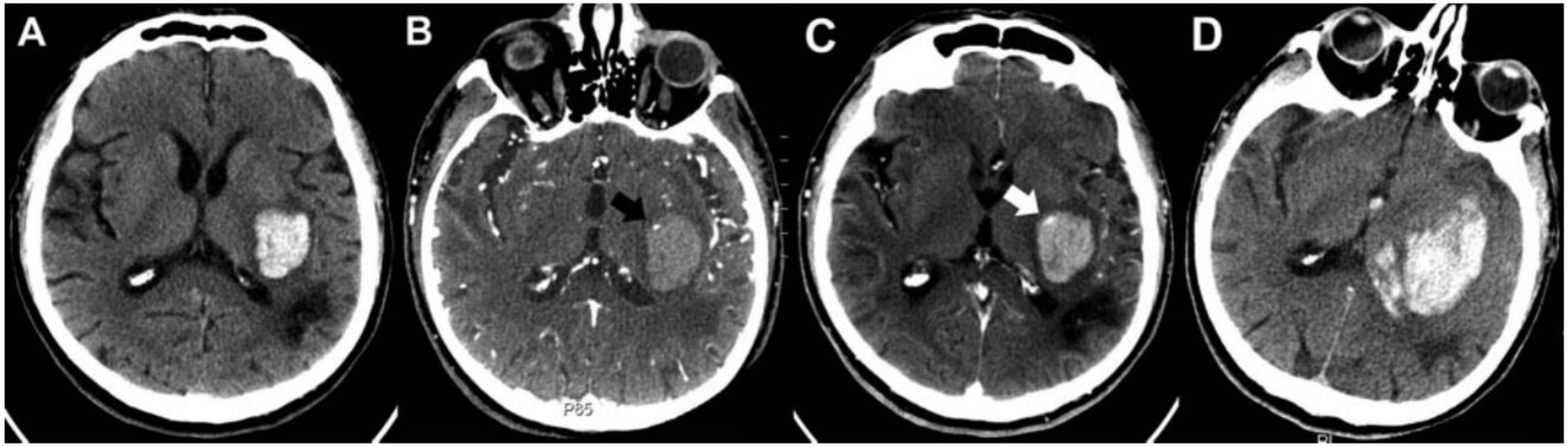
- Predicting hematoma expansion (outcome)
- Preventing hematoma expansion
- Monitoring for complications of ICH

Is it expanding?



Stroke 1996;27:1783-87

Spot Sign



Wada et al., 2007

Spot Sign

- The sensitivity of spot sign was 63%
- The specificity was 90%

BioMed Research International, 2017

Glasgow 昏迷指數（GCS）

張眼反應（eye open）	
自動張開	4
由聲音引導眼張開	3
由痛引發眼張開	2
無反應	1
運動反應（motor response）	
遵從口令做運動確認疼痛位置	6
試著去除刺激	5
予痛有回縮動作以去除痛刺激	4
不正常之屈曲	3
不正常之伸張	2
無反應	1
語言反應（verbal response）	
具定向力，能很正確說出人、時、地	5
對人、時、地回答不正確，但能與人交談	4
不適當的回話	3
發出無法理解之聲音	2
無反應	1

Calculating ICH Volume

$$\frac{A \times B \times C}{2}$$

- Select CT slice with largest ICH
- A = longest axis (cm)
- B = longest axis perpendicular to A (cm)
- C = number of slices x slice thickness (cm)

ICH score

ICH volume		
	> 30cc	1
	< 30cc	0
Intraventricular extension		
	Yes	1
	No	0
Infratentorial location		
	Yes	1
	No	0
Age		
	> 80	1
	< 80	0
Glasgow coma scale		
	3-4	2
	5-12	1
	13-15	0
Total score		**0-6**

Score	30-day mortality
0	0%
1	13
2	26
3	72
4	97
5, 6	100

Godoy, D. A. et al. Stroke 2006

Five-year outcomes of persons with moderate to severe TBI*

* Data are US population estimates based on the TBIMS National Database. Data refers to people 16 years of age and older who recieved inpatient rehabilitation services for a primary diagnosis of TBI.

IMPACT

Prognostic calculator

Based on extensive prognostic analysis the IMPACT investigators have developed prognostic models for predicting 6 month outcome in adult patients with moderate to severe head injury (Glasgow Coma Scale <=12) on admission. By entering the characteristics into the calculator, the models will provide an estimate of the expected outcome at 6 months. We present three models of increasing complexity (Core, Core + CT, Core + CT + Lab). These models were developed and validated in collaboration with the CRASH trial collaborators on large numbers of individual patient data (the IMPACT database). The models discriminate well, and are particularly suited for purposes of classification and characterization of large cohorts of patients. Extreme caution is required when applying the estimated prognosis to individual patients.

List of subpages

- Background
- Mission & Aims
- Collaboration
- Investigators
- Advisory Board
- IMPACT database
- Prognostic calculator
- IMPACT recommendations
- Common Data Elements (Draft)
- Data Sharing
- Acknowledgements

IMPACT

Prognostic models in TBI

1. Clinical Practice

- informing relatives

Prediction models for 6 month outcome after TBI

Admission Characteristics	Value
Core	
Age (14-99 years)	55
Motor Score	Localizes
Pupils	Both reacting
Core+CT	
Hypoxia	No
Hypotension	No
CT Classification	Diffuse Injury I
tSAH on CT	Yes
Epidural mass on CT	No
Core+CT+Lab	
Glucose (54-360 mg/dL)	120 mg/dL
Hb (6-17 g/dL)	12 g/dL

Calculate Reset

◆1 ：diffuse injury I (no visible pathology)

no visible intracranial pathology

◆2 ：diffuse injury II

midline shift of 0 to 5 mm
basal cisterns remain visible
no high or mixed density lesions >25 cm^3

◆3 ：diffuse injury III (swelling)

midline shift of 0 to 5 mm
basal cisterns compressed or completely effaced
no high or mixed density lesions >25 cm^3

◆4 ：diffuse injury IV (shift)

midline shift > 5mm
no high or mixed density lesions >25 cm^3

◆5 ：evacuated mass lesion V

any lesion evacuated surgically

◆6 ：non-evacuated mass lesion VI

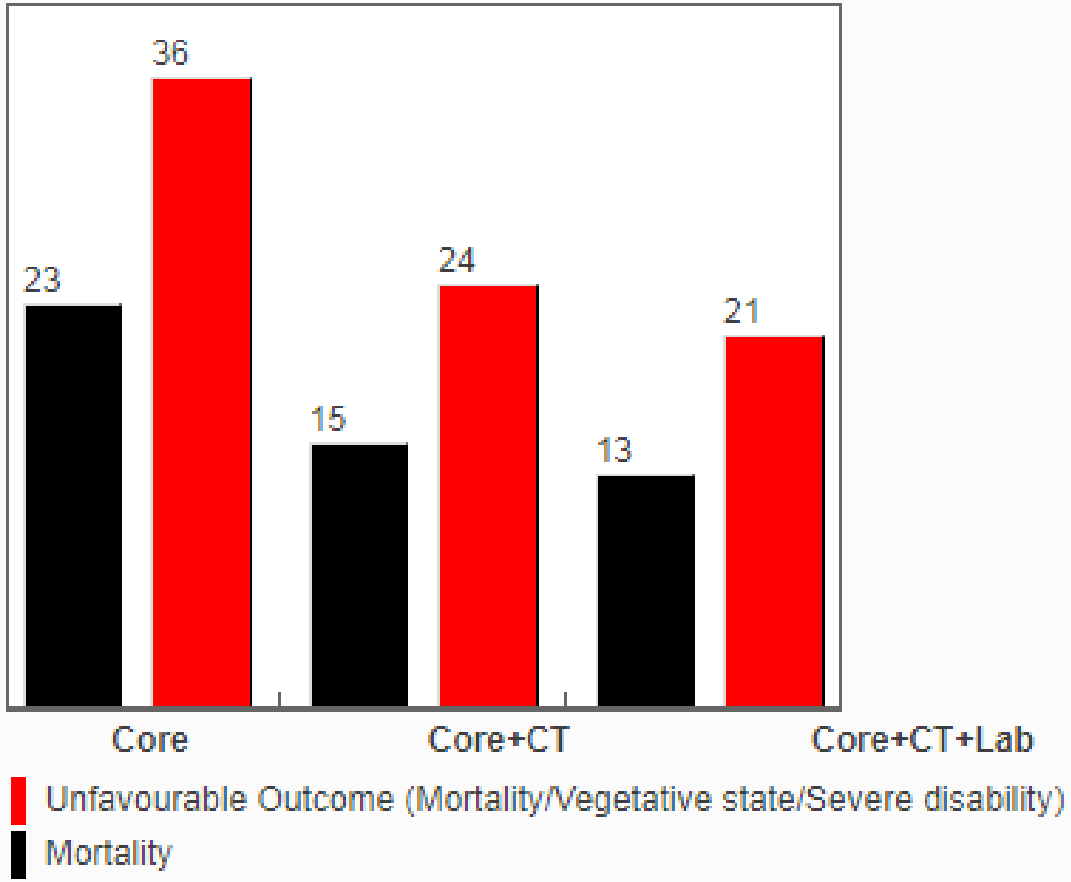
high or mixed density lesions >25 cm^3
not surgically evacuated

Prognostic Results:

Predicted probability of 6 month mortality: Core model: 23%
Predicted probability of 6 month unfavourable outcome: Core model: 36%

Predicted probability of 6 month mortality: Core+CT model: 15%
Predicted probability of 6 month unfavourable outcome: Core+CT model: 24%

Predicted probability of 6 month mortality: Core+CT+Lab model: 13%
Predicted probability of 6 month unfavourable outcome: Core+CT+Lab model: 21%



Preventing Hematoma Expansion

- Blood pressure control
- Reversing INR
- ? Platelet transfusion
- Metabolic

Preventing Hematoma Expansion

- Blood Pressure Control

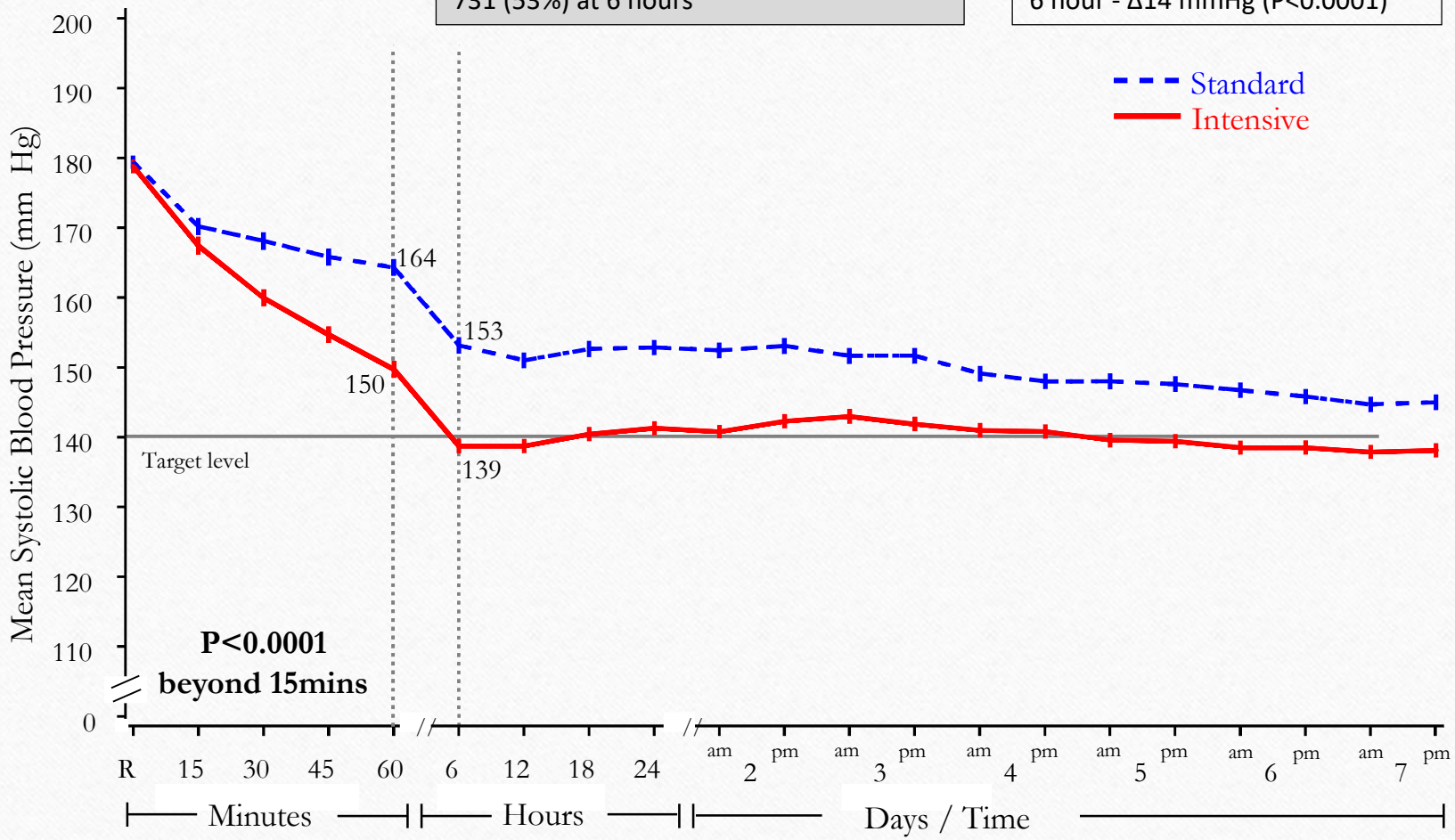
Target blood pressure 140 systolic?
INTERACT 2 trial

- Patients within 6 hours of onset of ICH
- Treatment arm: SBP <140
- Control arm: SBP <180

INTERACT 2: results

Intensive group to target (<140mmHg)
462 (33%) at 1 hour
731 (53%) at 6 hours

Systolic BP time trends
1 hour - Δ14 mmHg (P<0.0001)
6 hour - Δ14 mmHg (P<0.0001)



INTERACT 2: results

- No difference between groups in death or major disability
- Intensive blood pressure lowering resulted in better functional outcomes at 90 days than standard therapy

N Engl J Med. 2013;368:2355–2365

BP Control

- AHA Statement:
- For ICH patients presenting with SBP between 150-220 mm Hg and without contraindication to acute BP treatment, lowering of SBP to 140 mm Hg is safe (class1; Level of Evidence A) and can be effective for improving functional outcome (class 2a; Level of Evidence B)

AHA/ASA guideline, 2015

Preventing Hematoma Expansion

- Reversing Anticoagulation

Reversing the INR

- No more fresh frozen plasma
- Choose prothrombin complex concentrate
- Vitamin K dependent coagulation factors II, VII, IX, X and protein C+S
- Give vitamin K IV along with it

PCC vs. FFP

- Effective hemostasis in 72.4% of the 4-factor PCC group vs. 65.4% of the FFP group
  - PCC non-inferior to FFP
- INR ≤ 1.3 at half an hour after the end of the infusion in 62.2% of the PCC group vs. 9.6% of the FFP group
  - PCC superior to FFP

Advantages of PCC

- Less volume
- Rapid reversal of the INR to less than 1.3 within 30 minutes
- Rapid infusion rate – 8.4 mL/minute

Kcentra dose

Table 1: Dosage Required for Reversal of VKA Anticoagulation in Patients with acute major bleeding or need for an urgent surgery/invasive procedure

Pre-treatment INR	2–< 4	4–6	> 6
Dose* of Kcentra (units† of Factor IX) / kg body weight	25	35	50
Maximum dose‡ (units of Factor IX)	Not to exceed 2500	Not to exceed 3500	Not to exceed 5000

* Dosing is based on body weight. Dose based on actual potency as stated on the carton, which will vary from 20-31 Factor IX units/mL after reconstitution. Nominal potency is 500 or 1000 units per vial, approximately 25 units per mL after reconstitution.

† Units refer to International Units.

‡ Dose is based on body weight up to but not exceeding 100 kg. For patients weighing more than 100 kg, maximum dose should not be exceeded.

Usually 25 units/ mL
Therefore 3500 units = 140 mL

FFP would have been 1050 mL (15mL/kg)

Reversal

- AHA Statement:
- Patients with ICH whose INR is elevated because of VKA should have their VKA withheld, receive therapy to replace vitamin K-dependent factors and correct the INR and receive intravenous vitamin K (class 1; Level of Evidence C).
- PCCs may have fewer complications and correct the INR more rapidly than FFP and might be considered over FFP (class 2b; Level of Evidence B)

NOAC

	治療方式						
	Idarucizumab	Andexanet alfa	4-factors PCC	Activated PCC	新鮮冷凍血漿(FFP)	血液透析	活性碳
Dabigatran	第一線藥物	無效	第二線藥物	第二線藥物	不建議	有效	有效
Rivaroxaban Apixaban Edoxaban	無效	第一線藥物	第二線藥物	第二線藥物	不建議	無效	有效

Preventing Hematoma Expansion

- Platelet Transfusion

Platelet Transfusion for ASA use?

Published Ahead of Print on January 7, 2009 as 10.1212/01.wnl.0000342709.31341.88

Prior antiplatelet use does not affect hemorrhage growth or outcome after ICH

- 282 ICH cases imaged at onset and at 72 hours, including 70 (25%) taking antiplatelet medication
  - No difference in baseline hematoma volume
  - No difference in hematoma growth at 72 hours
  - No difference in need for surgical evacuation
  - No difference in Rankin score at 90 days
  - No difference in mortality

NEUROLOGY

Platelet Transfusion

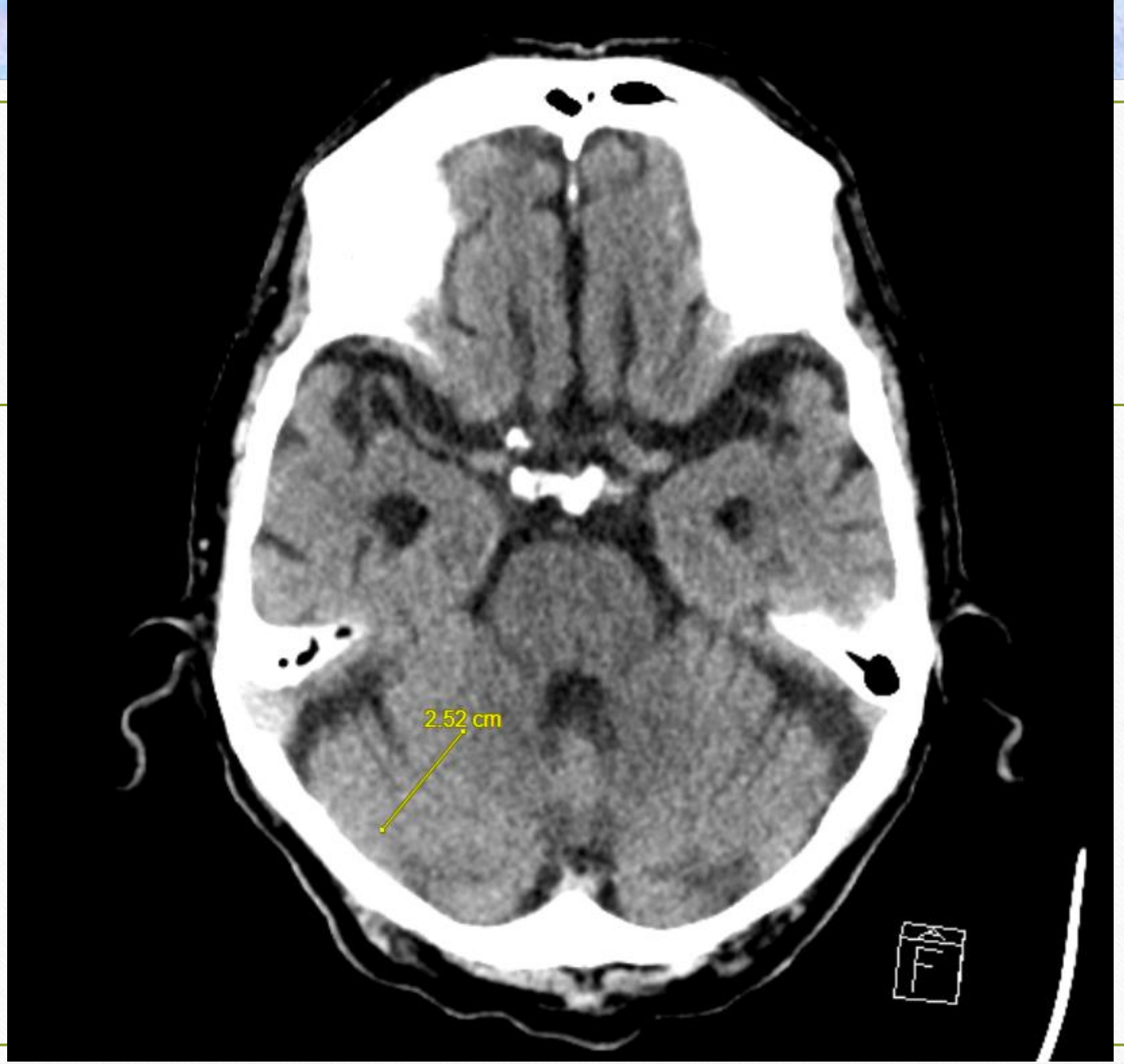
- AHA Statement:
- The usefulness of platelet transfusions in ICH patients with a history of antiplatelet use is uncertain (class 2b: Level of Evidence C)
- Patients with a severe coagulation factor deficiency or severe thrombocytopenia should receive appropriate factor replacement therapy or platelets, respectively (class 1; Level of Evidence C)

Surgery of ICH

- Lower morbidity from re-bleeding, edema, or necrosis from mass effect
- Rarely causes neurologic improvement
- Lower mortality for patients with GCS 7-10

Surgery

- Patients with cerebellar hemorrhage who are deteriorating neurologically or have brain stem compression or hydrocephalus should under go surgical removal as soon as possible (class 1; Level C)
- Initial treatment of these patients with ventricular drainage rather than surgical evacuation is not recommended (class 3; Level C)


2.52 cm

Surgical vs. Medical

- Marked mass effect, edema, midline shift
- Symptoms due to IICP or to mass effect from the clot or surrounding edema
- Volume: 30 c.c.
- Persistent elevated ICP
- Rapid deterioration
- Young patient (< 50 yrs)
- Favorable location
- Early intervention

- Minimal symptomatic lesions
- High ICH score
- Massive hemorrhage in dominant site
- Poor neurological condition
- Age > 80 yrs
- Severe coagulopathy
- Basal ganglion or thalamic hemorrhage

Hydrocephalus

Indications for EVD

- EVD as treatment for hydrocephalus is reasonable, esp. in patients with decreased level of consciousness (class 2a; Level B)
- Place in the lateral ventricle contralateral to the hemorrhage

Intraventricular Hemorrhage

- Although intraventricular administration of rtPA in IVH appears to have a fairly low complication rate, the efficacy and safety of this treatment are uncertain (class 2b; Level B)
- The efficacy of endoscopic treatment of IVH is uncertain (class 2b; Level B)

Severe Head Injury

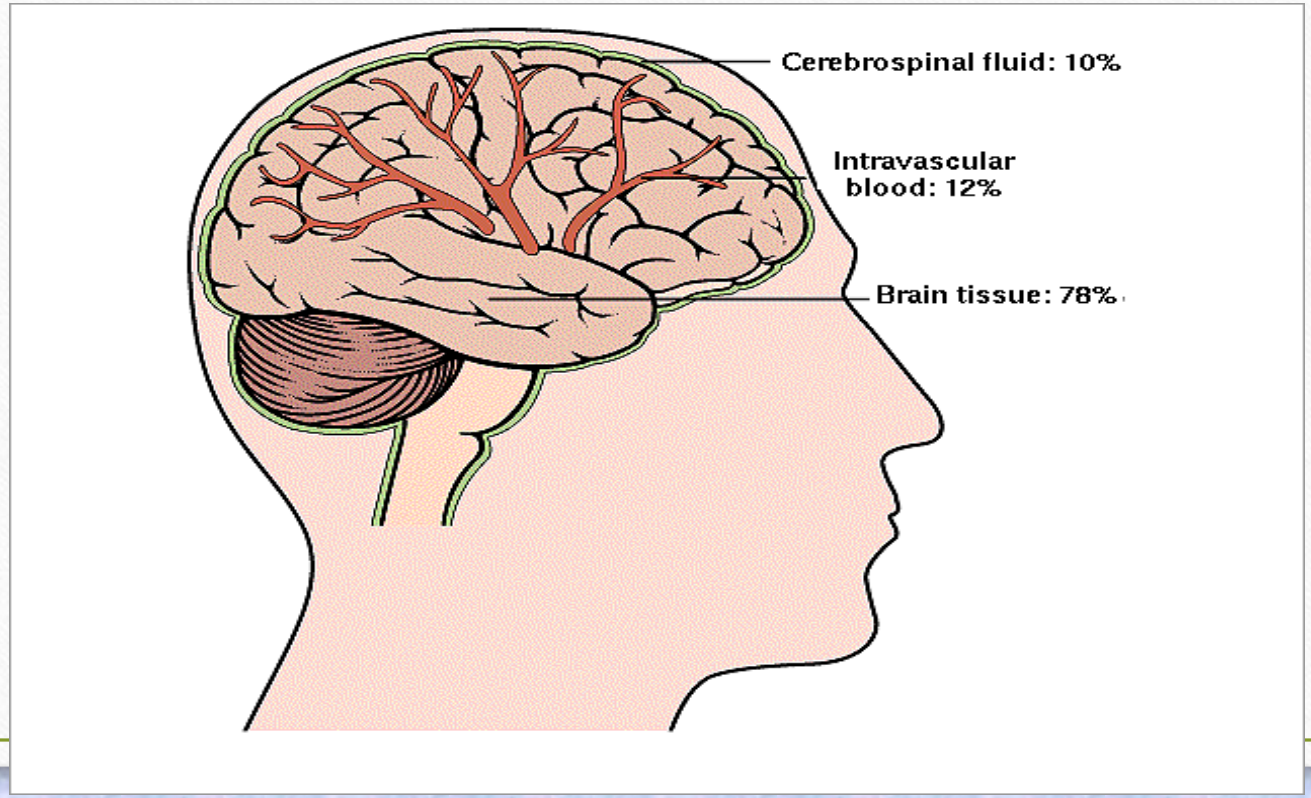
- First priority
  - Securing airway, breathing, and circulation (ABC)
- GCS scores ≦ 8→ emergent intubation
- Avoid hypoxia (PaO2<60mmHg)
- Avoid hypotension (SBP<90mmHg)
- Avoid electrolyte imbalance: Na, Glu, Mg
- Other system injury (life threatening): check chest and abdomen

壓力、循環

腦循環如何調節？

門羅定律

- $V_{intracranial\ vault} = V_{brain} + V_{blood} + V_{CSF}$



腦循環的流體力學

- 腦血流與腦灌流壓(cerebral perfusion pressure，CPP)成正比。

  CBF=CPP/CVR

- 腦灌流壓又等於平均動脈壓(mean arterial pressure，MAP)減顱內壓。

  CPP=MAP-ICP

- 在腦血管自動調節下，腦血流維持恒定。

神經加護照顧及腦部監測

- 主要面對的是腦部的二度傷害(secondary injury)，如顱內出血、腦水腫、血氧不足及缺血(常因顱內壓升高或休克)等

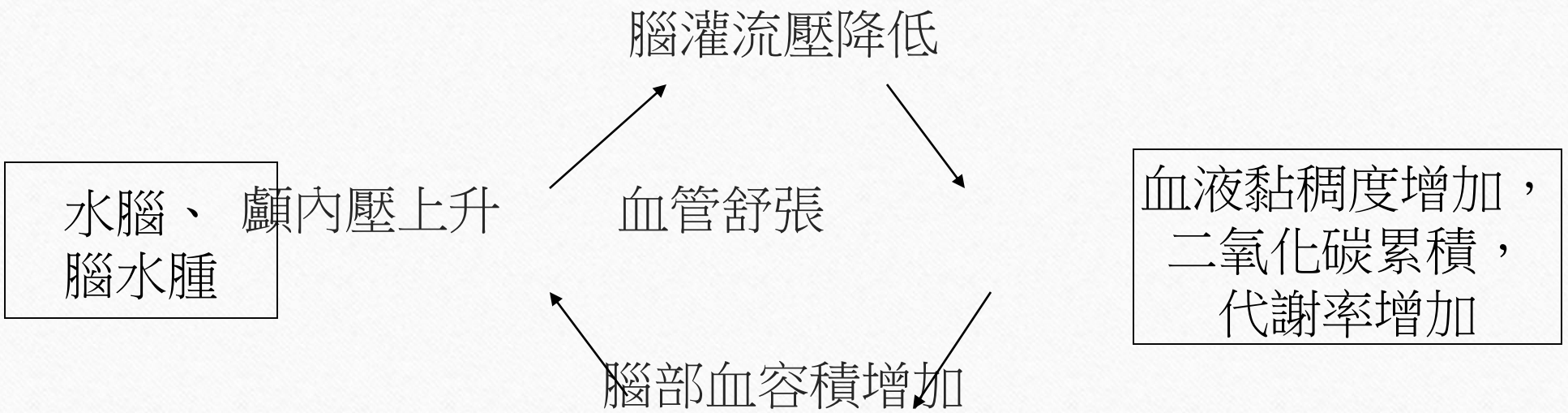
腦灌流壓降低，引發反應性血管舒張之惡性循環

$V_{intracranial\ vault} = V_{brain} + V_{blood} + V_{CSF}$

血壓下降，脫水

CBF=CPP/CVR

CPP=MAP-ICP



靜脈回流受阻，病人躁動與呼吸器對抗，胸腹壓增加

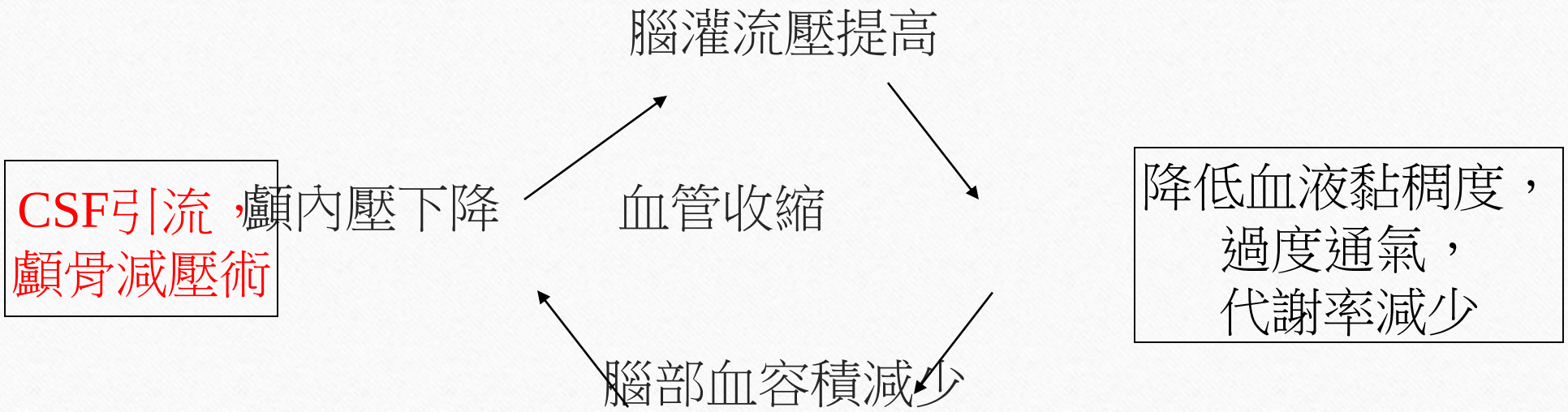
引發反應性血管收縮之良性循環

$V_{intracranial\ vault} = V_{brain} + V_{blood} + V_{CSF}$

提高血壓

CBF=CPP/CVR

CPP=MAP-ICP

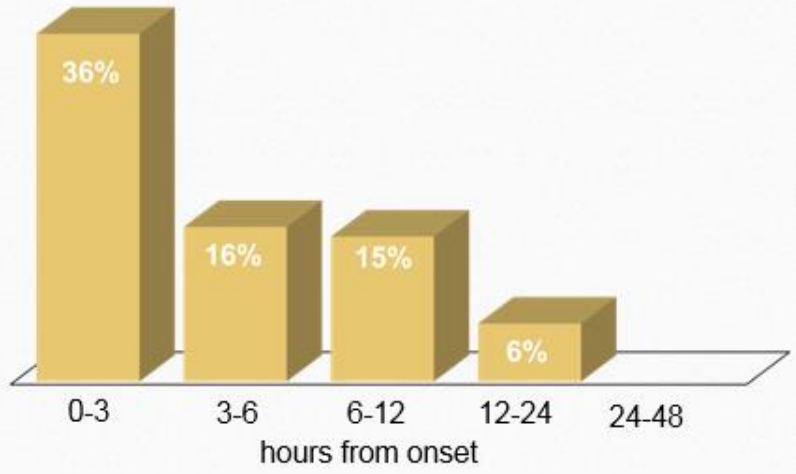


頭抬高30度，頸部維持正中

減少病人疼痛，鎮定劑的使用

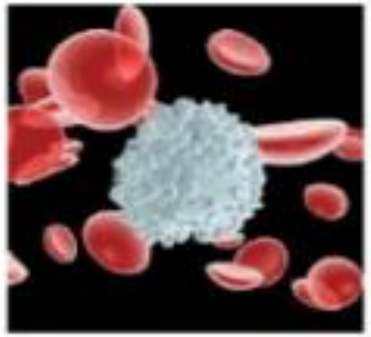
Timming

- Early surgery thus appears to be justified, but the timing of the surgery for ICH is controversial
- Mortality in patients with moderate to large hematomas can be reduced
- Time is life

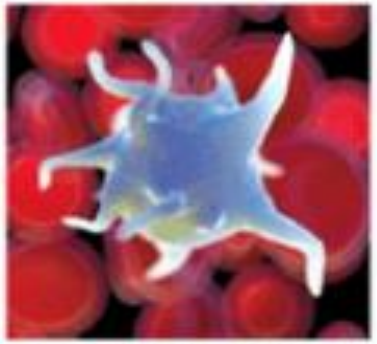


	刺激紅血球	刺激白血球	刺激血小板
作用			
原理	• 增加紅血球攜氧率 (PaO2) • 修復表面受損能力[1] • 提高膜變形能力	• 維持標準白血球數量 • 提昇 B-lymphocyte T-lymphocyte 免疫調節及吞噬效果	降低血小板在血管內凝集
效應	血液循環及微循環改善	調節免疫及抗病菌能力	血液濃稠度及改變血流

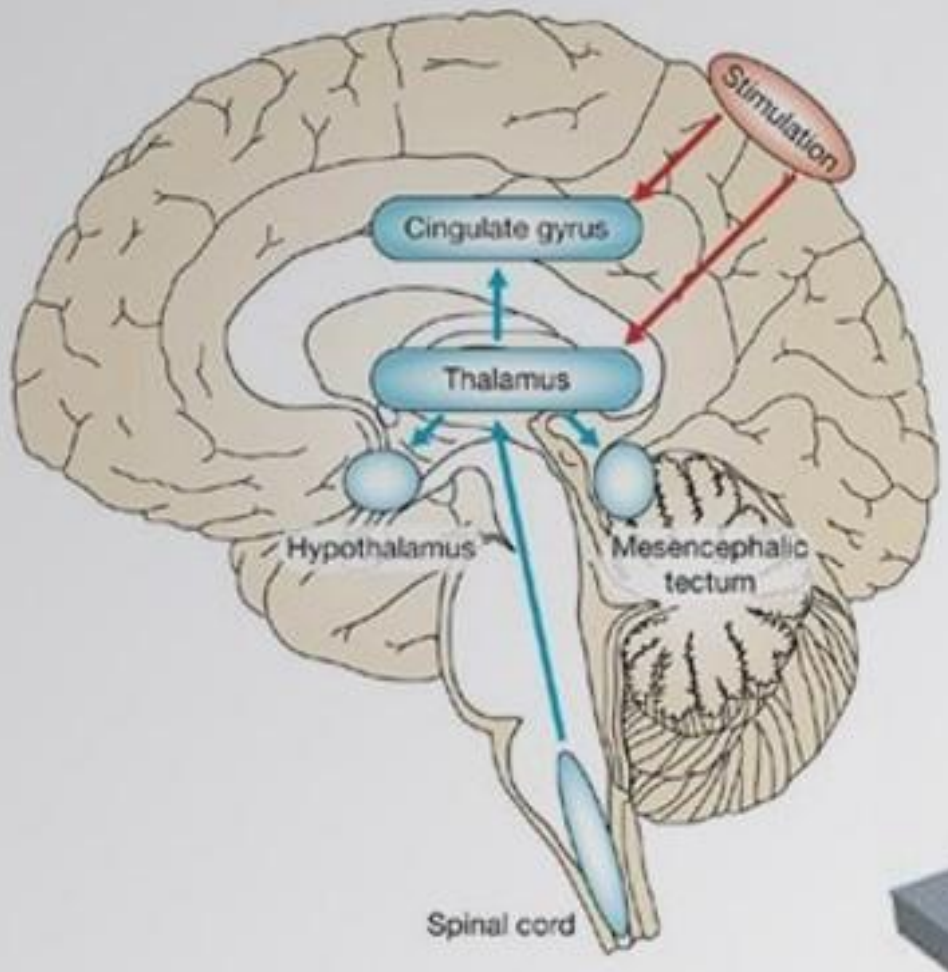
Erythrocyte 紅血球

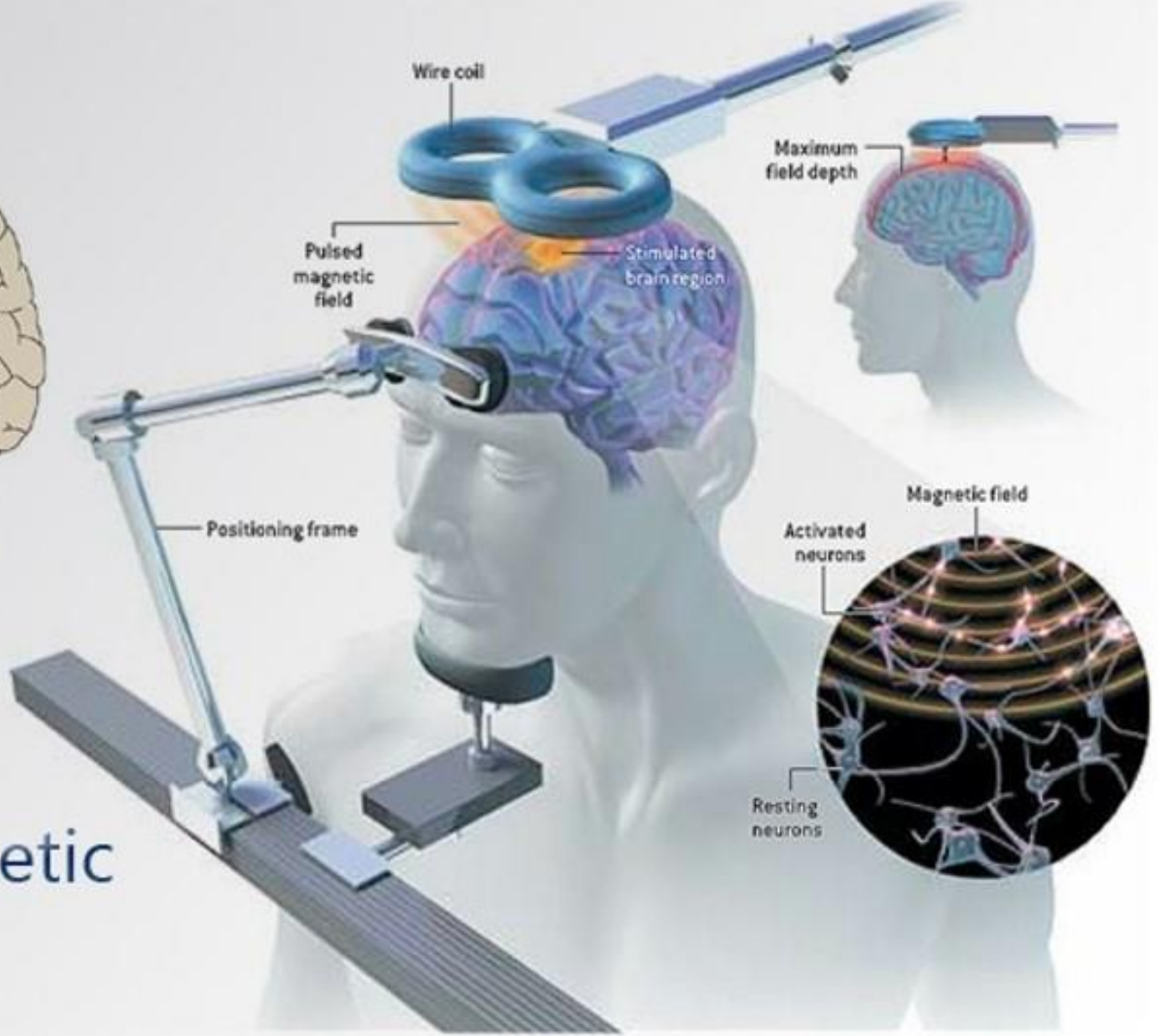


Leucocyte 白血球

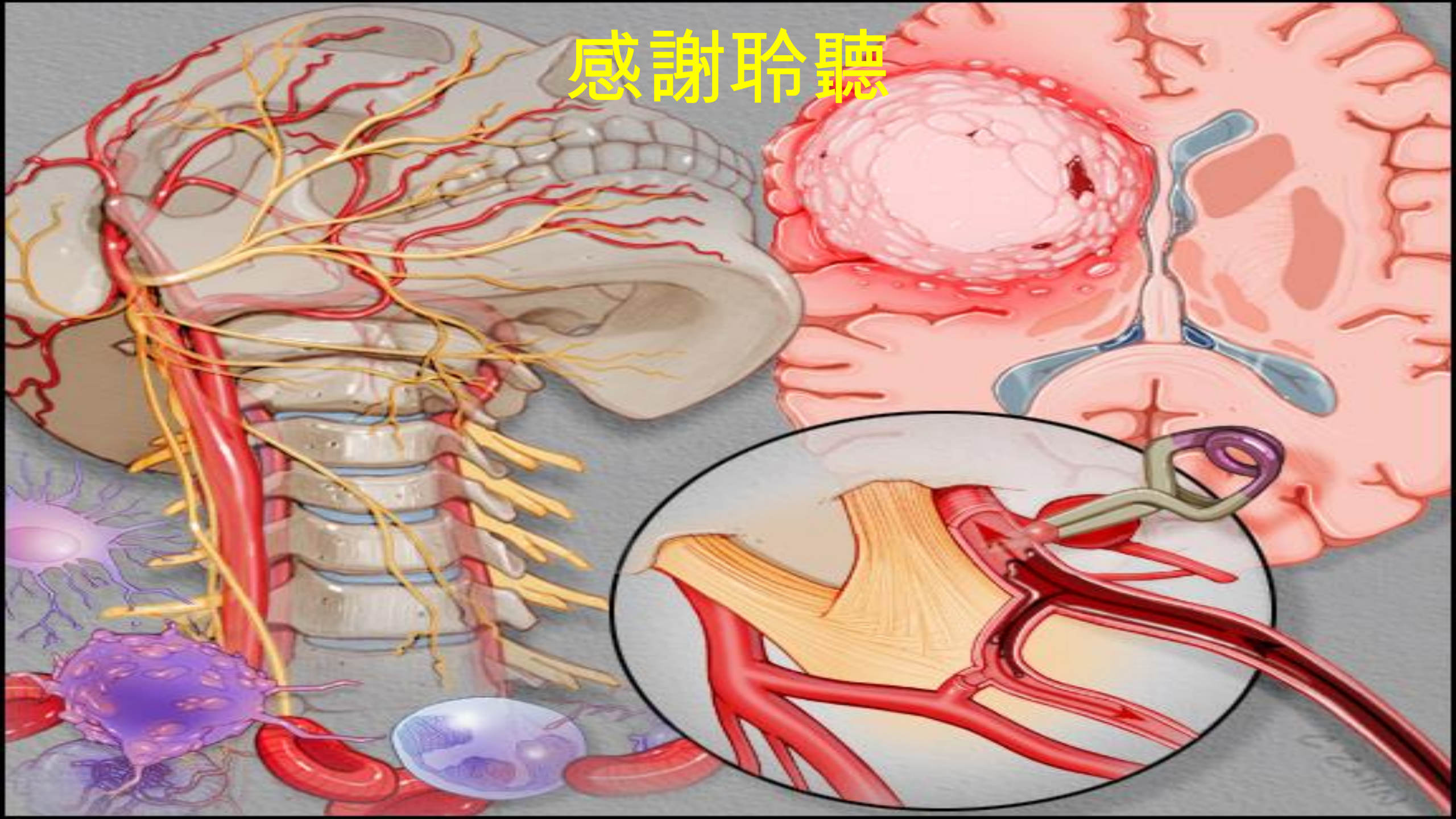


Platelet 血小板





Transcranial Magnetic Stimulation


感謝聆聽