BaltAnestIC 2023

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RĪGAS AUSTRUMU KLĪNISKĀ UNIVERSITĀTES SLIMNĪCA

RĪGA STRADIŅŠ UNIVERSITY

DETECTION OF CEREBRAL VASOSPASM IN SUBARACHNOID HAEMORRHAGE

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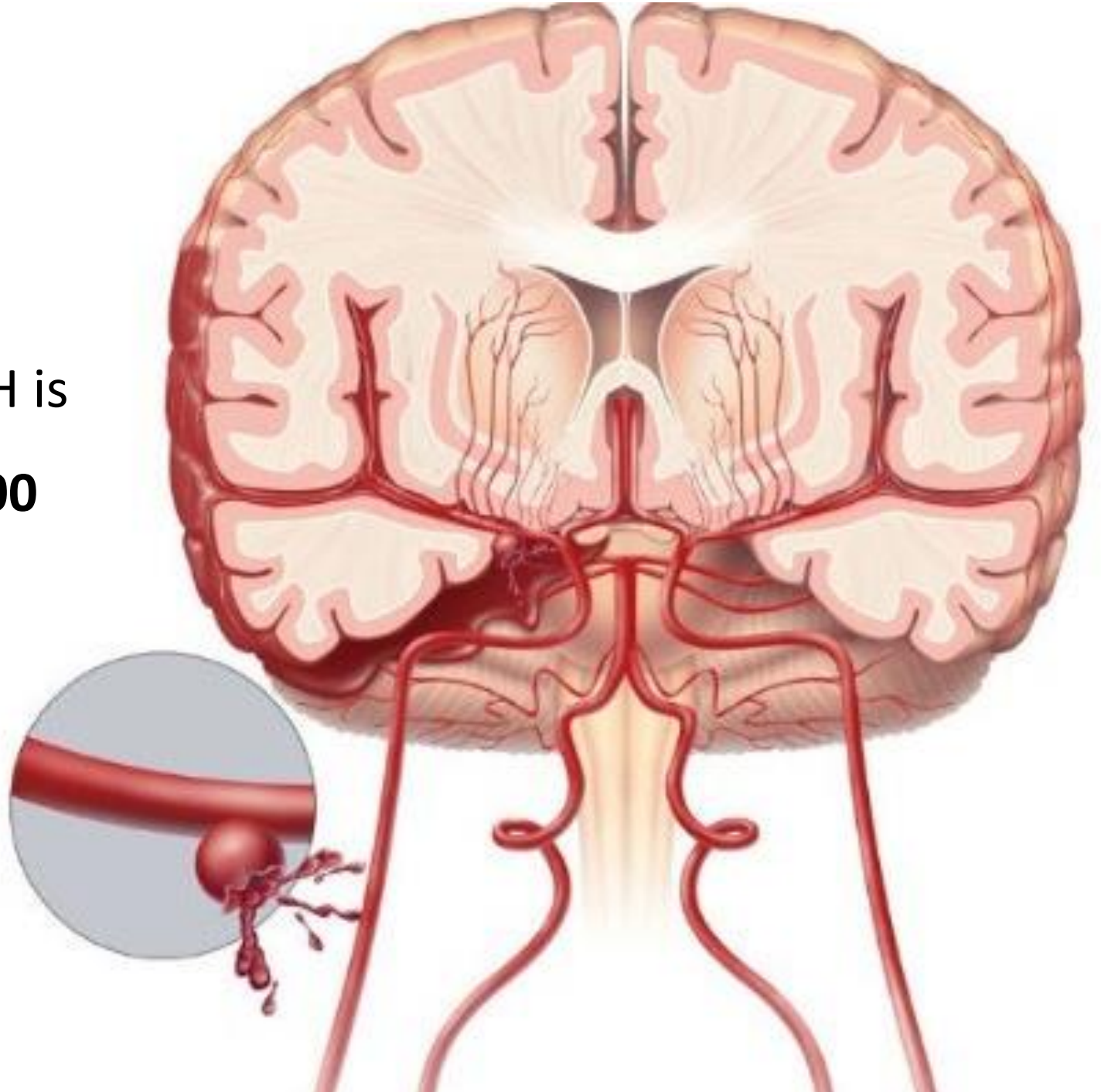
30.09.2023, Tartu, Estonia

- Definitive SAH patients treatment.
- 60-70 subarachnoid haemorrhage patients **in ICU** per year.

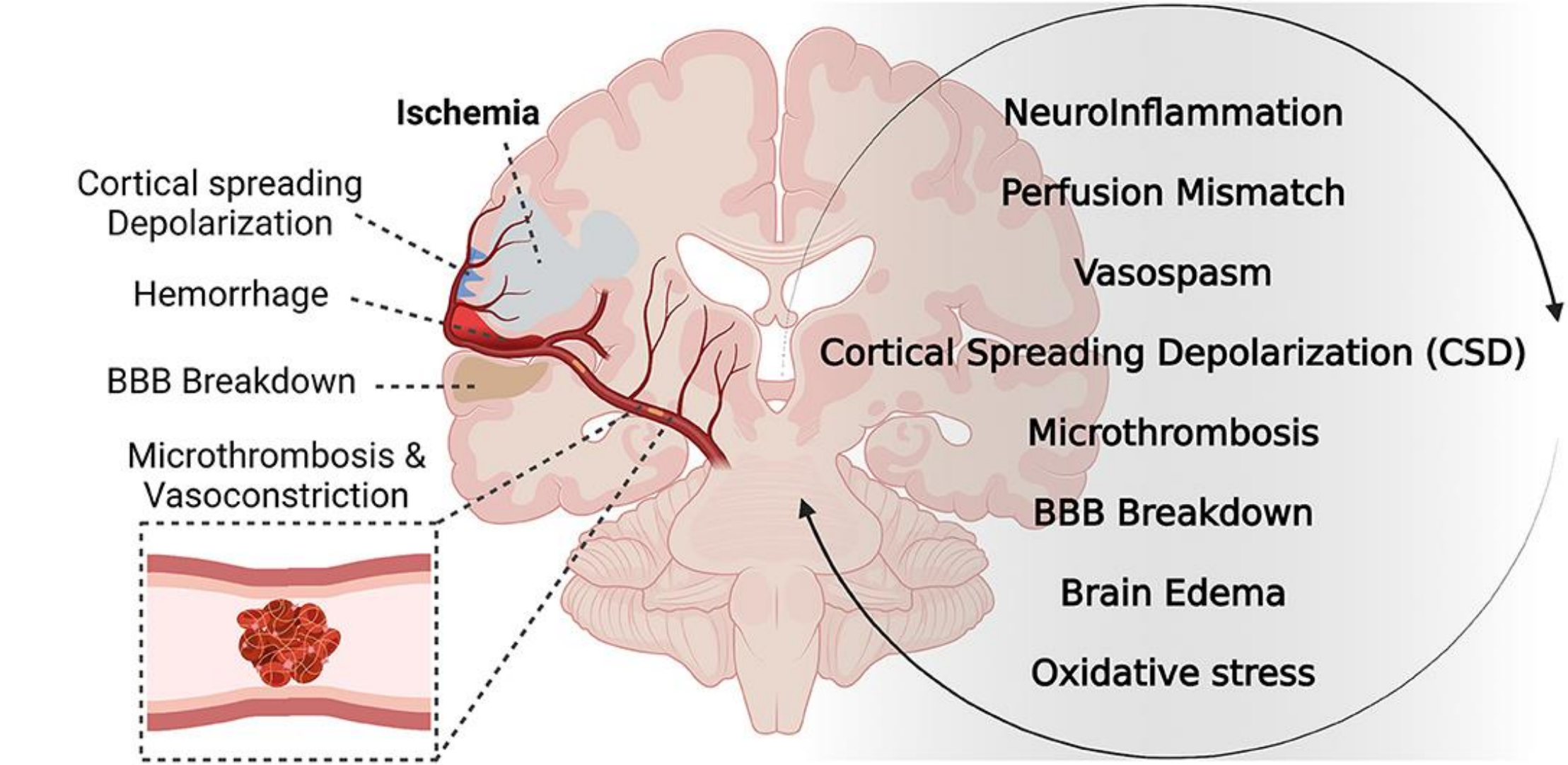
No disclosure to declare.

The overall **worldwide** incidence of aneurysmal SAH is **≈6.1 per 100 000** person-years.

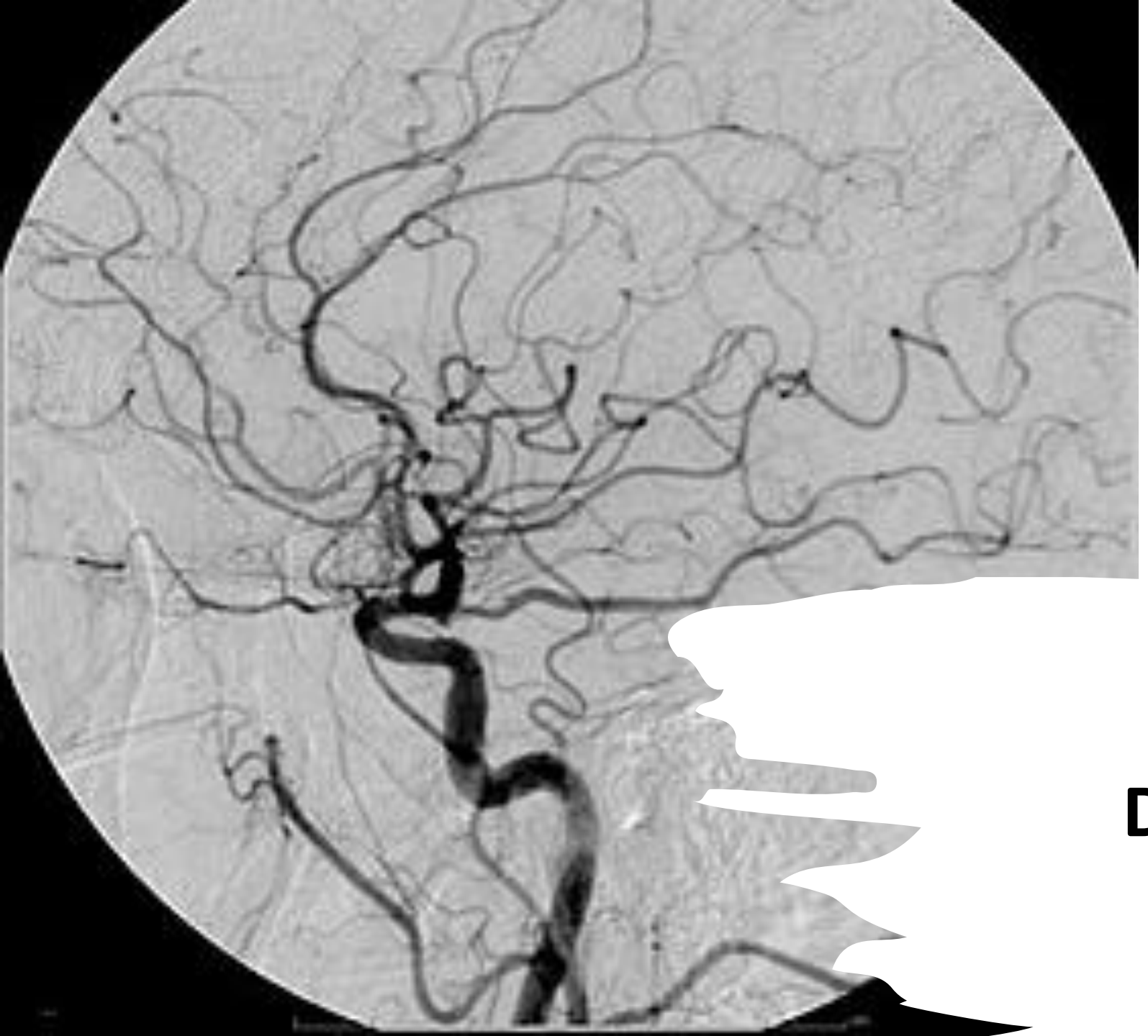


Stroke. 2023;54:e314–e370.

Pathophysiology of Delayed Cerebral Ischemia after SAH



Front Cardiovasc Med. 2021 Nov 15;8:752769.



DIGITAL SUBTRACTION ANGIOGRAPHY

PREDICTION OF CEREBRAL VASOSPASM

Risk factors for vasospasm
Thick subarachnoid clots
Intraventricular hematoma
Persistent subarachnoid clots (slow clearance)
Poor neurological condition on admission
Loss of consciousness associated with rupture
History of cigarette smoking
Preexisting hypertension
Diabetes mellitus
Cocaine use

medicina MDPI

Medicina (Kaunas). 2022 Feb; 58(2): 323. PMCID: PMC8880412
Published online 2022 Feb 21. doi: 10.3390/medicina58020323 PMID: 35208646

Leukocytosis and C-Reactive Protein May Predict Development of Secondary Cerebral Vasospasm in Patients with Aneurysmal Subarachnoid Hemorrhage

Ieva Buce-Satoba,[1,2,*] Daina Rozkalne,[2] Biruta Mamaja,[3,4] Gaida Krumina,[2,4] and Agnese Ozolina[2,3]

3. Results

In total, we found that a CRP increase for each 1 mg/L at admission increases the odds to develop CV by 5% (OR, 1.05; CI, 1.014–1.087; $p = 0.006$). Concomitantly, we found that a WBC count increase for each 1 × 10^9/L at admission increases the odds to develop CV by 16% (OR, 1.16; CI, 1.02–1.32; $p = 0.02$).

In aSAH-CV patients, a ROC analysis showed 96% sensitivity and 40% specificity for an association with WBC count at admission with a cut off value of 10.015 × 10^9/L (AUC 0.683; $p = 0.006$), as depicted in **Figure 3**. A more significant association was found with CRP values determined at the same time point, with a sensitivity and specificity of 54% and 90%, respectively, with a cut of value of 8.95 mg/L (AUC 0.751; $p < 0.001$), as shown in **Figure 4**.

5. Conclusions

Inflammatory parameters such as WBC count and CRP values at admission may be used as additional prognostic factors, along with widely used clinical and radiological classification scores, to identify patients who have a higher risk of developing secondary CV after aSAH. Moreover, they may be used as additional prognostic factors to select patients who need more attention and monitoring in ICU.

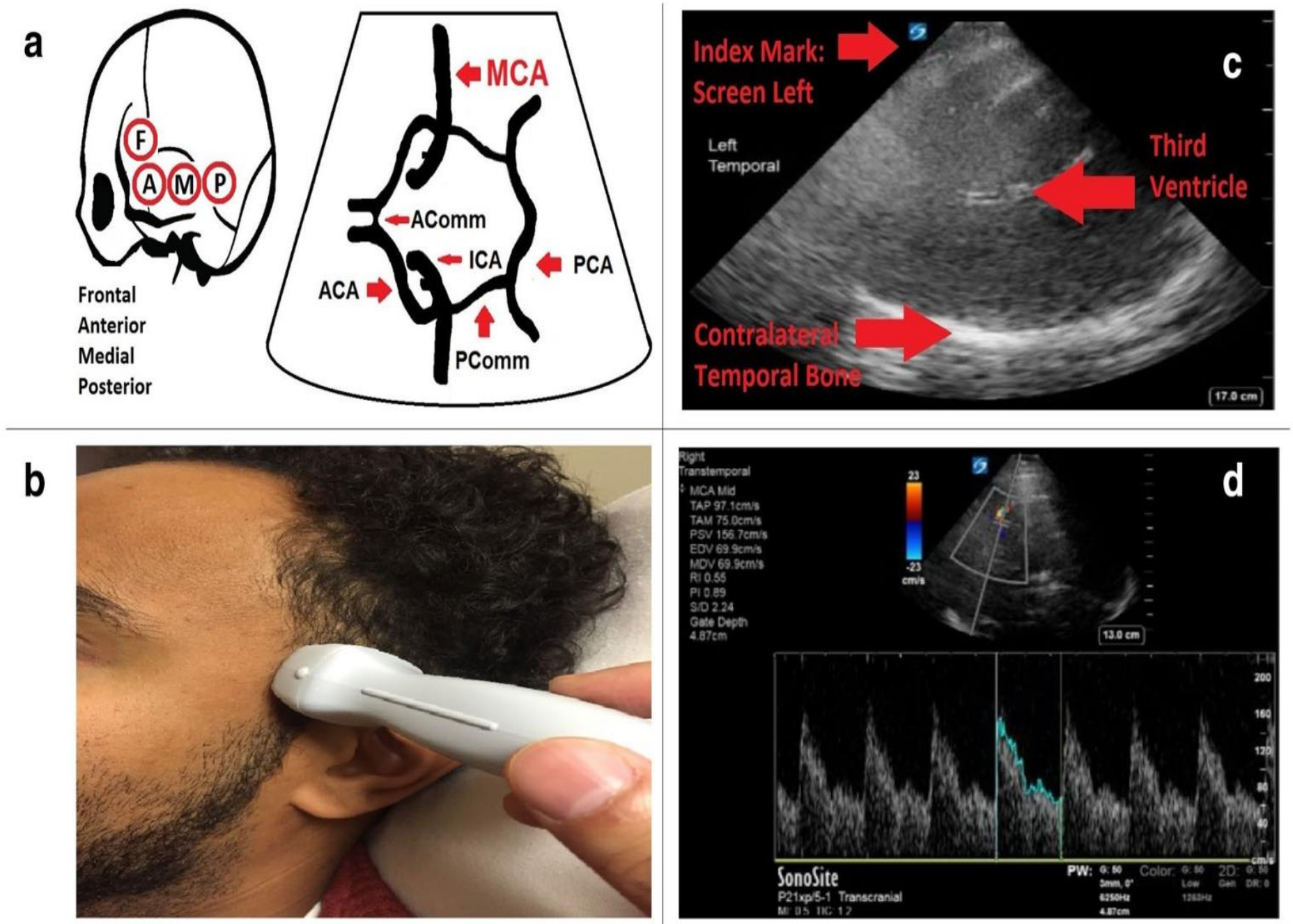
DIAGNOSTIC OPTIONS

Other causes of neurological deterioration

- Increasing brain swelling
- Rebleeding of the aneurysm
- Hydrocephalus
- Sepsis
- Cortical spreading depression
- Hyponatremia
- Hypoxia
- Hypotension

CONSCIOUS *VS.* UNCONSCIOUS

NON-INVASIVE METHODS



Lau and Arntfield *Crit Ultrasound J (2017) 9:21* DOI 10.1186/s13089-017-0077-9

TRANSCRANIAL DOPPLER

+Non-invasive

+Easy to perform

+**Repetitive bedside examination**

- Operator dependent
- **Is done infrequently**
- Does not detect vasospasm in peripheral branches
- Poor temporal bone window

Stroke
Volume 54, Issue 7, July 2023; Pages e314-e370
https://doi.org/10.1161/STR.0000000000000436

AHA/ASA GUIDELINE

2023 Guideline for the Management of Patients With Aneurysmal Subarachnoid Hemorrhage: A Guideline From the American Heart Association/American Stroke Association

8.2. MONITORING AND DETECTION OF CEREBRAL VASOSPASM AND DCI

Recommendations for Monitoring and Detection of Cerebral Vasospasm and DCI
Referenced studies that support recommendations are summarized in online Data Supplement 9.

COR	LOE	Recommendations
2a	B-NR	1. In patients with aSAH with suspected vasospasm or limited neurological examination, CTA or CT perfusion (CTP) can be useful to detect vasospasm and predict DCI.[270–275]
2a	B-NR	2. In patients with aSAH, transcranial Doppler (TCD) ultrasound monitoring is reasonable to detect vasospasm and predict DCI.[253,276–280]
2a	B-NR	3. In patients with high-grade aSAH, continuous EEG (cEEG) monitoring can be useful to predict DCI.[276,280–292]
2b	B-NR	4. In patients with high-grade aSAH, invasive monitoring of brain tissue oxygenation, lactate/pyruvate ratio, and glutamate may be considered to predict DCI.[293–305]

COMPUTED TOMOGRAPHIC PERFUSION AND ANGIOGRAPHY

CTP:

- Easy to use
- Allows early prediction of perfusion abnormalities
- Images can be acquired quickly
- Detects alterations in microcirculation

CTA:

- 80% sensitivity and 93% specificity in CV detection

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American Journal of Neuroradiology November 2010, 31 (10) 1853-1860.

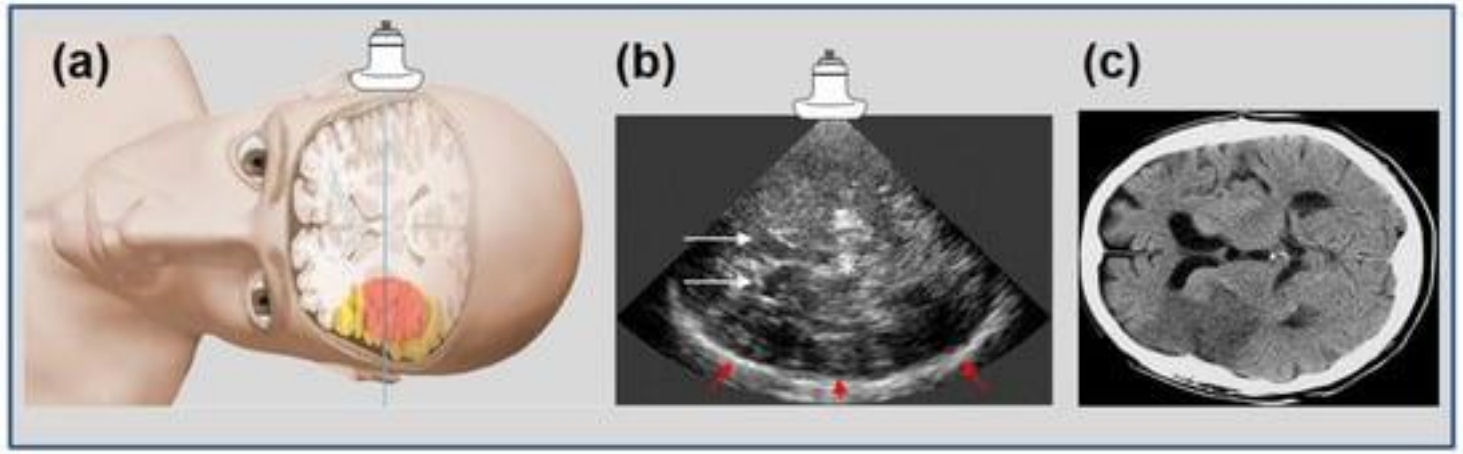
Single-photon emission CT (SPECT)

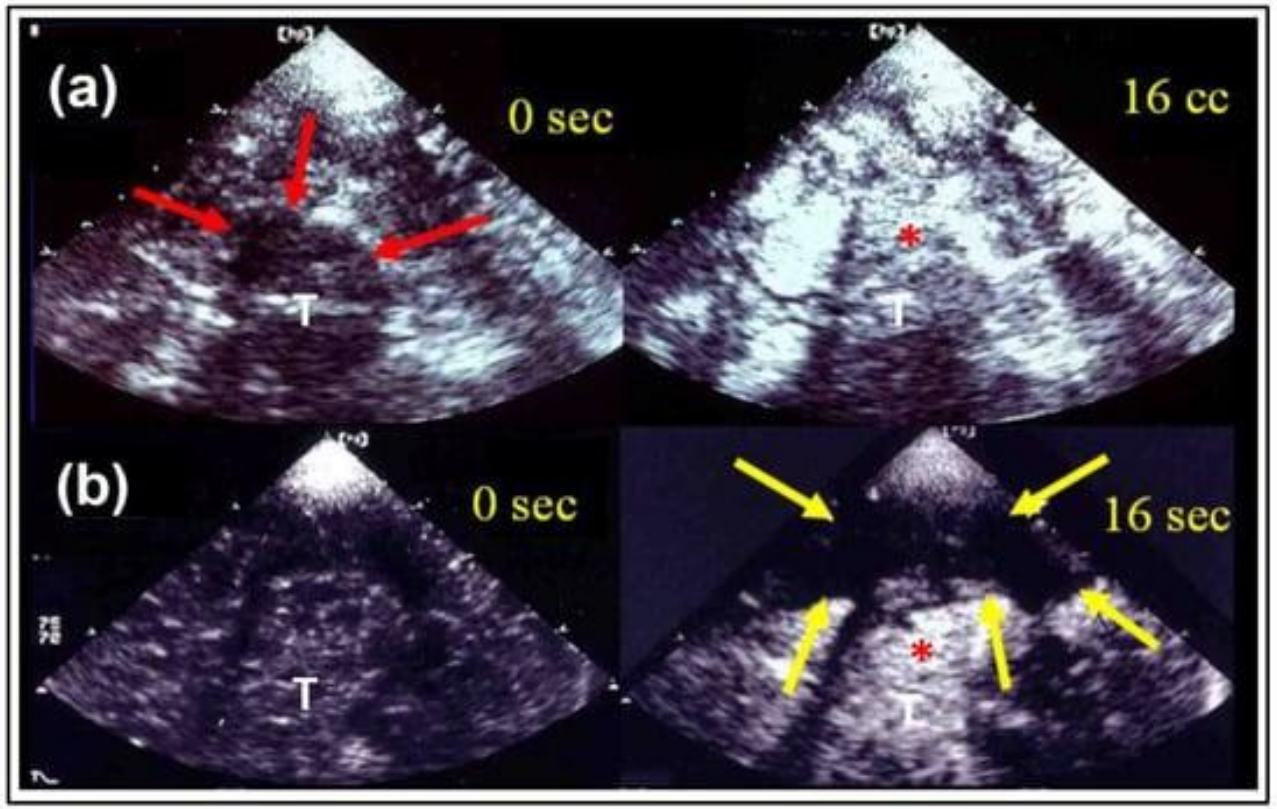
quantitative stable xenon-enhanced CT (Xe/CT)

positron emission tomography (PET)

Magnetic resonance diffusion-weighted images (DWI)

Ultrasound Perfusion Imaging





- Non-invasive
- Performed at the bedside
- May be applied even with poor temporal bone window

Neurocrit Care. 2022 Aug;37(1):149-159.

J. Clin. Med. **2020**, *9*(3), 816.

Near-Infrared Spectroscopy

+ Simple, non-invasive continuous bedside monitoring of cerebral oxygenation
+ Relatively low-cost

− May be affected by haemoglobin level
− **Continuous monitoring at least up to 7 days**
− More studies are required

Cerebral deterioration detection with Near-infrared spectroscopy in patients with aneurysmal subarachnoid hemorrhage

I. Buce-Satoba[1,2], D Rozkalne[2], G. Krumina[1,2], B. Mamaja[1,2], A. Ozolina[1,2].
1 – Rigas Stradiņš University, Riga, Latvia; 2 – Riga East University Hospital, Riga, Latvia.

Background: Early detection of cerebral vasospasm (CV) is essential in patients with aneurysmal subarachnoid haemorrhage (aSAH). Near-infrared spectroscopy (NIRS) is non-invasive, promising bedside monitoring method of regional cerebral oxygen saturation (rSO_2). We present our experience in detecting cerebral deterioration with NIRS in patients with aSAH.

Case Report: NIRS with INVOS 5100, Medtronic (Covidien) was applied to 11 Intensive care patients* (7 females), mean age 60±9 years, with aSAH, Riga, Latvia. NIRS was started within the first 48 hours after ictus and continued up to 7 days. All patients at least had one risk factor**, but 45.5% had two. Amount of aSAH was Fisher III for 2 and Fisher IV for 9 patients. Median Glasgow Coma scale was 10 points (5-15).

Mean rSO_2 at baseline (BL) was 72±6% on the left and 73±6% on the right side. CV occurred in 3 patients within 7 days. All presented a reduction of rSO_2, but more than 20% from BL was detected in two cases (see Chart 1 and 2). One patient experienced cerebral stroke without detected reduction of rSO_2. For another patient NIRS was useful to detect intracerebral hematoma (ICH) after endovascular embolization (EVE), when rSO_2 dropped from 77 to 55% on the left and 71 to 53% on the right side with continuing to decrease (see Chart 3). Mortality was 3/4 vs. 3/7 and median hospitalisation 8 vs. 15 days in patients with changed NIRS vs. without.

Chart 1. One of patient with CV and reduction of rSO_2 >20% from BL.

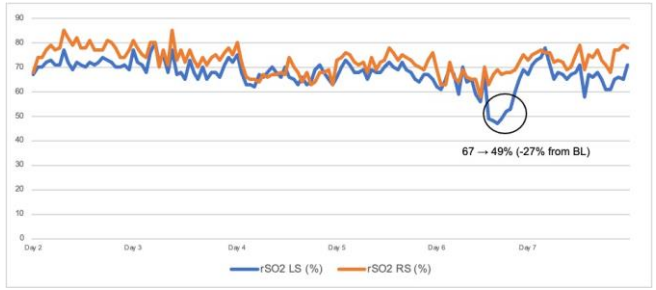


Chart 2. Second patient with CV and reduction of rSO_2 >20% from BL.

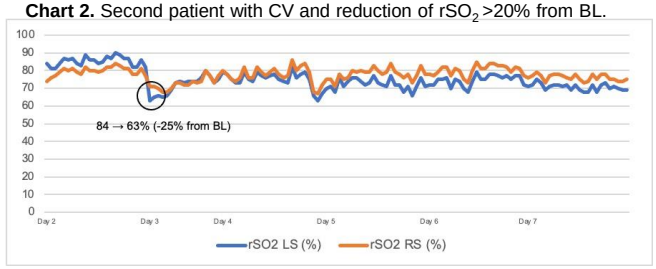
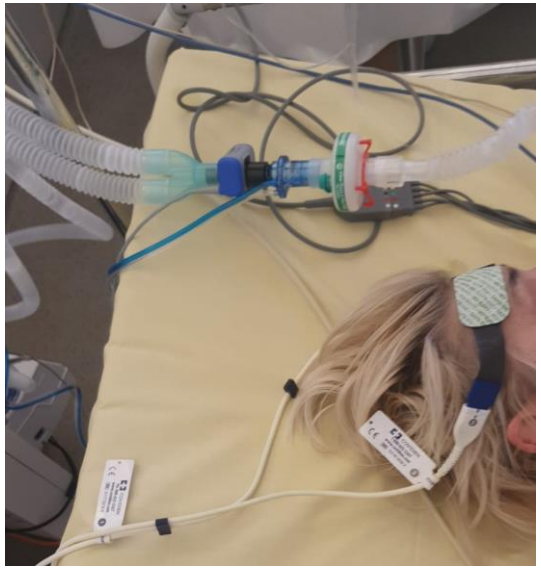


Chart 1. Patient with ICH after EVE and reduction of rSO_2 >20% from BL

*Inclusion criteria: 1) age ≥18 years; 2) proven acute aSAH on computer tomography angiography; 3) Glasgow Coma Scale 5-15 points.

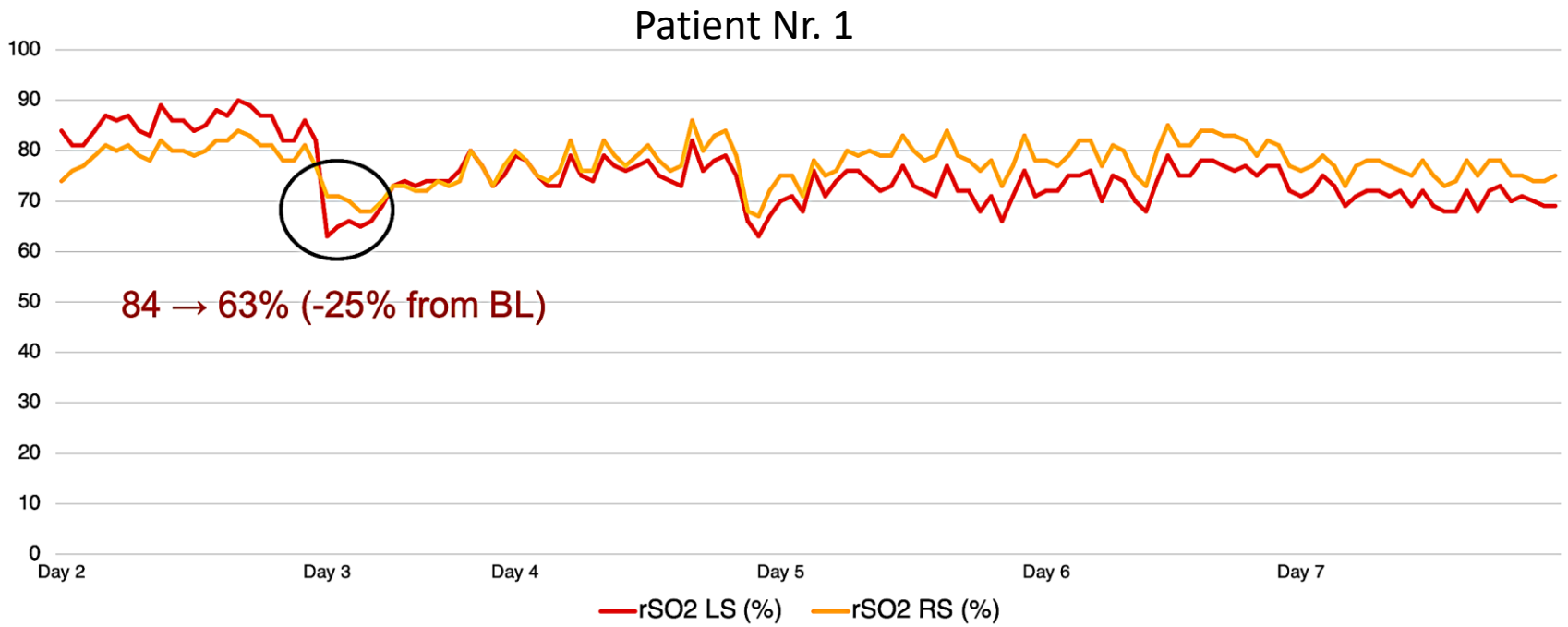
**primary arterial hypertension, atherosclerosis, diabetes mellitus, smoking, chronic alcohol intake, obesity

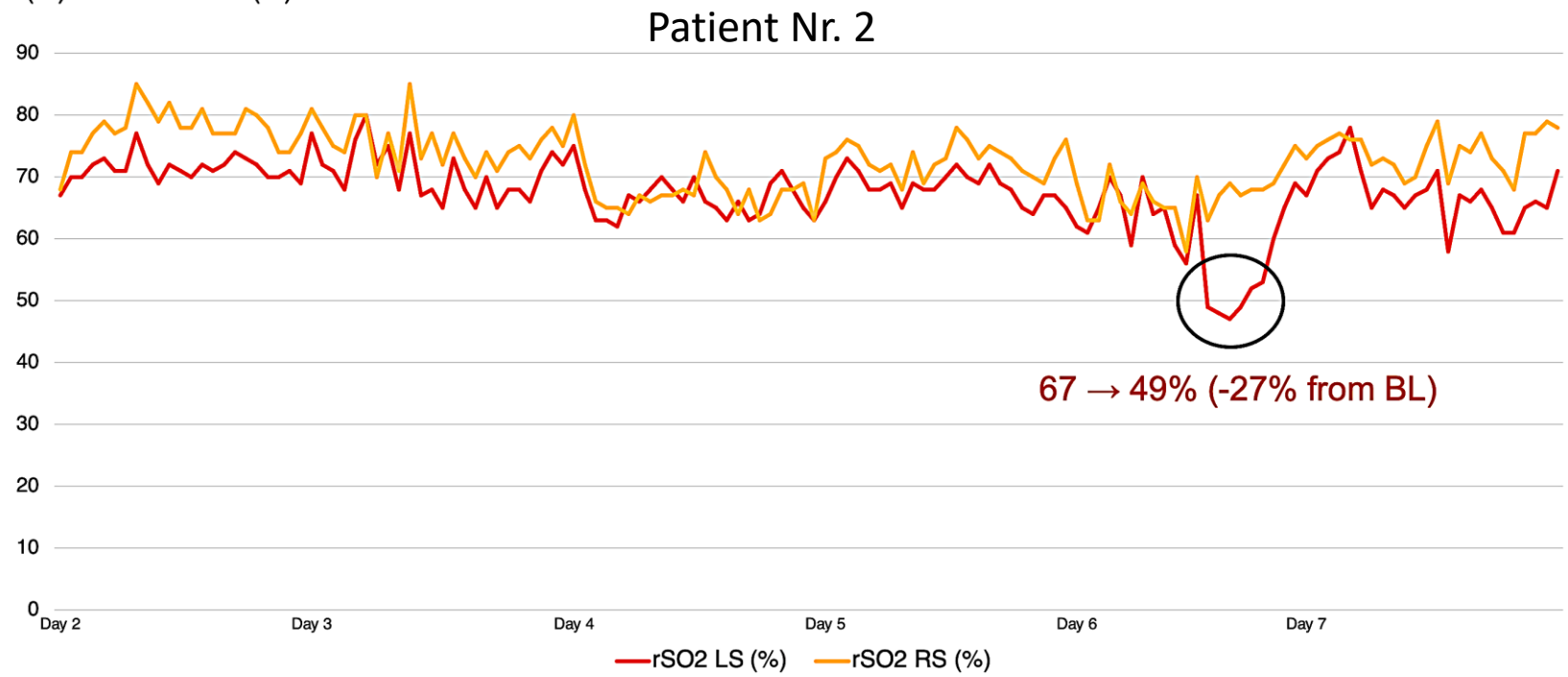


Discussion: NIRS has been described as a good toll for real-time detection of cerebral ischemia [1]. Our results show that NIRS helped early detect cerebral deterioration in 3 out of 5 aSAH patients who experienced complications during the monitoring period. Therefore, we encourage to use NIRS for aSAH patients as additional tool in detection of early cerebral deterioration [2].

Learning points: Our first experience shows that NIRS seems to be promising method for early detection of cerebral deterioration using together with clinical course in aSAH patients.

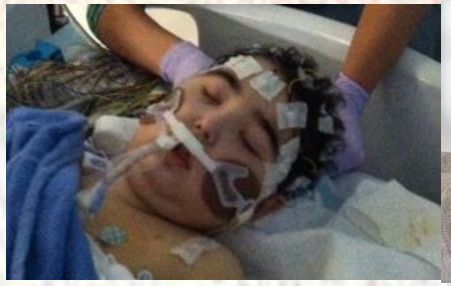
1. Jeong Jin Park, Chulho Kim, Jin Pyeong Jeon. Monitoring of Delayed Cerebral Ischemia in Patients with Subarachnoid Hemorrhage via Near-Infrared Spectroscopy. J Clin Med. 2020 May 24; 9(5): 1595. DOI: 10.3390/jcm9051595.
2. Andrey Khozhenko, Massimo Lamperti, Sergio Terracina, Federico Bilotta. Can Cerebral Near-infrared Spectroscopy Predict Cerebral Ischemic Events in Neurosurgical Patients? A Narrative Review of the Literature. J Neurosurg Anesthesiol. 2019 Oct; 31 (4): 378-384. DOI: 10.1097/ANA.0000000000000522.





EJA. 2022 June. Volume 39 (e-Supplement 60):185.

CONTINUOUS ELECTROENCEPHALOGRAPHY (EEG)



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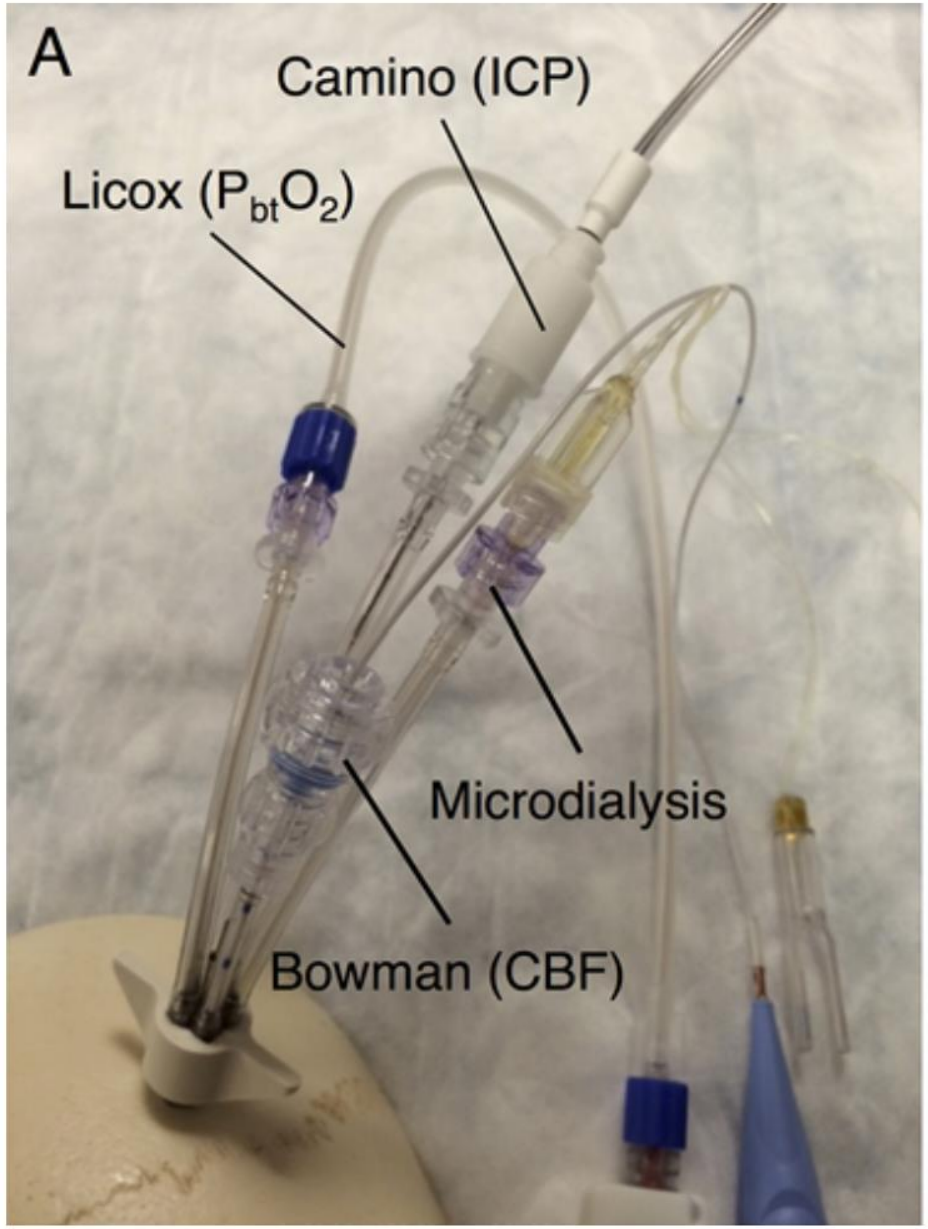
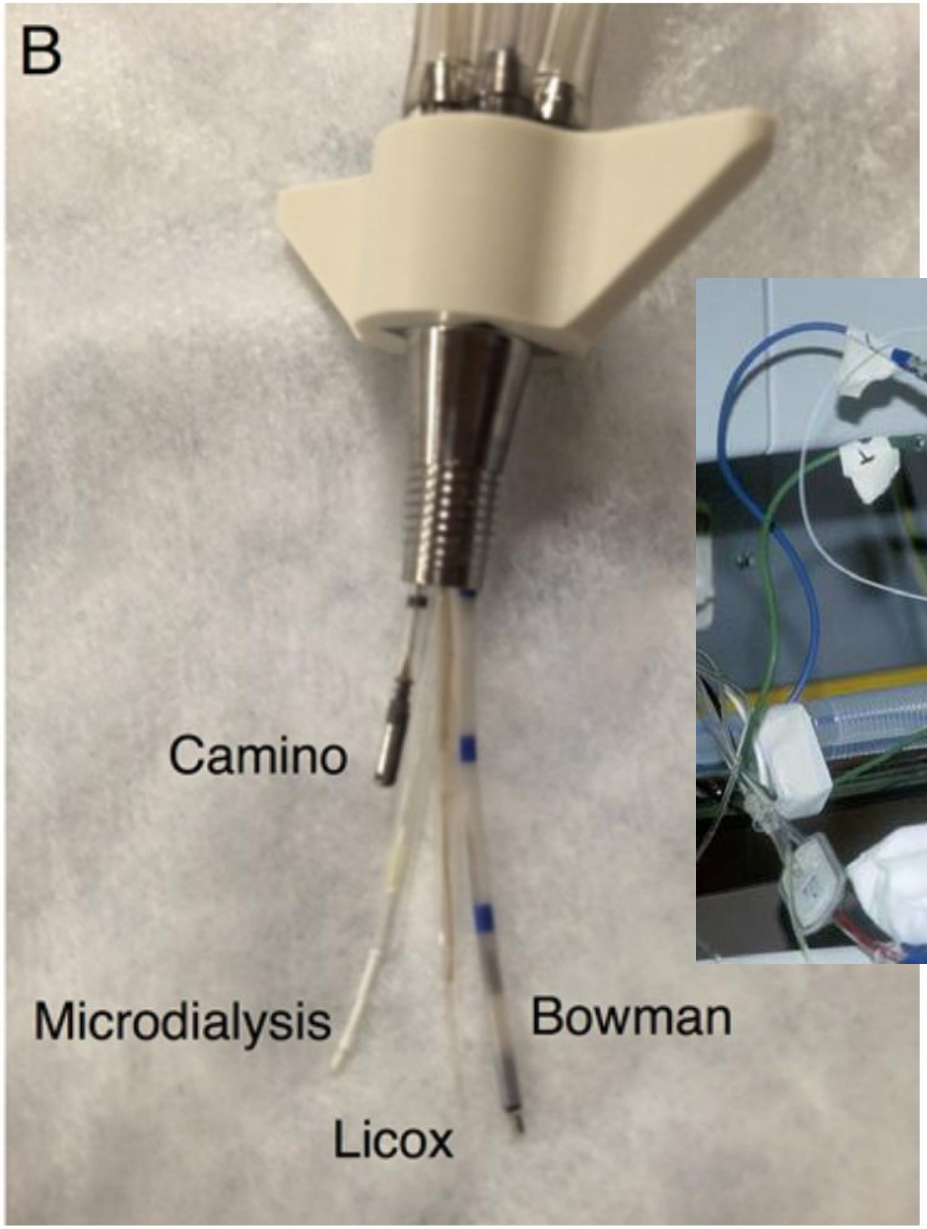
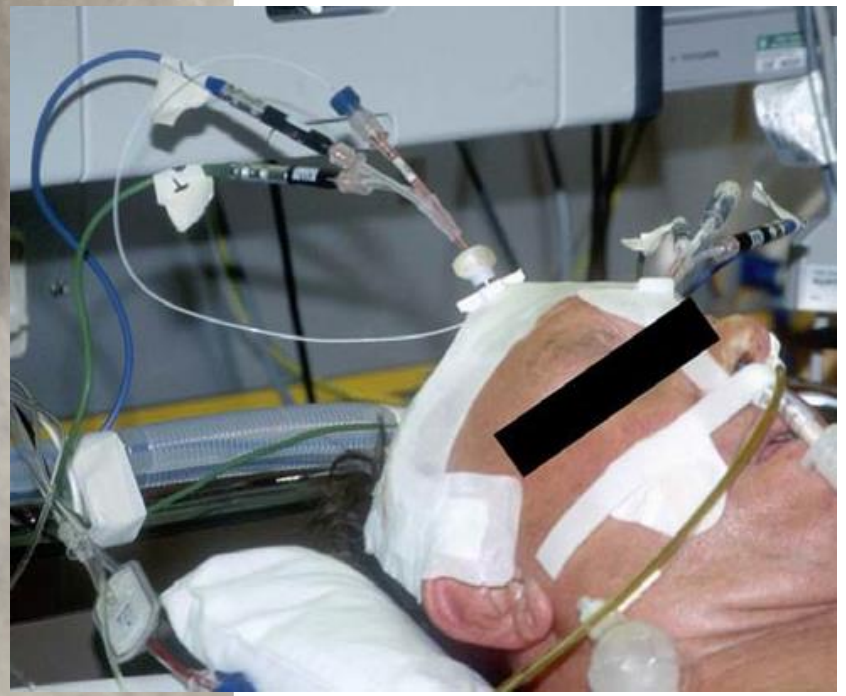
- Non-invasive
- Continuous real-time monitoring
- ***cEEG changes*** (epileptiform abnormalities, alpha variability, poststimulation alpha/delta ratio 4-6) ***appear prior DCI***
- Collaboration with neurophysiologists required

Neurology. 2022 Feb 1; 98(5): e459-e469.
Neurosurg Focus 52 (3):E3, 2022.

INVASIVE METHODS



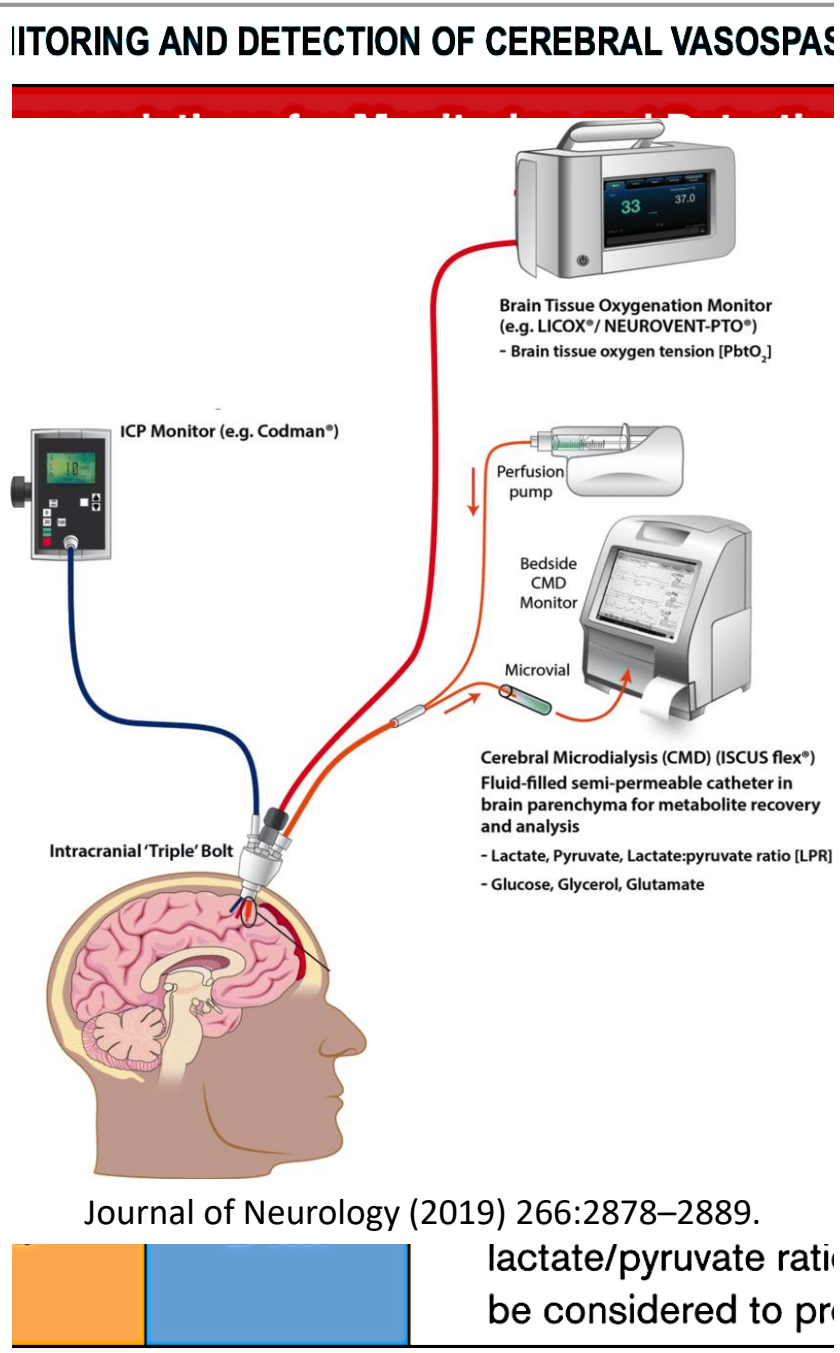




Neurosurg Focus 43 (5):E4, 2017.

Brain Tissue Oxygenation

- Continuous bedside monitoring
- Probe placement can cause local tissue injury
- Provides information about a small region of the brain



Microdialysis Monitoring

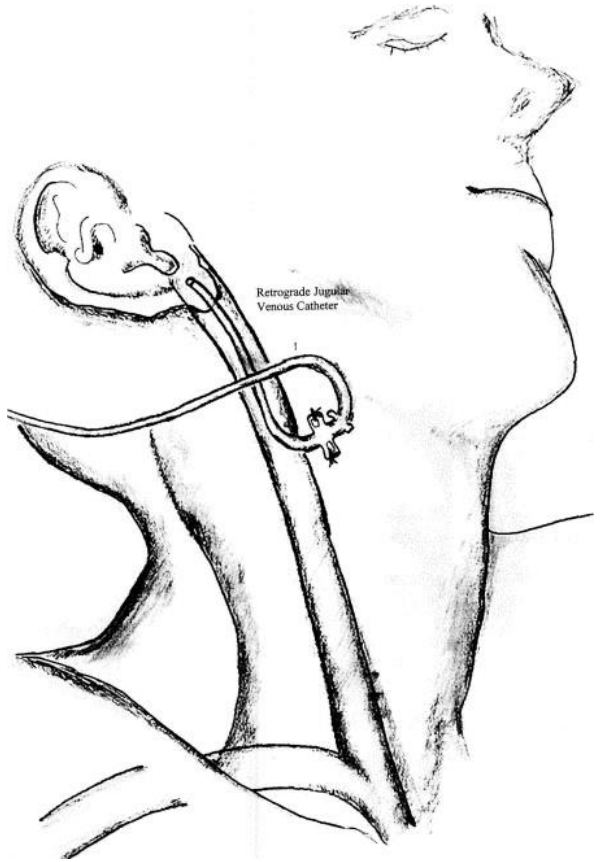
- Continuous bedside monitoring
- Low sampling rates (1 per hour)
- Probe placement can cause local tissue injury
- Provides information about a small region of the brain
- ***Glutamate and lactate level changes*** may predict ischemia ***24 hours beforehand***;
- ***Glycerol*** level ***increases 12 hours before*** clinical ischemia.

THERMAL DIFFUSION FLOWMETRY

+ Measures real-time cerebral blood flow
+ Continuous bedside monitoring

– Frequent calibration is required (every 30 min.)
– Provides information about a small region of the brain
– Probe placement can cause local tissue injury

JUGULAR BULB OXIMETRY



+ Safe and easy to perform
+ **Increase in cerebral oxygen extraction** (SaO_2 - $SjvO_2$) predicts CV **hours to days before** onset of symptoms

− Highly sensitive to catheter position
− Reflects global cerebral oxygen supply and demands balance and may miss smaller regional changes

Healthcare **2021**, *9*(9), 1104.

CONCLUSIONS

- CV is still difficult to recognise at early stages.
- No ideal method exists.
- Brain multimodality monitoring allows detection of physiological changes at an early stage and increases the predictive power.
- Non-invasive vs. invasive monitoring methods?
- Methods in intensivists hands (point-of-care TCD)
- New technologies…?

THANK YOU FOR YOUR ATTENTION!