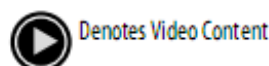


Neurocritical Care



Denotes Video Content

Guest Editor: Alejandro A. Rabinstein, MD, FAAN

Editor's Preface	1261
-----------------------------------	-------------

REVIEW ARTICLES

Diagnosis and Management of Subarachnoid Hemorrhage	1263
--	-------------

Jose I. Suarez, MD, FNCS, FANA

Diagnosis and Management of Spontaneous Intracerebral Hemorrhage . . .	1288
---	-------------

Andrew M. Naidech, MD, MSPH, FANA

Management of Intracranial Pressure	1299
--	-------------

W. David Freeman, MD, FSNS, FAAN

Acute Neuromuscular Respiratory Failure	1324
--	-------------

Alejandro A. Rabinstein, MD, FAAN

Management of Hemispheric Infarction and Ischemic Swelling	1346
---	-------------

Kevin N. Sheth, MD, FAHA, FCCM, FNCS, FAAN, FANA

Status Epilepticus	1362
-------------------------------------	-------------

Sara E. Hocker, MD

Cardiac Arrest and Postanoxic Encephalopathy	1384
---	-------------

David M. Greer, MD, MA, FCCM, FAHA, FNCS, FAAN, FANA

Evaluating the Potential for Recovery of Consciousness in the Intensive Care Unit.	1397
---	-------------

G. Bryan Young, MD, FRCPC; Adrian M. Owen, PhD

Determining Brain Death	1411
--	-------------

Eelco F. M. Wijdicks, MD, PhD, FAAN

Complications of Neurosurgery	1425
--	-------------

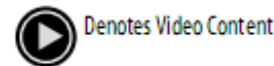
Jennifer E. Fugate, DO

ETHICAL PERSPECTIVES

Ethical Aspects of Organ Donation After Circulatory Death	1445
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Erik K. St. Louis, MD, FAAN; Richard R. Sharp, PhD

Neurocritical Care



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Editor's Preface 1261

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Diagnosis and Management of Subarachnoid Hemorrhage 1263

Jose I. Suarez, MD, FNCS, FANA

Diagnosis and Management of Spontaneous Intracerebral Hemorrhage . . . 1288

Andrew M. Naidech, MD, MSPH, FANA

Management of Intracranial Pressure 1299

W. David Freeman, MD, FSNS, FAAN

Acute Neuromuscular Respiratory Failure 1324

Alejandro A. Rabinstein, MD, FAAN

Management of Hemispheric Infarction and Ischemic Swelling 1346

Kevin N. Sheth, MD, FAHA, FCCM, FNCS, FAAN, FANA

~~**Status Epilepticus 1362**~~

~~Sara E. Hocker, MD~~

Cardiac Arrest and Postanoxic Encephalopathy 1384

David M. Greer, MD, MA, FCCM, FAHA, FNCS, FAAN, FANA

**Evaluating the Potential for Recovery of Consciousness
in the Intensive Care Unit. 1397**

G. Bryan Young, MD, FRCPC; Adrian M. Owen, PhD

~~**Determining Brain Death 1411**~~

~~Eelco F. M. Wijdicks, MD, PhD, FAAN~~

Complications of Neurosurgery 1425

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ETHICAL PERSPECTIVES

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ÚSTŘEDNÍ VOJENSKÁ NEMOCNICE –
VOJENSKÁ FAKULTNÍ NEMOCNICE PRAHA
1. LÉKAŘSKÁ FAKULTA UNIVERZITY KARLOVY V PRAZE
ÚSTAV KLINICKÝCH NEUROBORŮ
NEUROCHIRURGICKÁ A NEUROONKOLOGICKÁ KLINIKA
prof. MUDr. David Netuka, Ph. D.
přednosta



Kuncův memoriál 2025

26. června od 15 hodin

Novotného lávka 201/1, Praha 1 – Staré Město

Program

15:00 – 15:20

Úvod

15:00 – 15:05

D. Netuka

15:05 – 15:10

M. Vokurka

15:10 – 15:15

V. Masopust

15:15 – 15:20

M. Sameš

15:20 – 16:00

Zvaná přednáška

prof. PhDr. Martin Kovář, Ph.D.: Trumpova Amerika a/versus Evropa

16:30 – 17:30

16:30 – 16:40

16:40 – 16:50

16:50 – 17:00

17:00 – 17:15

17:15 – 17:30

Odborné přednášky

D. Netuka: ÚKN

D. Netuka: Klinická randomizovaná studie v časopise s IF 93,7

R. Voldřich: Léčba intraneurálních peroneálních gangliových cyst

R. Kučera: Komplexní spinální program?

M. Májovský: AI a denní praxe

17:30 – 18:10

17:30 – 17:40

17:40 – 17:50

17:50 – 18:00

18:00 – 18:10

Kazuistiky

J. Kašík: Spinální případ

M. May: Kraniální případ

T. Moravec: Bolestivý případ

M. Černý: Elektrofyziologický případ

Ich management

AHA: Guidelines for the Management of Spontaneous Intracerebral Hemorrhage, Stroke 2010

- Konzervativní terapie:
 - ICH $<10\text{cm}^3$, nebo min. neurol. deficit
 - GCS <5 (mozečková ICH?)
- Chirurgie:
 - mozečková ICH $>3\text{cm}$, zhoršující se deficit, komprese kmene, nebo hydrocefalus
 - lobární ICH + mladý pacient + zhoršující se neurol. deficit
- Nejasné:
 - všechna ostatní ICH



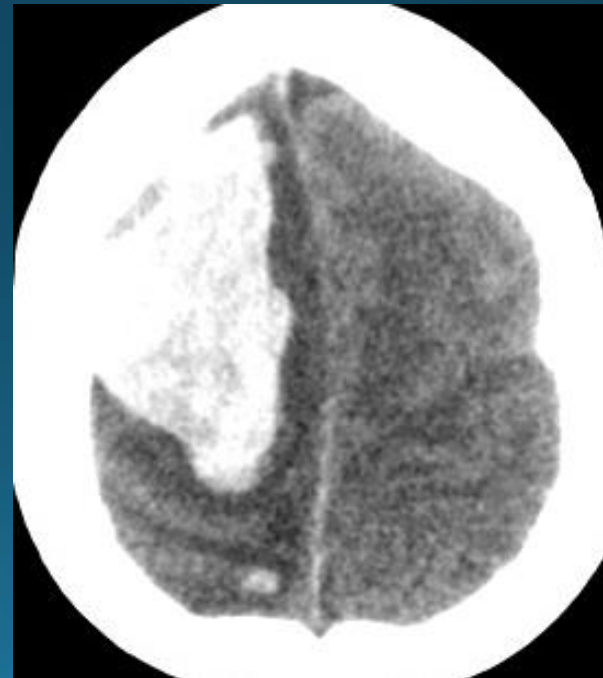
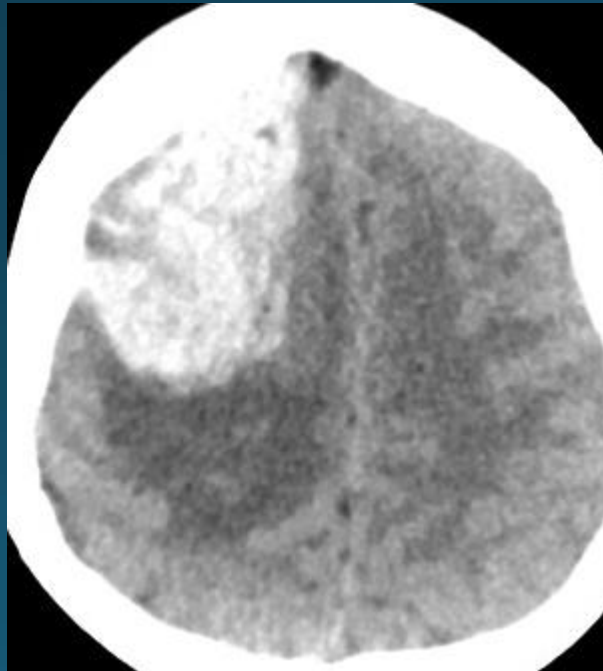
Recommendations

1. For most patients with ICH, the usefulness of surgery is uncertain (*Class IIb; Level of Evidence: C*). (New recommendation) Specific exceptions to this recommendation follow
2. Patients with cerebellar hemorrhage who are deteriorating neurologically or who have brainstem compression

and/or hydrocephalus from ventricular obstruction should undergo surgical removal of the hemorrhage as soon as possible (*Class I; Level of Evidence: B*). (Revised from the previous guideline) Initial treatment of these patients with ventricular drainage alone rather than surgical evacuation is not recommended (*Class III; Level of Evidence: C*). (New recommendation)

3. For patients presenting with lobar clots >30 mL and within 1 cm of the surface, evacuation of supratentorial ICH by standard craniotomy might be considered (*Class IIb; Level of Evidence: B*). (Revised from the previous guideline)

- Koagulace + možnost rychlosti úpravy koagulopatie



Progrese hematomu + otoku



Early surgery versus initial conservative treatment in patients with spontaneous supratentorial lobar intracerebral haematomas (STICH II): a randomised trial

A David Mendelow, Barbara A Gregson, Elise N Rowan, Gordon D Murray, Anil Gholkar, Patrick M Mitchell, for the STICH II Investigators

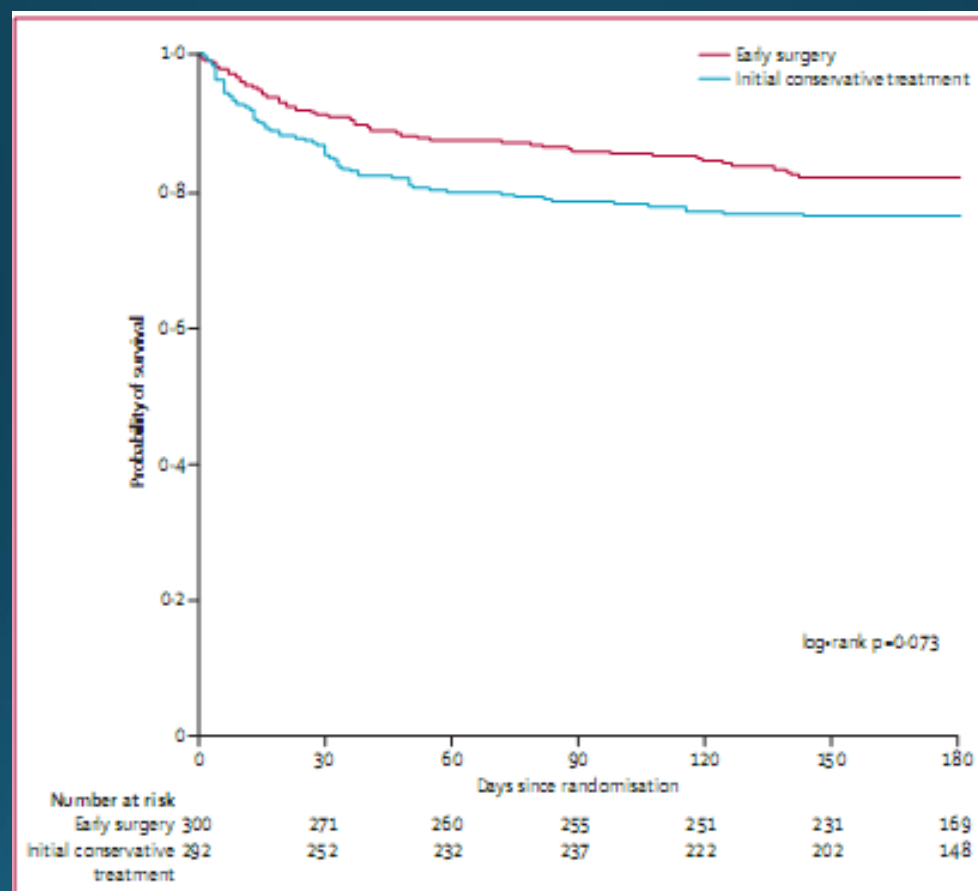
Summary

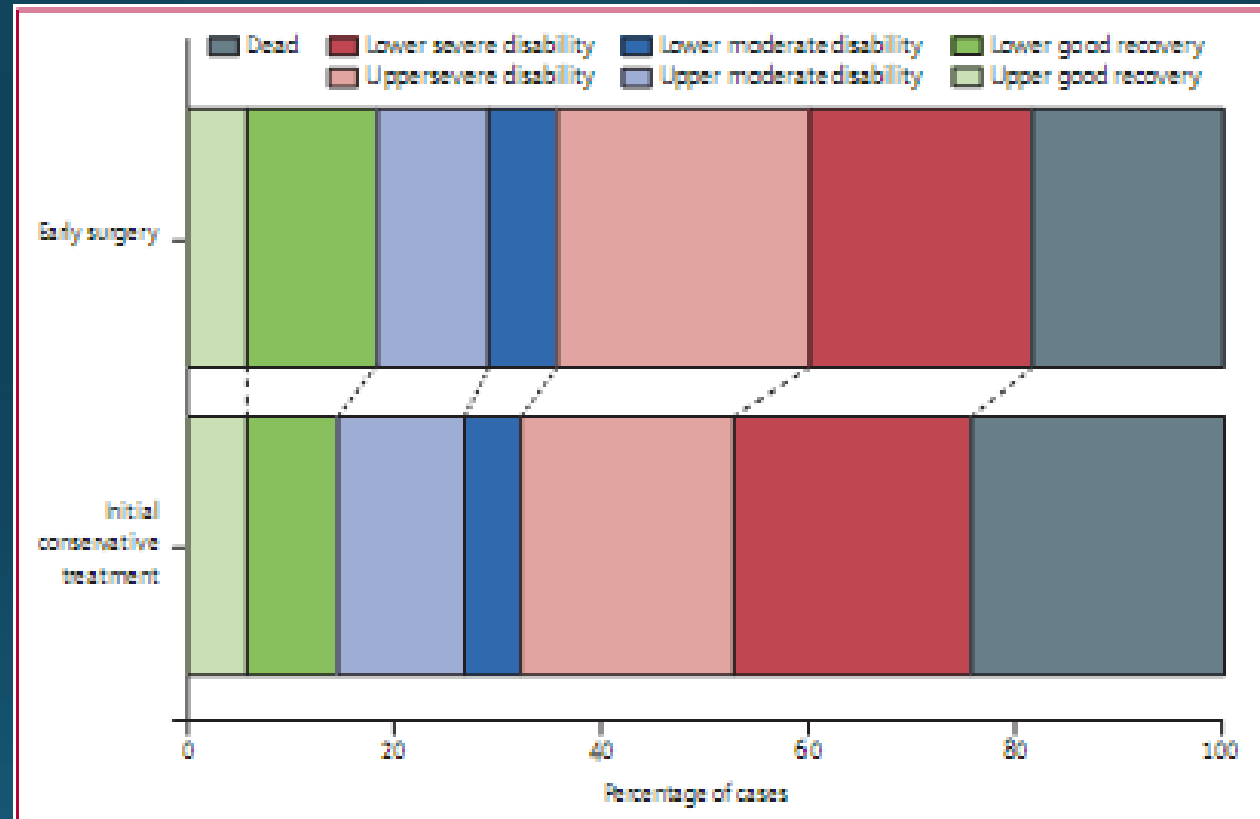
Background The balance of risk and benefit from early neurosurgical intervention for conscious patients with superficial lobar intracerebral haemorrhage of 10–100 mL and no intraventricular haemorrhage admitted within 48 h of ictus is unclear. We therefore tested the hypothesis that early surgery compared with initial conservative treatment could improve outcome in these patients.

Methods In this international, parallel-group trial undertaken in 78 centres in 27 countries, we compared early surgical haematoma evacuation within 12 h of randomisation plus medical treatment with initial medical treatment alone (later evacuation was allowed if judged necessary). An automatic telephone and internet-based randomisation service was used to assign patients to surgery and initial conservative treatment in a 1:1 ratio. The trial was not masked. The primary outcome was a prognosis-based dichotomised (favourable or unfavourable) outcome of the 8 point Extended Glasgow Outcome Scale (GOSE) obtained by questionnaires posted to patients at 6 months. Analysis was by intention to treat. This trial is registered, number ISRCTN22153967.

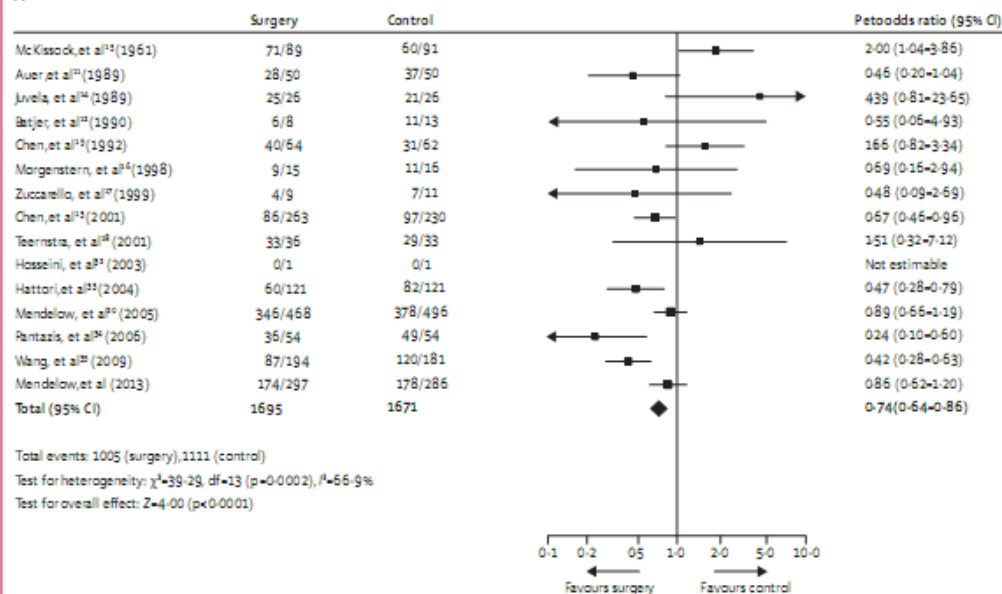
Findings 307 of 601 patients were randomly assigned to early surgery and 294 to initial conservative treatment; 298 and 291 were followed up at 6 months, respectively; and 297 and 286 were included in the analysis, respectively. 174 (59%) of 297 patients in the early surgery group had an unfavourable outcome versus 178 (62%) of 286 patients in the initial conservative treatment group (absolute difference 3·7% [95% CI –4·3 to 11·6], odds ratio 0·86 [0·62 to 1·20]; $p=0·367$).

Interpretation The STICH II results confirm that early surgery does not increase the rate of death or disability at 6 months and might have a small but clinically relevant survival advantage for patients with spontaneous superficial intracerebral haemorrhage without intraventricular haemorrhage.

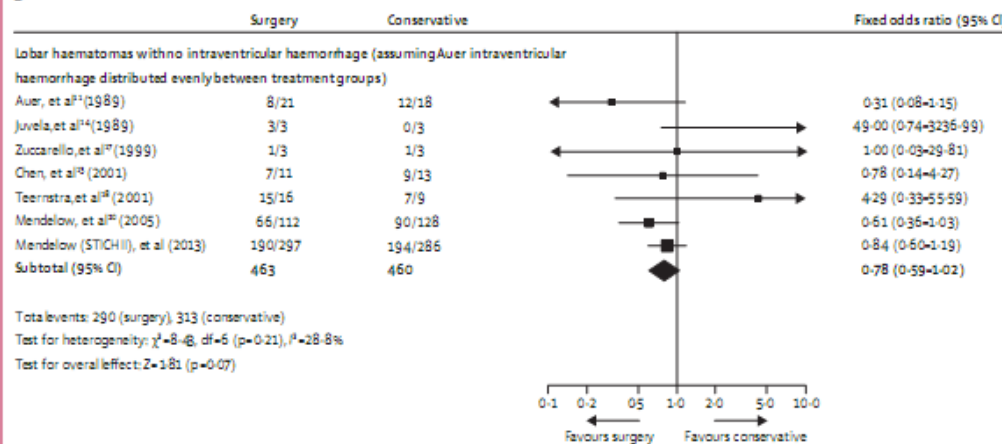




A



B





**1. LÉKAŘSKÁ
FAKULTA**
Univerzita Karlova



ÚVN
ÚSTŘEDNÍ VOJENSKÁ NEMOCNICE
Vojenská fakultní nemocnice Praha

ICH v 2024: KONEČNĚ ČAS NA ZMĚNU?

Department of Neurosurgery and Neurooncology
1st Medical Faculty, Charles University
Central Military Hospital
Prague, Czech Republic

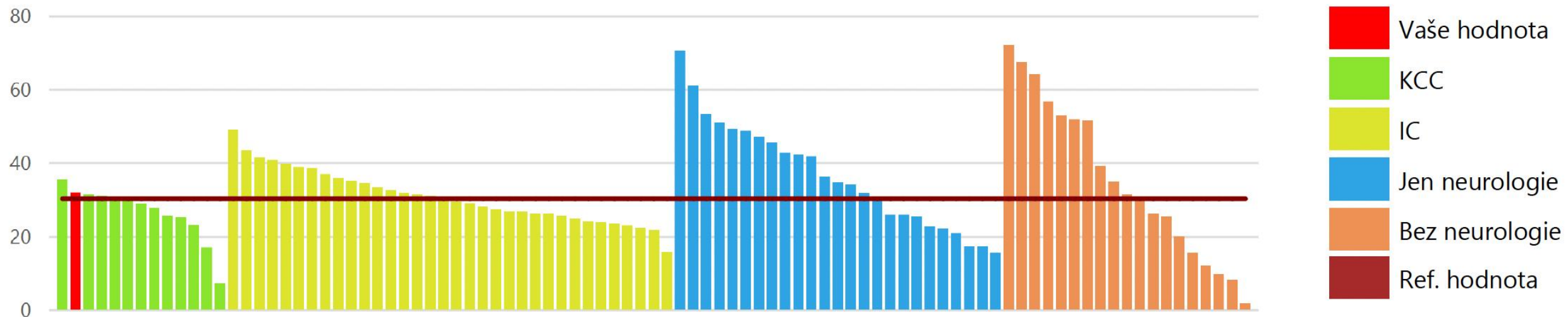
Hodnoty pro ÚVN-Vojenská fakultní nemocnice Praha:

Hlavní diagnóza	Standardizovaná 5denní mortalita	Standardizovaná 30denní mortalita	Standardizovaná 90denní mortalita
I60	6,63%	11,26%	17,09%
I61	18,57%	26,39%	38,77%
I63	7,30%	12,83%	16,84%
G45	0,00%	0,00%	5,38%
Celkem	9,45%	15,22%	21,51%

Referenční hodnoty ČR:

Hlavní diagnóza	Standardizovaná 5denní mortalita	Standardizovaná 30denní mortalita	Standardizovaná 90denní mortalita
I60	10,66%	16,88%	19,15%
I61	24,93%	37,49%	45,14%
I63	5,11%	12,66%	18,14%
G45	0,14%	0,80%	2,33%
Celkem	6,23%	12,98%	17,90%

Průměrný počet dnů strávených doma při I61 v roce 2022



2000

mozek		15	12	2	24	6	25	34	22	7	21	27	13	3	15	1	4	231
mozeček		14	5	3	6		9	7	3	1	1	1	6	3			1	60

2010

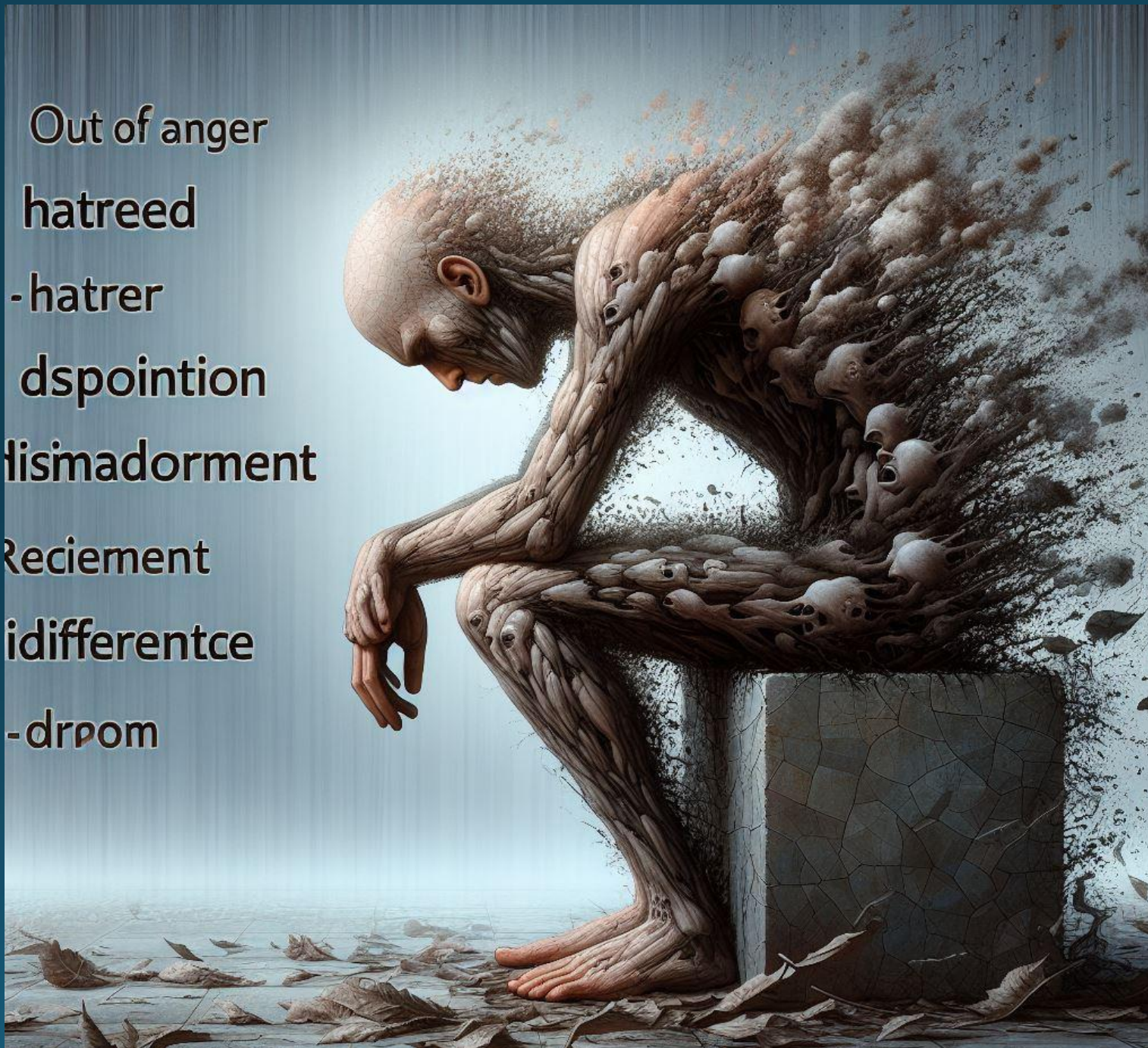
mozek		25	13	17	17	5	9	16	26	9	1	44	15	14	9	16	1	4	241
mozeček		4	12	4	4	3	5	4	9	3	2	4	5	3	11	9		5	87

2022

mozek		24	18	15	16	6	8	14	7	4	3	6	5	1	5	17		12	161
mozeček		5	4	6	4	1	1	19	4	1	2	8	6	2	2	7		10	82

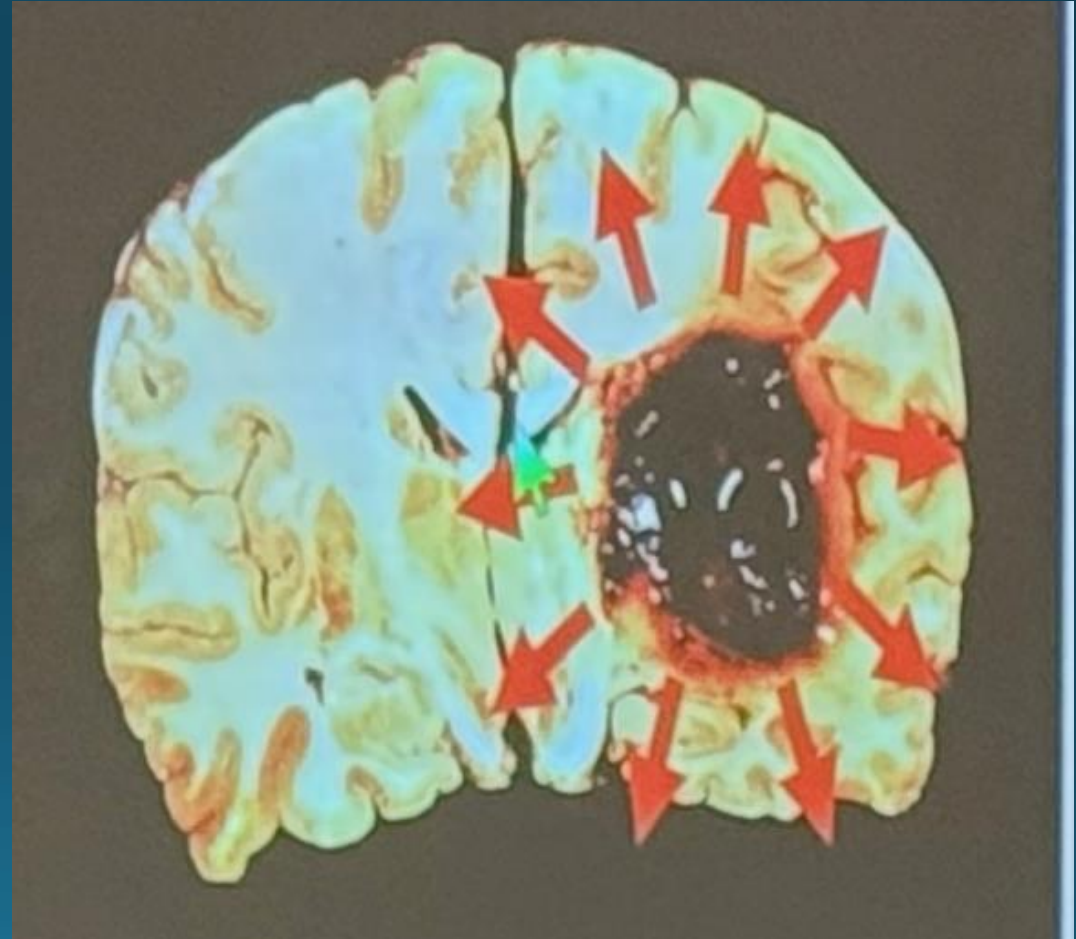


Out of anger
hatred
- hatred
disappointment
disappointment
Rejection
indifference
- dream



Proč operovat ICH???

1. ICP
2. Progrese ICH
3. Sekundární zánět



The NEW ENGLAND JOURNAL *of* MEDICINE

ORIGINAL ARTICLE

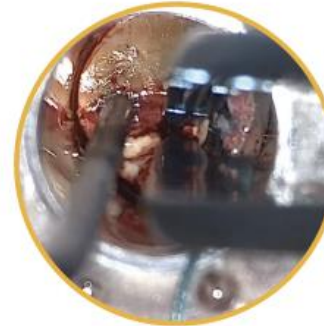
Trial of Early Minimally Invasive Removal of Intracerebral Hemorrhage

G. Pradilla, J.J. Ratcliff, A.J. Hall, B.R. Saville, J.W. Allen, G. Paulon, A. McGlothlin, R.J. Lewis, M. Fitzgerald, A.F. Caveney, X.T. Li, M. Bain, J. Gomes, B. Jankowitz, G. Zenonos, B.J. Molyneaux, J. Davies, A. Siddiqui, M.R. Chicoine, S.G. Keyrouz, J.A. Grossberg, M.V. Shah, R. Singh, B.N. Bohnstedt, M. Frankel, D.W. Wright, and D.L. Barrow, for the ENRICH trial investigators*

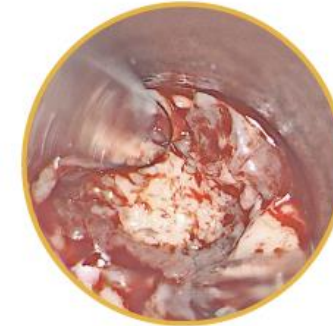
ABSTRACT

NICO BRAINPATH®

BrainPath has an atraumatic tip designed to minimize tissue disruption during advancement to the surgical site. The BrainPath family of products includes 13.5mm and 11mm diameter devices in a variety of lengths to address multiple surgical needs.



BrainPath allows for bi-manual and micro-surgical techniques to manage bleeding.

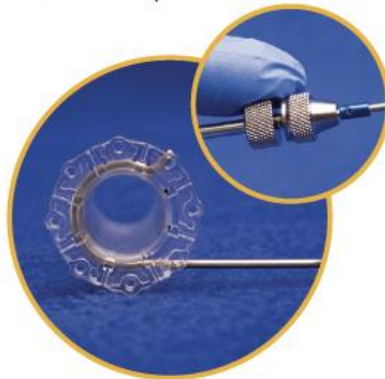


BrainPath allows surgeons to easily maintain access to the surgical site.

NICO TOOLS for ACCESS

Select-Lock Shepherd's Hook®

Stabilizes the sheath with the ability to lock it into place.



MeniGLIDE®

Safely opens the meninges with surgeon control while protecting collateral tissue.



SecureHOLD Retractors®

Retracts and retains the skin with a low-profile, wide-hook design.



Navigation Probe Adapter*

Enables navigation without having to pin the patient, creating the potential for less equipment and less set-up time in the OR.



*2021 release

PRINCIPLES OF THE BRAINPATH APPROACH™

Referenced from Multi-Center & Single Center Studies

Minimizing Injury to Tissue¹

- Integrates with Navigation to Improve Trajectory Planning²
- Parafascicular Approach to Minimize Shear Forces applied to Primary White Matter Tracts³
- Trans-Sulcal Corridors to preserve normal tissue to access lesion⁴

Direct Visualization to Manage Hemostasis¹

- Air Medium & Utilization of Bi-Manual Technique

Maximize Resection of Clot⁵

- Protects Healthy Tissue Behind and Below Aspirator
- Direct Visualization of Resection
- Ability to Resect Cross-Linked or Suction Liquefied Clot



^{1,2,3} Balles, et al. Minimally Invasive Transsulcal Resection of Intraventricular and Periventricular Lesions through a Tubular Retractor System: Multicentric Experience and Results. World Neurosurgery; 2016

⁴ Bain, et al. Initial Single Center Technical Experience with the BrainPath System for Acute Intracerebral Hemorrhage Evacuation. Operative Neurosurgery 0:1-7, 2016

Narrower Corridor “open”

11ga 11x13 Myriad Handpiece



13ga 13x13 Myriad Handpiece



For Educational Purposes ONLY

Trans-Sulcal Endoport-Assisted Evacuation of Supratentorial Intracerebral Hemorrhage: Initial Single-Institution Experience Compared to Matched Medically Managed Patients and Effect on 30-day Mortality

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Nabiha F. Quadri, BS

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Congress of Neurological Surgeons

BACKGROUND: The surgical management of supratentorial intracerebral hemorrhages (ICH) remains controversial due to large trials failing to show clear benefits. Several minimally invasive techniques have emerged as an alternative to a conventional craniotomy with promising results.

OBJECTIVE: To report our experience with endoport-assisted surgery in the evacuation of supratentorial ICH and its effects on outcome compared to matched medical controls.

METHODS: Retrospective data were gathered of patients who underwent endoport-assisted evacuation between January 2014 and October 2016 by a single surgeon. Patients who were managed medically during the same period were matched to the surgical cohort. Previously published cohorts investigating the same technique were analyzed against the present cohort.

RESULTS: Sixteen patients were identified and matched to 16 patients treated medically. Location, hemorrhage volume, and initial Glasgow Coma Scale (GCS) score did not differ significantly between the 2 cohorts. The mean volume reduction in the surgical cohort was 92.05% ± 7.05%. The improvement in GCS in the surgical cohort was statistically significant (7-13, $P = .006$). Compared to the medical cohort, endoport-assisted surgery resulted in a statistically significant difference in in-hospital mortality (6.25% vs 75.0%, $P < .001$) and 30-d mortality (6.25% vs 81.25%, $P < .001$). Compared to previously published cohorts, the present cohort had lower median preoperative GCS (7 vs 10, $P = .02$), but postoperative GCS did not differ significantly (13 vs 14, $P = .28$).

CONCLUSION: Endoport-assisted surgery is associated with high clot evacuation and decreases 30-d mortality compared to a similar medical group.

KEY WORDS: Intracerebral hemorrhage, Endoport, BrainPath, Minimally invasive clot evacuation, Stroke

Operative Neurosurgery 62: 18, 2017

DOI: 10.1226/00006123-1706100-00018

Spontaneous intracerebral hemorrhages (ICH) are among the deadliest and most morbid type of stroke. Only 38% of affected patients survive the first year after

the ictus, most with significant morbidity.¹ Despite multiple treatment attempts, outcomes remain very poor. Surgical decompression with or without evacuation of the hematoma has been attempted without significant difference in mortality and morbidity. Data from the first surgery vs initial conservative treatment in patients with ICH trial (Surgical Trial in Intracerebral Hemorrhage, STICH) suggested that supratentorial ICH patients do better if managed conservatively.² Given poor outcomes with conventional surgical approaches, minimally invasive surgery (MIS)

ABBREVIATIONS: CT, computed tomography; CTA, computed tomography angiography; GCS, Glasgow Coma Scale; ICD, international classification of diseases; ICH, intracerebral hemorrhage; IQR, interquartile range; MIS, minimally invasive surgery; mRS, modified Rankin score; PHE, perihematomal edema; STICH, Surgical Trial in Intracerebral Hemorrhage

ORIGINAL ARTICLE

Trial of Early Minimally Invasive Removal of Intracerebral Hemorrhage

G. Pradilla, J.J. Ratcliff, A.J. Hall, B.R. Saville, J.W. Allen, G. Paulon, A. McGlothlin, R.J. Lewis, M. Fitzgerald, A.F. Caveney, X.T. Li, M. Bain, J. Gomes, B. Jankowitz, G. Zenonos, B.J. Molyneaux, J. Davies, A. Siddiqui, M.R. Chicoine, S.G. Keyrouz, J.A. Grossberg, M.V. Shah, R. Singh, B.N. Bohnstedt, M. Frankel, D.W. Wright, and D.L. Barrow, for the ENRICH trial investigators*

ABSTRACT

RESULTS

A total of 300 patients were enrolled, of whom 30.7% had anterior basal ganglia hemorrhages and 69.3% had lobar hemorrhages. After 175 patients had been enrolled, an adaptation rule was triggered, and only persons with lobar hemorrhages were enrolled. The mean score on the utility-weighted modified Rankin scale at 180 days was 0.458 in the surgery group and 0.374 in the control group (difference, 0.084; 95% Bayesian credible interval, 0.005 to 0.163; posterior probability of superiority of surgery, 0.981). The mean between-group difference was 0.127 (95% Bayesian credible interval, 0.035 to 0.219) among patients with lobar hemorrhages and -0.013 (95% Bayesian credible interval, -0.147 to 0.116) among those with anterior basal ganglia hemorrhages. The percentage of patients who had died by 30 days was 9.3% in the surgery group and 18.0% in the control group. Five patients (3.3%) in the surgery group had postoperative rebleeding and neurologic deterioration.

END POINTS

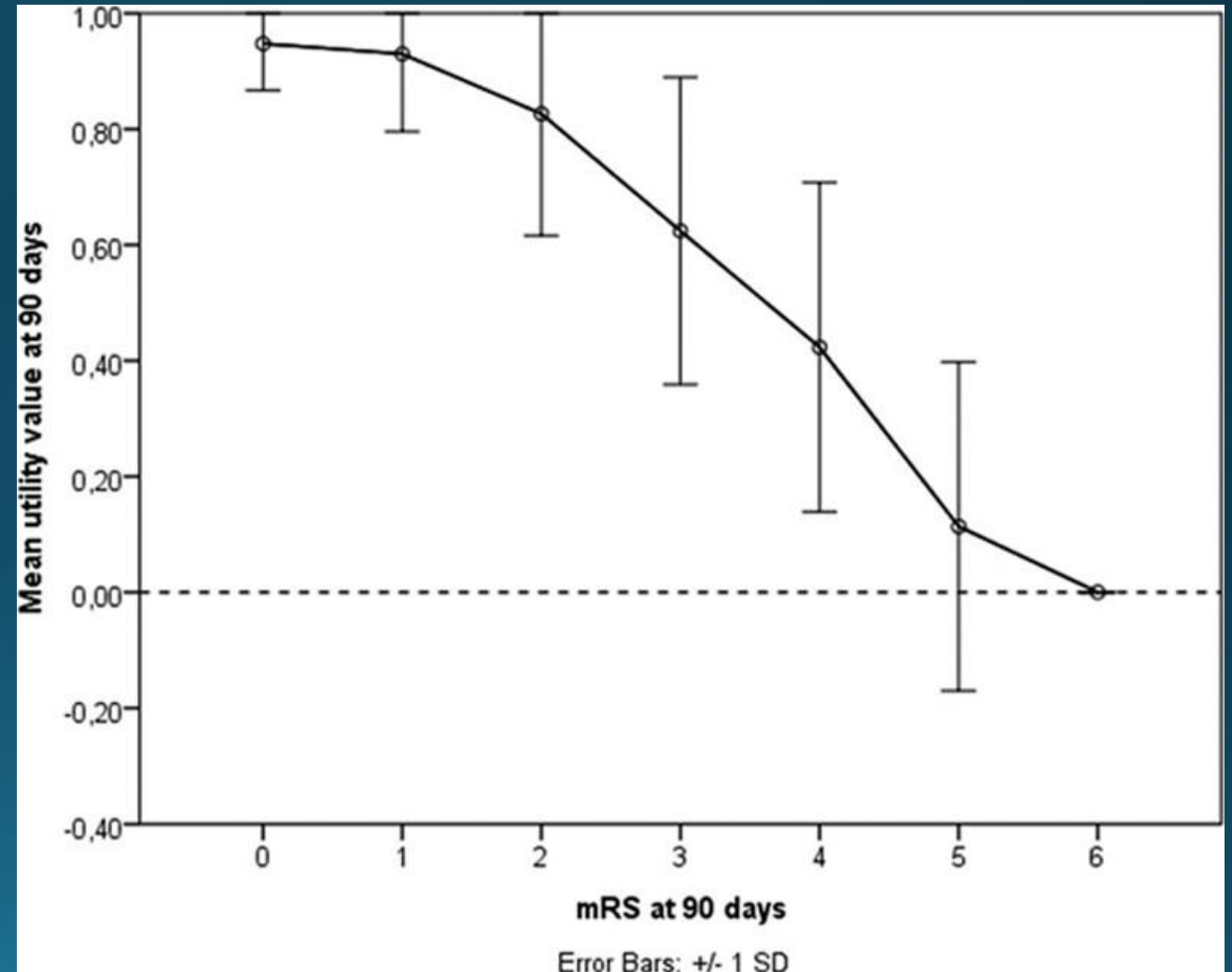
The primary efficacy end point was the score on the utility-weighted modified Rankin scale at 180 days. The modified Rankin scale is a seven-level ordinal scale that ranges from 0 (no symptoms) to 6 (death); we assigned the following utility weights to the seven levels: 1.0, 0.91, 0.76, 0.65, 0.33, 0.0, and 0.0 (with higher scores indicating a better outcome, according to patients' assessment).⁹ These utility weights have been used previously in trials involving ischemic stroke.¹⁴⁻¹⁸

Utility weighted mRS



mRS	UW-mRS
0 (asymptomatic)	1.0
1 (no significant disability)	0.91
2 (slight disability)	0.76
3 (moderate disability)	0.65
4 (moderate-severe disability)	0.33
5 (severe disability)	0
6 (dead)	0

Adopting a Patient-Centered Approach to Primary Outcome Analysis of Acute Stroke Trials Using a Utility-Weighted Modified Rankin Scale.
Chaisinanunkul N, et al. 015 Aug;46(8):2238-43. doi: 10.1161/STROKEAHA.114.008547. Epub 2015 Jul 2. PMID: 26138130



CONCLUSIONS

Among patients in whom surgery could be performed within 24 hours after an acute intracerebral hemorrhage, minimally invasive hematoma evacuation resulted in better functional outcomes at 180 days than those with guideline-based medical management. The effect of surgery appeared to be attributable to intervention for lobar hemorrhages. (Funded by Nico; ENRICH ClinicalTrials.gov number, NCT02880878.)

11,603 Patients were assessed for eligibility

11,303 Were excluded

10,611 Did not meet inclusion criteria or met exclusion criteria

1,259 Were <18 or >80 yr of age

3,618 Had a secondary cause of ICH: hemorrhagic conversion, trauma, ruptured aneurysm, arteriovenous malformation, vascular anomaly, Moyamoya disease, venous sinus thromboses, a mass or tumor, recurrent ICH within 1 yr, or primary thalamic or infratentorial ICH

2,635 Had ICH volume <30 or >80 ml

406 Had intraventricular hemorrhage >50% of either lateral ventricle

474 Were >24 hr from last known normal

821 Had GCS <5 or >14 or NIHSS <5

333 Had score on the modified Rankin scale >1 before the hemorrhage occurred

214 Had do-not-resuscitate or comfort-measures-only order

168 Were unable or declined to give consent

437 Had other exclusion criteria

246 Did not provide a reason

692 With anterior basal ganglia hemorrhage were excluded after adaptation of enrollment criteria

300 Underwent randomization
(adaptation of enrollment criteria occurred after 175 patients were enrolled)

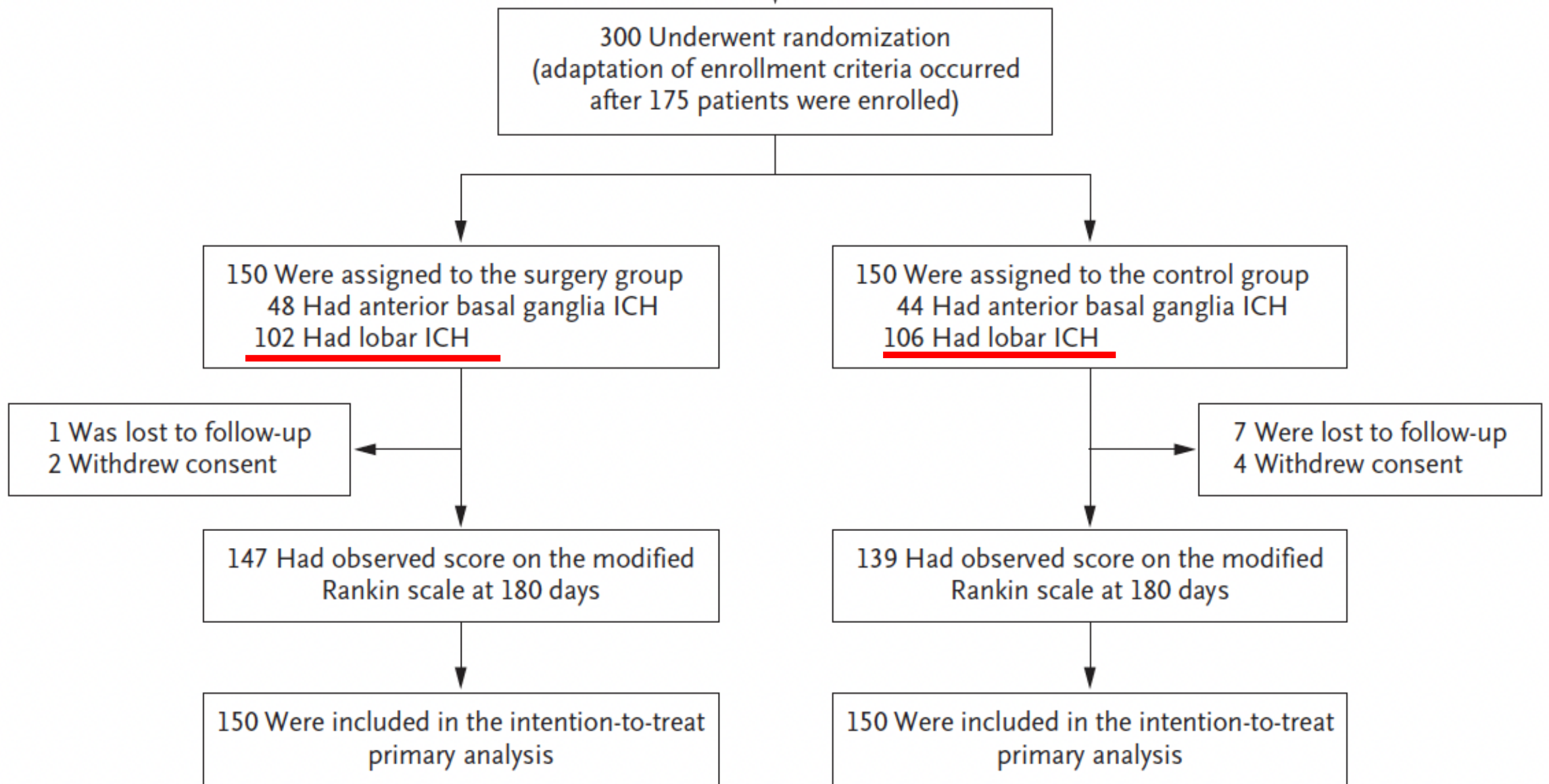


Table 1. Demographic and Clinical Characteristics of the Patients at Baseline.*

Characteristic	Surgery Group (N=150)	Control Group (N=150)
Median age (IQR) — yr	64 (56–72)	62 (51–73)
Female sex — no. (%)	72 (48)	78 (52)
Median score on NIH stroke scale (IQR) [†]	16 (11–22)	18 (13–22)
Score on the Glasgow Coma Scale at randomization — no. (%) [‡]		
4–8	25 (17)	29 (19)
9–14	125 (83)	121 (81)
Median hematoma volume (IQR) — ml [§]	54 (39–72)	55 (40–73)
Intraventricular hemorrhage present — no. (%) [§]	65 (43)	59 (39)
ICH location — no. (%) [¶]		
Anterior basal ganglia	48 (32)	44 (29)
Lobar	102 (68)	106 (71)
Left hemisphere	73 (49)	79 (53)
Median ICH score (IQR)	2 (1–2)	2 (1–2)
Median FUNC score (IQR) ^{**}	8 (6–8)	8 (6–8)
Median APACHE II score (IQR) ^{††}	12 (10–14)	12 (11–14)
Median CCI score (IQR) ^{‡‡}	3 (1–4)	2 (1–4)
Score on modified Rankin scale of ≤1 before ICH occurred — no. (%) ^{§§}	29 (19)	17 (11)
Medical history — no./total no. (%) ^{¶¶}		
Cardiovascular disease	123/150 (82)	117/150 (78)
Central nervous system disease	45/150 (30)	42/150 (28)
Endocrine or renal disorder	42/150 (28)	39/150 (26)
Cigarette smoking, current or former	59/132 (45)	53/132 (40)
Daily alcohol use	38/148 (26)	46/144 (32)
Time from patient last known to be well to randomization		
≤8 hr — no. (%)	42 (28)	38 (25)
≤12 hr — no. (%)	73 (49)	69 (46)
Median (IQR) — hr	12.8 (7.8–18.7)	12.9 (7.5–17.7)

Table 1. (Continued.)

Characteristic	Surgery Group (N = 150)	Control Group (N = 150)
Median time from patient last known to be well to surgery (IQR) — hr	16.75 (10.70–21.25)	NA
Median time from randomization to surgery (IQR) — hr	1.48 (0.97–2.43)	NA

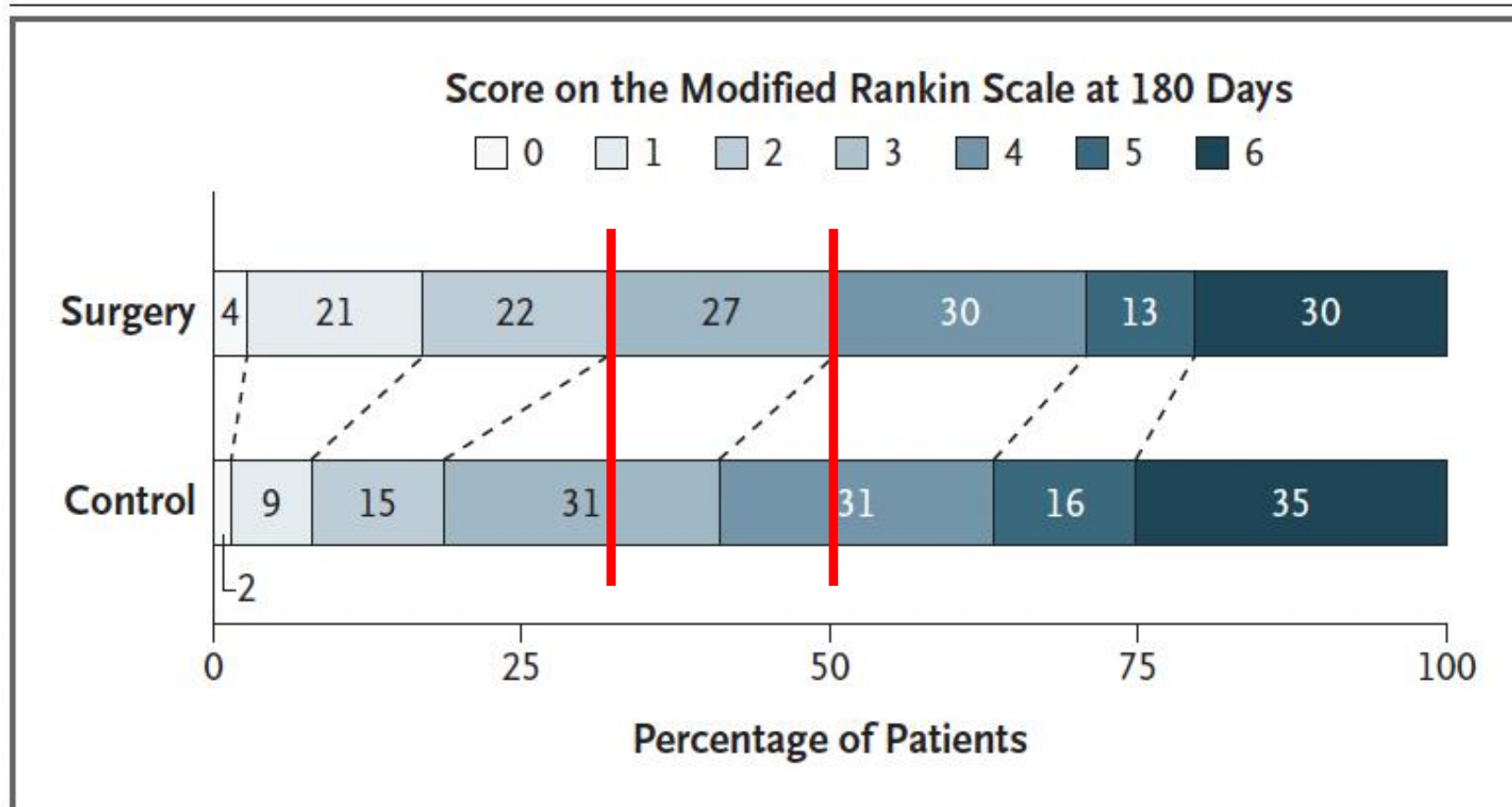


Figure 2. Distribution of Surgery Effect and Observed Scores on the Modified Rankin Scale.

The raw distribution of scores for disability on the observed modified Rankin scale at 180 days is shown according to treatment group. Scores on the modified Rankin scale range from 0 to 6, with a score of 1 or lower indicating no or minimal deficit and 6 indicating death.

Table 2. Efficacy End Points.*

End Point	No. of Patients			Value for Surgery Group	Value for Control Group	Estimated Difference (95% Credible Interval) [†]	Posterior Probability of Superiority [‡]
	Surgery	Control	Total				
Primary end point							
Mean score on the utility-weighted modified Rankin scale at 180 days [§]	147	139	286	0.458	0.374	0.084 (0.005 to 0.163)	0.981
Anterior basal ganglia hemorrhage location	40	47	87	0.340	0.381	−0.013 (−0.147 to 0.116)	
Lobar hemorrhage location	99	100	199	0.513	0.371	0.127 (0.035 to 0.219)	
Secondary end points [¶]							Odds Ratio (95% Credible Interval)
ICU length of stay — days**	141	132	273	6.9±6.8	9.7±7.6	−2.832 (−4.527 to −1.134)	
Hospital length of stay — days**	141	132	273	14.9±11.2	18.1±11.9	−3.125 (−5.903 to −0.393)	
Surgery effect on modified Rankin scale							
At discharge or 7 days ^{††}	148	144	292				0.376 (0.230 to 0.577)
At 30 days	147	146	293				0.504 (0.326 to 0.741)
At 90 days	143	139	282				0.665 (0.437 to 0.970)
At 180 days	147	139	286				0.658 (0.433 to 0.957)
Hematoma reduction after completion of surgery — % ^{‡‡}	147	NA	NA	73.2±37.8	NA		0.871 (0.792 to 0.951)
Hematoma volume after completion of surgery — ml ^{‡‡}	147	NA	NA	14.9±21.7	NA		0.725 (0.604 to 0.845)
Score of ≤3 on modified Rankin scale at 180 days — no. (%) ^{§§}	147	139	286	74 (50.3)	57 (41.0)	9.2 (−2.0 to 20.3)	
Exploratory end points							
Mechanical ventilation** — no. (%)				88 (58.7)	78 (52.0)	6.7 (4.6 to 17.8)	
No. of days receiving mechanical ventilation**	141	132	273	5.3±6.3	8.8±6.6	−3.5 (−5.7 to −1.5)	
Decompressive hemicraniectomy — no. (%)				5 (3.3)	30 (20.0)	−16.6 (−23.9 to −9.9)	
Median hematoma reduction (IQR) — %				87.7 (65.15–96.61)	NA		
Median volume after completion of surgery (IQR) — ml				7.17 (1.95–17.34)	NA		
Volume after completion of surgery ≤15 ml — no. (%)				109 (72.7)	NA		

Table 3. Safety End Points.*

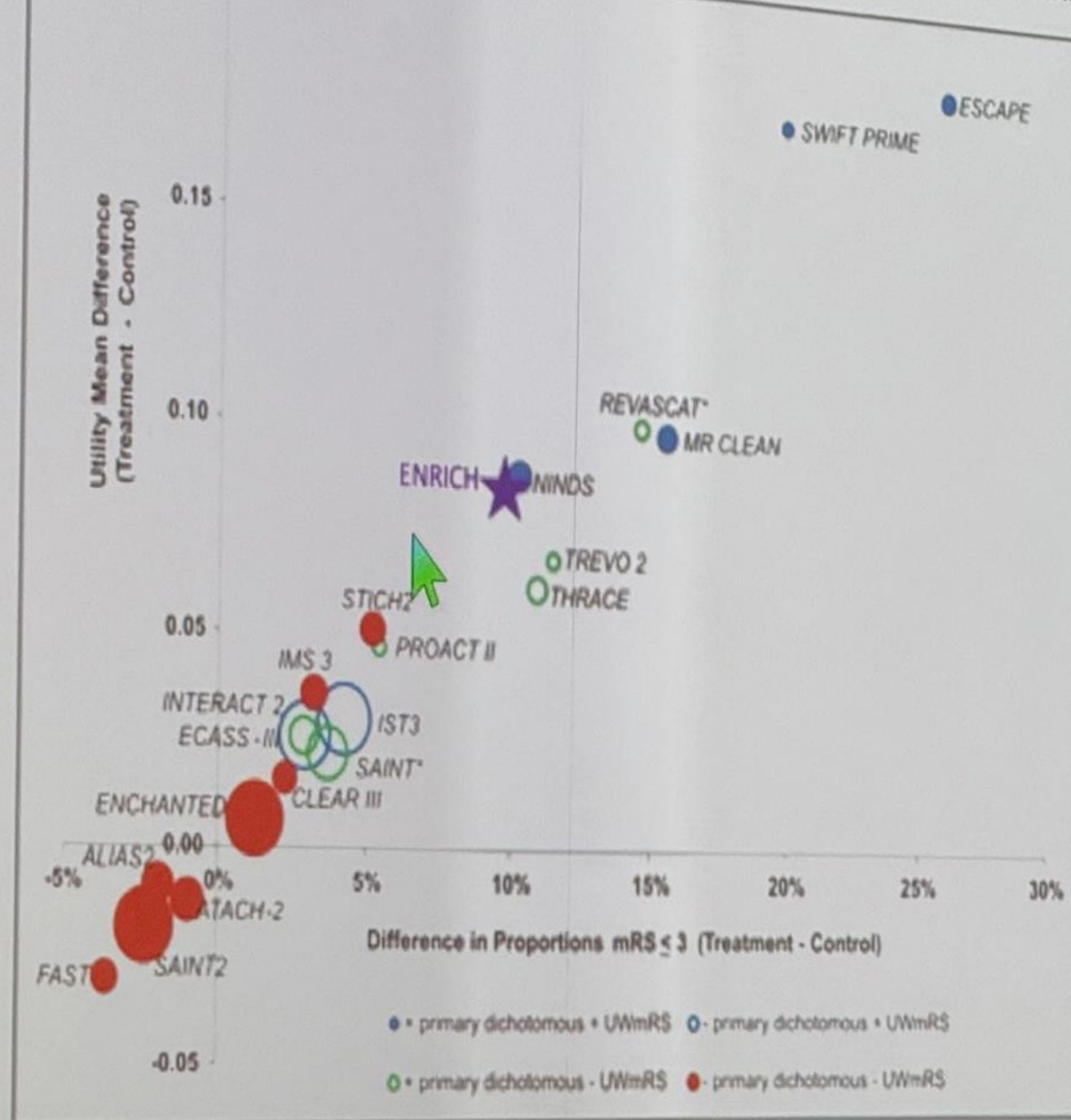
End Point	Surgery Group (N=150)	Control Group (N=150)	Estimated Difference (95% Credible Interval)	Posterior Probability of Superiority
Death by 30 days — no. (%)	14 (9.3)	27 (18.0)	−8.7 (−16.4 to −1.0)	0.987
Postoperative rebleeding associated with neurologic deterioration — no. (%)†	5 (3.3)	NA		NA
Change in hematoma volume — ml‡	−43.9±30.09	4.0±17.82	−47.91 (−53.59 to −42.36)	>0.999
One or more serious adverse events — no. (%)	95 (63.3)	118 (78.7)	−15.3 (−25.4 to −5.2)	0.998
Death in the hospital after randomization — no. (%)	7 (4.7)	19 (12.7)	−8.0 (−14.5 to −1.8)	0.994

* Plus-minus values are means $\pm$ SD. Percentages were compared across treatment groups with the use of a Bayesian beta-binomial model with noninformative prior distributions. Details regarding safety events are provided in Table S12.

† Rebleeding was defined as growth in hematoma volume between the initial CT and follow-up neuroimaging. Neurologic deterioration was defined as an increase of 4 or more points on the NIH stroke scale or a decrease of up to 2 points on the GCS that was not explained by planned medical interventions (e.g., sedatives, analgesics, and procedures).

‡ The absolute change in hematoma volume was calculated as the follow-up neuroimaging volume minus the baseline volume. This was a safety measure (i.e., increase in volume can be an early sign of inadequate surgical procedures). One value was missing in the control group.

In this trial of minimally invasive surgical evacuation of intracerebral hemorrhage of 30 to 80 ml within 24 hours after onset, weighted disability scores were better with surgery plus medical management than with medical management alone. The result was apparently attributable to intervention for lobar supratentorial hemorrhages.



ECONOMIC ANALYSIS PRESENTED AT ISC 2024

A Cost-effectiveness Analysis Of Early Minimally Invasive Removal Of Intracerebral Hemorrhage: Hospital And Societal Perspectives

Janel Hanmer, MD, PhD, Gustavo Pradilla, MD, Jonathan J Ratcliff, MD, Alex Hall, DHSc, MS, RN, Kenneth J Smith, MD, MS
1. University of Pittsburgh, Pittsburgh, PA 2. Emory University, Atlanta, GA



RESULTS

Table 1. Trial-based estimates of per patient total costs, lobar intracerebral hemorrhage, hospital perspective

	Unit cost	MIPS	MM
ICU LOS (days)	\$5,104	6.3	9.1
Total ICU cost		\$32,155	\$46,446
Non-ICU LOS (days)	\$2,883	7.6	6.9
Total non-ICU cost		\$21,911	\$19,893
MIPS OR time (min)	\$41	178	
MIPS OR time cost (total)		\$7,298	
MIPS Surgeon fee		\$1,293	
MIPS device costs		\$5,705	
Total MIPS cost		\$14,296	\$0
Non-MIPS cost/risk	\$9,364	8.0%	23.2%
Total other procedure cost		\$749	\$2,175
Rehospitalization cost/risk	\$14,688	35.0%	58.0%
Total rehospitalization cost		\$5,141	\$8,519

Total initial hospitalization cost (per pt)

Including surgeon fees	\$69,111	\$68,515
Omitting surgeon fees	\$67,653	\$68,035

Total hospitalization costs with readmission cost (per pt)

Including surgeon fees	\$74,252	\$77,034
Omitting surgeon fees	\$72,794	\$76,554

Table 1 includes estimated costs for MIPS vs MM strategies from the hospital perspective (grey rows).

In lobar ICH, MIPS strategy costs were \$2782 less per patient than MM (\$74,252 vs \$77,034) when including rehospitalization costs and surgeon fees (dark pink row).

Findings were similar when rehospitalization costs and surgeon fees were excluded (light pink rows).

Table 2. Cost-effectiveness results, healthcare perspective

	Cost	Incr Cost	Eff (QALY)	Incr Eff (QALY)	ICER
Lobar ICH					
MIPS	\$106,230	-	0.1879	-	-
MM	\$116,509	\$10,279	0.1365	-0.0514	Dominated
All ICH					
MIPS	\$114,340	-	0.1611	-	-
MM	\$124,465	\$10,124	0.1272	-0.0339	Dominated

Table 2 shows the incremental cost effectiveness analysis of MIPS vs MM from the US healthcare perspective. The cost includes hospital costs from Table 1 and non-hospital costs such as nursing home care. MIPS in lobar ICH cost \$10,279 less and gained 0.0514 QALY per patient compared to MM; thus MIPS dominated MM (dark pink boxes).

Figure 1. Probabilistic sensitivity analysis, lobar intracerebral hemorrhage, healthcare perspective.

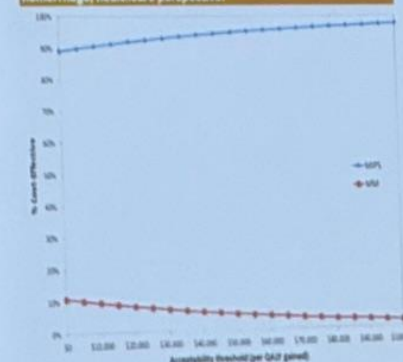
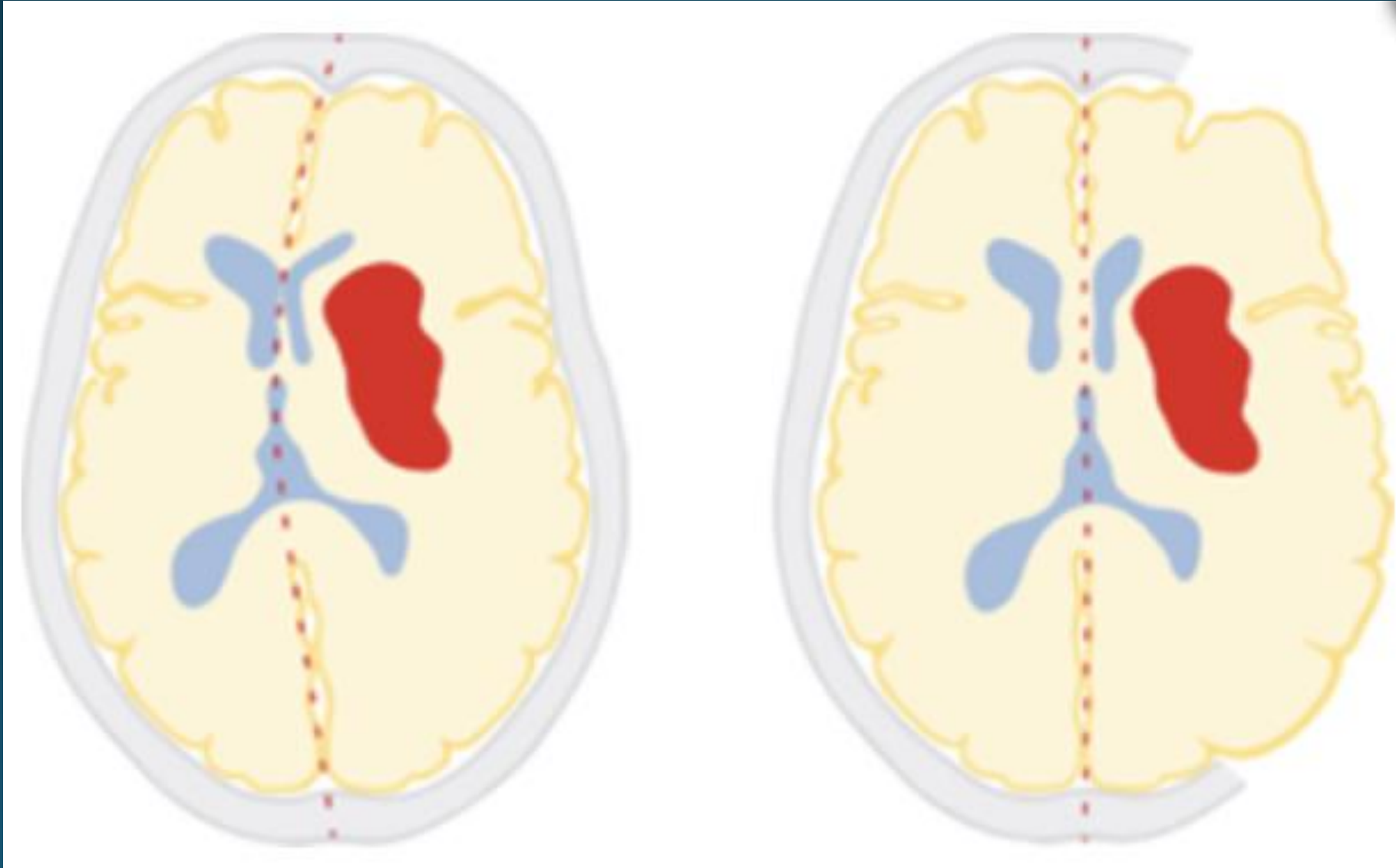


Figure 1 illustrates results when all parameters were varied simultaneously over plausible ranges in a probabilistic sensitivity analysis. MIPS was dominant in >91% of 10,000 model iterations and favored in >98% at \$100,000/QALY gained (a common US benchmark).

Dominated = more costly, less effective

For Lobar Hemorrhages: Surgery cost \$10,279 less and gained 0.0514 QALY per patient

Decompression for deep ICH???????



Lancet, 15th May, 2024

Decompressive craniectomy plus best medical treatment versus best medical treatment alone for spontaneous severe deep supratentorial intracerebral haemorrhage: a randomised controlled clinical trial

*Jürgen Beck, Christian Fung, Daniel Strbian, Lukas Bütikofer, Werner J Z'Graggen, Matthias F Lang, Seraina Beyeler, Jan Gralla, Florian Ringel, Karl Schaller, Nikolaus Plesnila, Marcel Arnold, Werner Hacke, Peter Jüni, Alexander David Mendelow, Christian Stapf, Rustam Al-Shahi Salman, Jenny Bressan, Stefanie Lerch, Arsany Hakim, Nicolas Martinez-Majander, Anna Piippo-Karjalainen, Peter Vajkoczy, Stefan Wolf, Gerrit A Schubert, Anke Höllig, Michael Veldeman, Roland Roelz, Andreas Gruber, Philip Rauch, Dorothee Mielke, Veit Rohde, Thomas Kerz, Eberhard Uhl, Enea Thanasi, Hagen B Huttner, Bernd Kallmünzer, L Jaap Kappelle, Wolfgang Deinsberger, Christian Roth, Robin Lemmens, Jan Leppert, Jose L Sanmillan, Jonathan M Coutinho, Katharina A M Hackenberg, Gernot Reimann, Mikael Mazighi, Claudio L A Bassetti, Heinrich P Mattle, Andreas Raabe, Urs Fischer, on behalf of the SWITCH study investigators**

Decompressive craniectomy plus best medical treatment might be superior to best medical treatment alone in people with severe deep supratentorial intracerebral haemorrhage, but the evidence is weak. The point estimate of the treatment effect was higher than that seen with any other specific intervention previously tested in people with intracerebral haemorrhage. Based on the 95% CI a null effect is plausible, but harm is unlikely. The results of SWITCH apply to a subgroup of people with severe deep intracerebral haemorrhage and cannot be generalised to people with intracerebral haemorrhage in other locations. Irrespective of treatment, survival was associated with severe disability in both treatment groups.

	Safety set (n=197)	Received decompressive craniectomy plus best medical treatment (n=103)	Received best medical treatment alone (n=94)	Risk difference (95% CI)	p value
Any serious adverse event	83 (42%)	42 (41%)	41 (44%)	-3% (-16 to 11)	0.77
Cardiac disorders	7 (4%)	2 (2%)	5 (5%)	-3% (-10 to 2)	0.26
Gastrointestinal disorders	2 (1%)	2 (2%)	0	2% (-2 to 7)	0.50
General disorders and administration site conditions	15 (8%)	6 (6%)	9 (10%)	-4% (-12 to 4)	0.42
Hepatobiliary disorders	1 (1%)	1 (1%)	0	1% (-3 to 5)	1.00
Immune system disorders	1 (1%)	1 (1%)	0	1% (-3 to 5)	1.00
Infections and infestations	23 (12%)	12 (12%)	11 (12%)	0 (-9 to 9)	1.00
Injury, poisoning, and procedural complications	15 (8%)	10 (10%)	5 (5%)	4% (-3 to 12)	0.29
Metabolism and nutrition disorders	2 (1%)	1 (1%)	1 (1%)	0 (-5 to 4)	1.00
Neoplasms benign, malignant, and unspecified (including cysts and polyps)	3 (2%)	2 (2%)	1 (1%)	1% (-4 to 6)	1.00
Nervous system disorders	34 (17%)	17 (17%)	17 (18%)	-2% (-12 to 9)	0.85
Psychiatric disorders	1 (1%)	0	1 (1%)	-1% (-6 to 3)	0.48
Renal and urinary disorders	3 (2%)	1 (1%)	2 (2%)	-1% (-7 to 3)	0.61
Respiratory, thoracic, and mediastinal disorders	9 (5%)	3 (3%)	6 (6%)	-3% (-11 to 3)	0.31
Surgical and medical procedures*	15 (8%)	8 (8%)	7 (7%)	0 (-8 to 8)	1.00
Vascular disorders	2 (1%)	1 (1%)	1 (1%)	0 (-5 to 4)	1.00

Data are numbers and percentages of participants with at least one serious adverse event involving the respective system organ class. Incidences are shown in the appendix (p 33). *Including two decompressive craniectomies at days 8 and 9.

Table 3: Serious adverse events

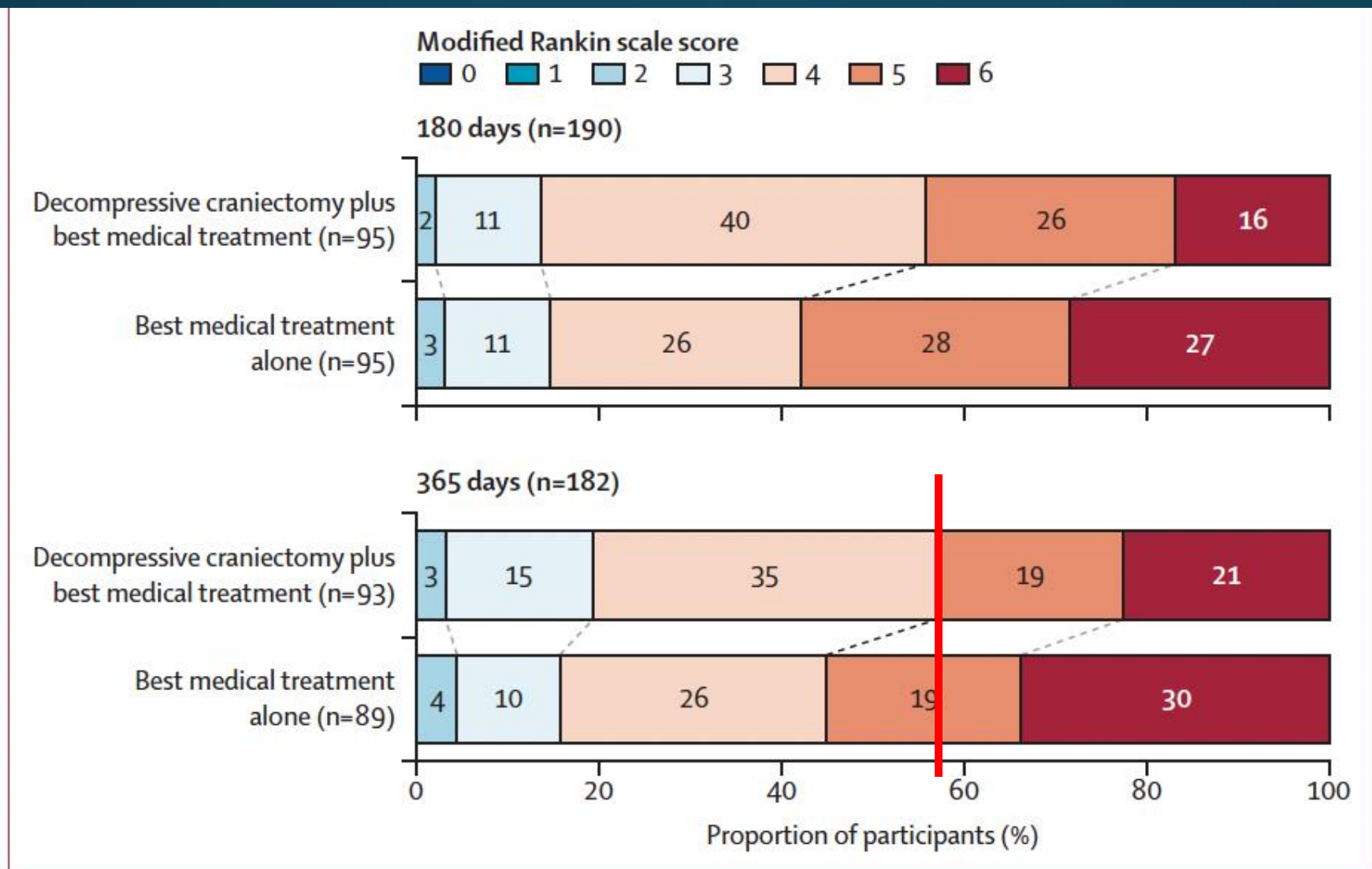
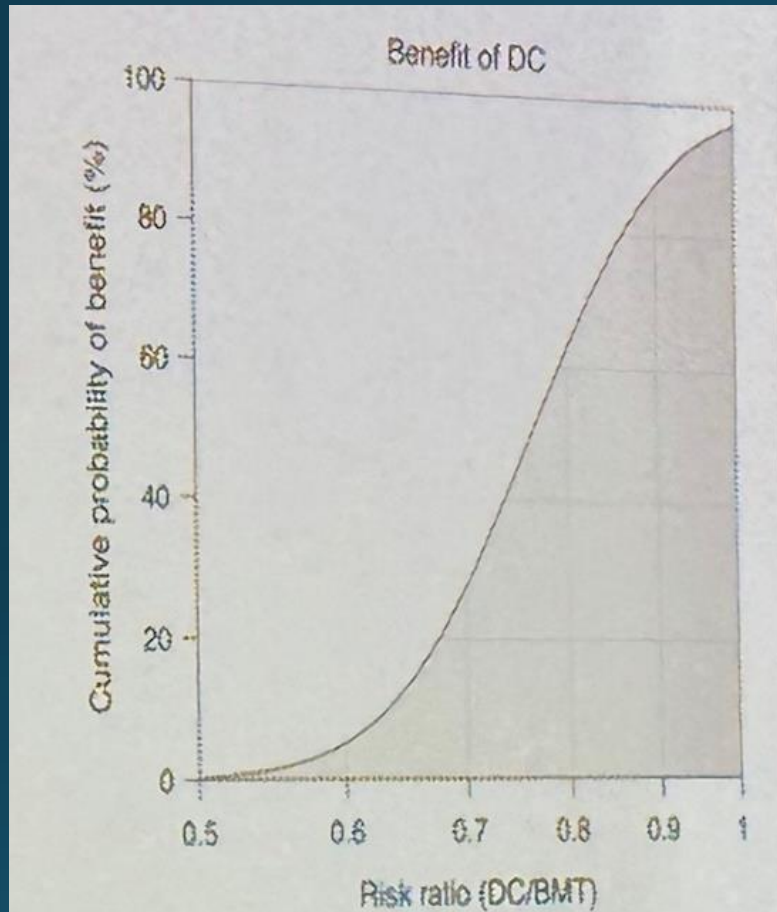


Figure 2: mRS score at day 180 and day 365

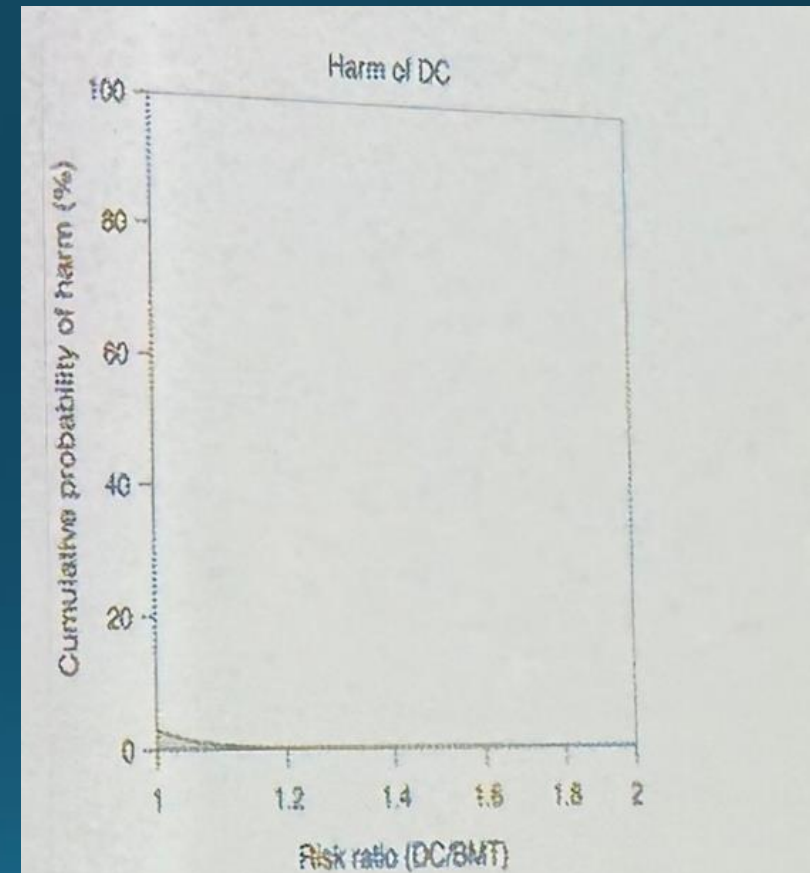
mRS scores are shown for participants for whom data were available. Scores range from 0 (no symptoms) to 6 (death). The thick dashed line between the stacked bar charts shows the cutoff for primary outcome (mRS 5–6). Numbers in the bars refer to the number of participants. mRS=Modified Rankin Scale.

	Decompressive craniectomy plus best medical treatment (n=96)	Best medical treatment alone (n=101)
Age at inclusion, years	60 (49–68)	61 (53–67)
Sex		
Male	64 (67%)	70 (69%)
Female	32 (33%)	31 (31%)
Glasgow Coma Scale	10 (9–12)	10 (9–12)
NIHSS score*	18 (16–22)	19 (15–21)
Pre-stroke score on the modified Rankin scale†		
0	80 (83%)	86 (85%)
1	16 (17%)	15 (15%)
Volume of haematoma, mL‡	55 (45–74)	59 (44–77)
Systolic blood pressure, mm Hg§	142 (130–154)	150 (130–170)
Blood glucose level, mmol/L¶	7.5 (6.4–9.2)	7.4 (6.3–8.9)
Risk factors		
Previous ischaemic stroke	7 (7%)	6 (6%)
Previous asymptomatic intracerebral haemorrhage	0	0
History of hypertension	51 (53%)	60 (59%)
History of diabetes	19 (20%)	15 (15%)
Known heart disease	18 (19%)	12 (12%)
Haematoma with intraventricular haemorrhage extension	27 (28%)	30 (30%)
Medication		
Warfarin or other anticoagulant	6 (6%)	9 (9%)
Acetylsalicylic acid or other antiplatelet agent	17 (18%)	17 (17%)
Baseline imaging		
CT	94 (98%)	100 (99%)
MRI	2 (2%)	1 (1%)
Side of intracerebral haemorrhage		
Left	43 (45%)	54 (53%)
Right	53 (55%)	47 (47%)
Graeb score**	2.0 (0.0–5.0)	3.0 (0.0–5.0)
Symptom onset to randomisation, hours	23 (13–37)	25 (12–41)
Symptom onset to imaging, hours	6.9 (2.5–18.6)	7.5 (3.0–19.5)

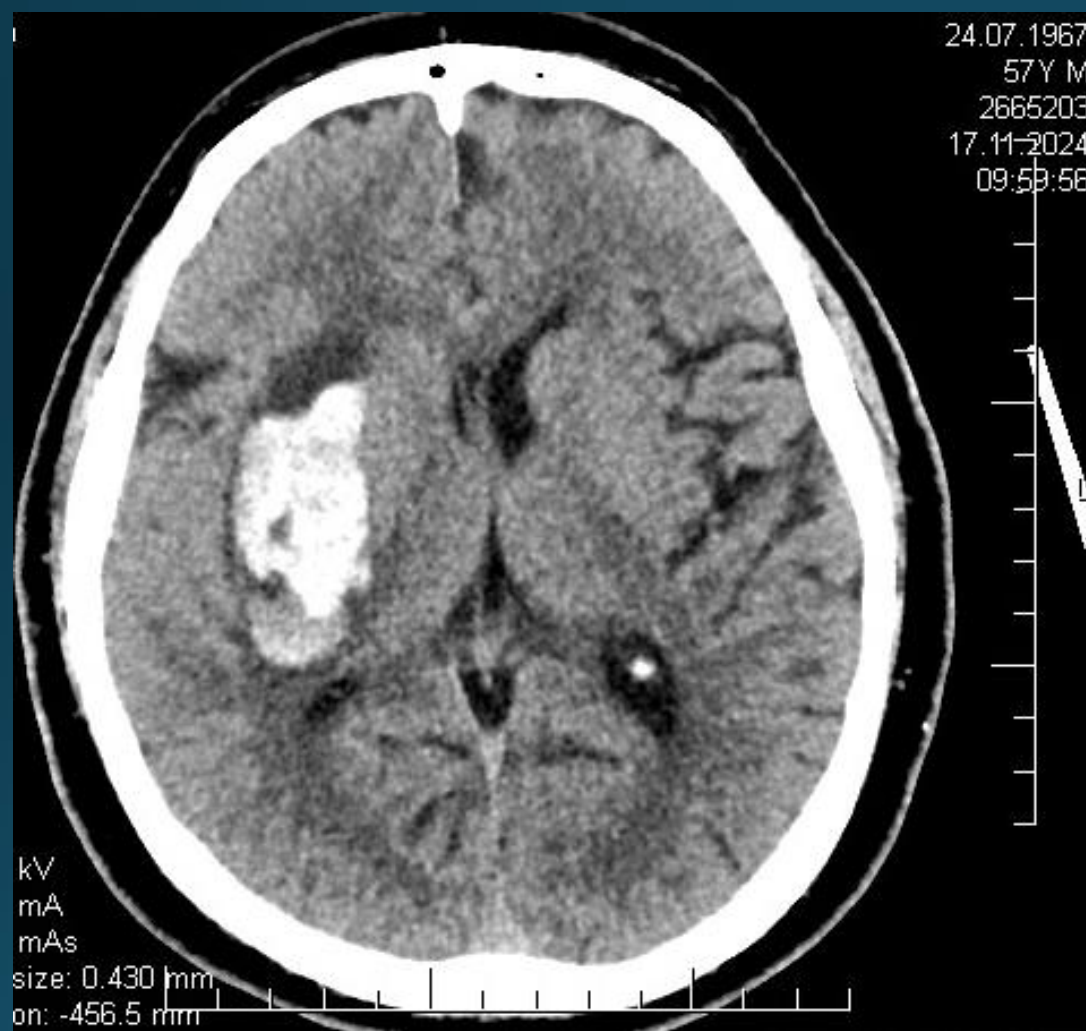
Pravděpodobnost benefitu / poškození



confidence of a
benefit of DC = 97.2%

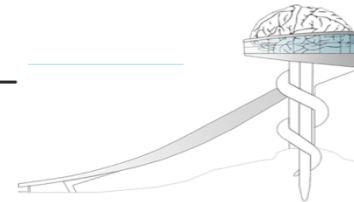
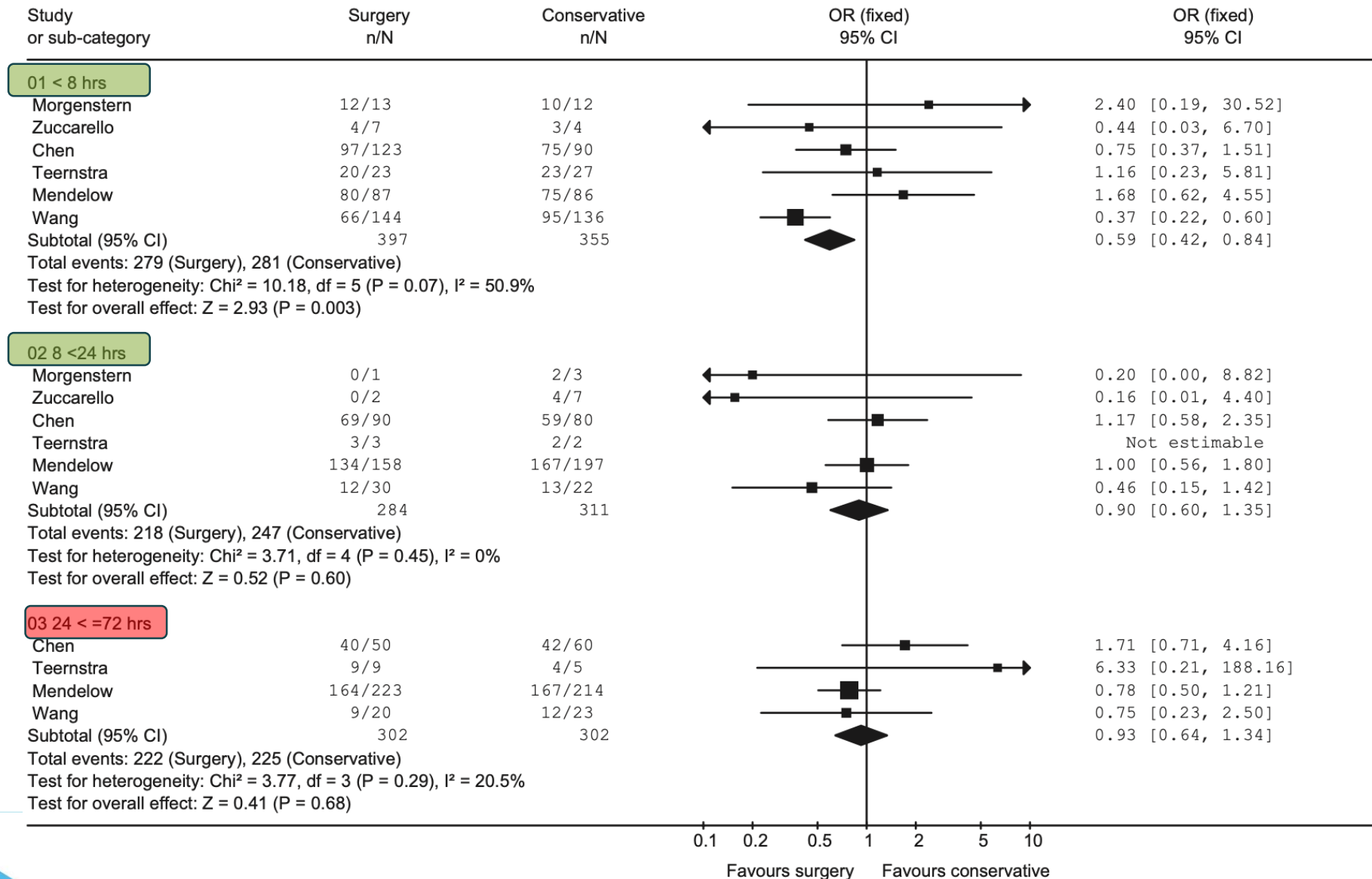


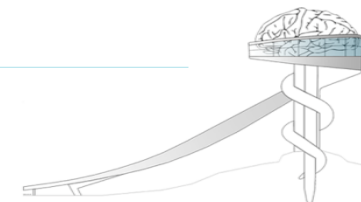
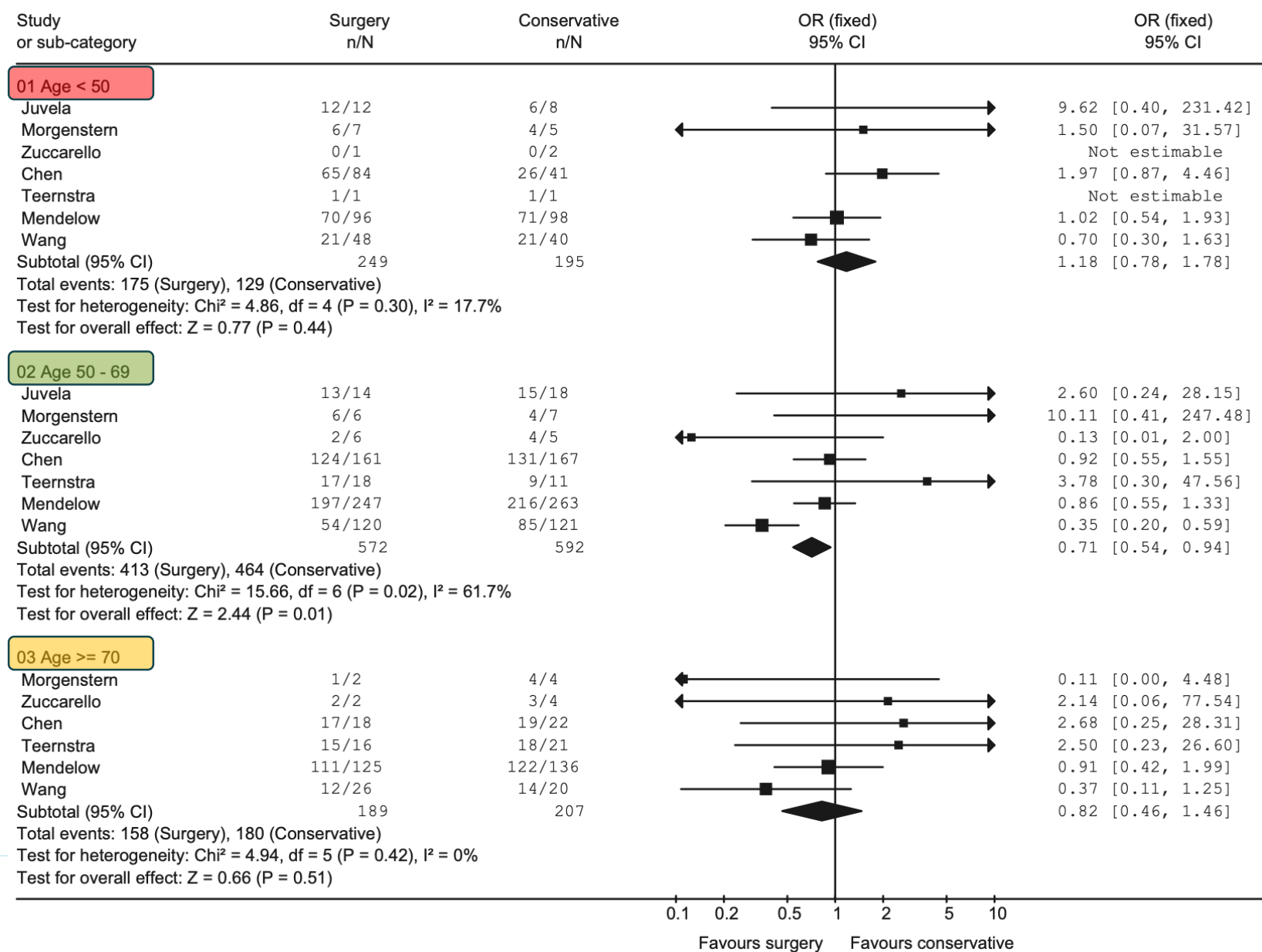
confidence that there is
no risk increase > 10% = 99.5%

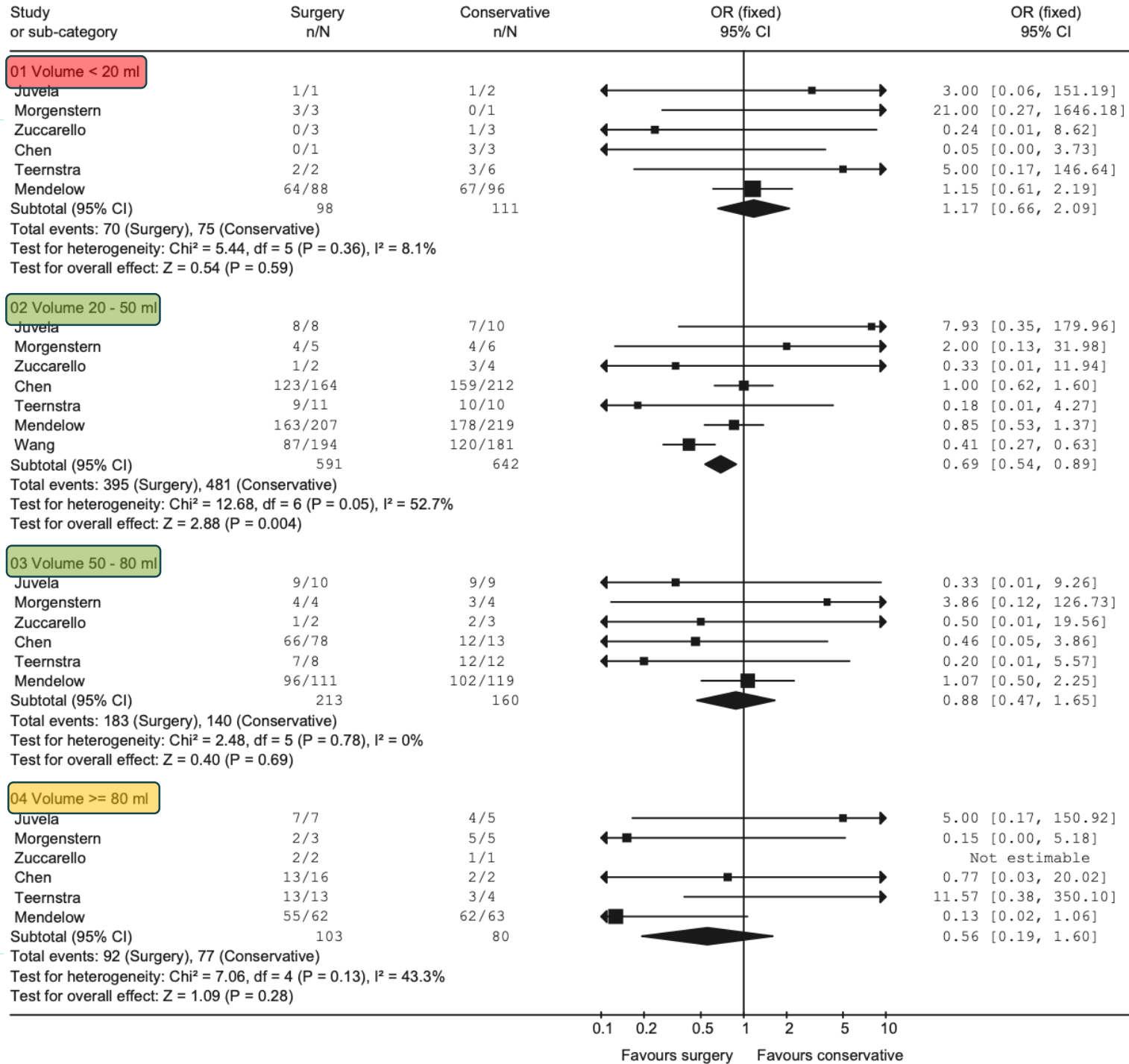


Individual Patient Data Subgroup Meta-Analysis of Surgery for Spontaneous Supratentorial Intracerebral Hemorrhage

Barbara A. Gregson, PhD; Joseph P. Broderick, MD; Ludwig M. Auer, MD; Hunt Batjer, MD; Xian-Cheng Chen, MD; Seppo Juvela, MD; Lewis B. Morgenstern, MD; George C. Pantazis, MD; Onno P.M. Teernstra, PhD; Wen-Zhi Wang, MD; Mario Zuccarello, MD; A. David Mendelow, FRCS

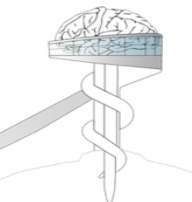






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Patient
selection

GCS 8-14 & age 50-70y

Review Article

TIMING < 24h <8h ? < 6h??

Size
20-80 ml

EUROPEAN
STROKE JOURNAL

European Stroke Journal

1-8

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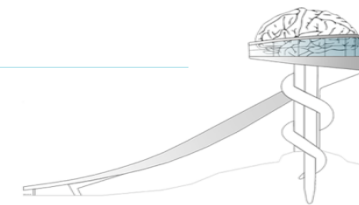
Sage

Acute care bundles should be used for patients with intracerebral haemorrhage: An expert consensus statement

Adrian R Parry-Jones¹, Susann J Järhult², Natalie Kreitzer³,
Andrea Morotti⁴, Danilo Toni⁵, David Seiffge⁶,
Alexander David Mendelow⁷, Hiren Patel¹, Hens Bart Brouwers⁸,
Catharina JM Klijn⁹, Thorsten Steiner¹⁰, Walter Brian Gibler³
and Joshua N Goldstein¹¹

Thinking

Location



2024/25 Intracerebral Haemorrhage Guidelines



THE EUROPEAN ASSOCIATION
OF NEUROLOGICAL SOCIETIES

SUPRATENTORIAL ICH

PICO 4.1.3: In adults with acute spontaneous supratentorial ICH, does **minimally invasive surgical removal (MIS)** of the clot versus no surgery reduce the risk of death or dependence?

Evidence-based Recommendation

In adults with supratentorial ICH, we suggest for **early** (<24 hours) minimally invasive evacuation of the haematoma to reduce mortality and to improve functional outcome **in those with lobar ICH**, whereas the effect in deep hematomas remains uncertain.

Quality of evidence: **Low** ⊕⊕⊖⊖

Strength of recommendation: **Weak for intervention** † ?

MIS

To není o jednom produktu

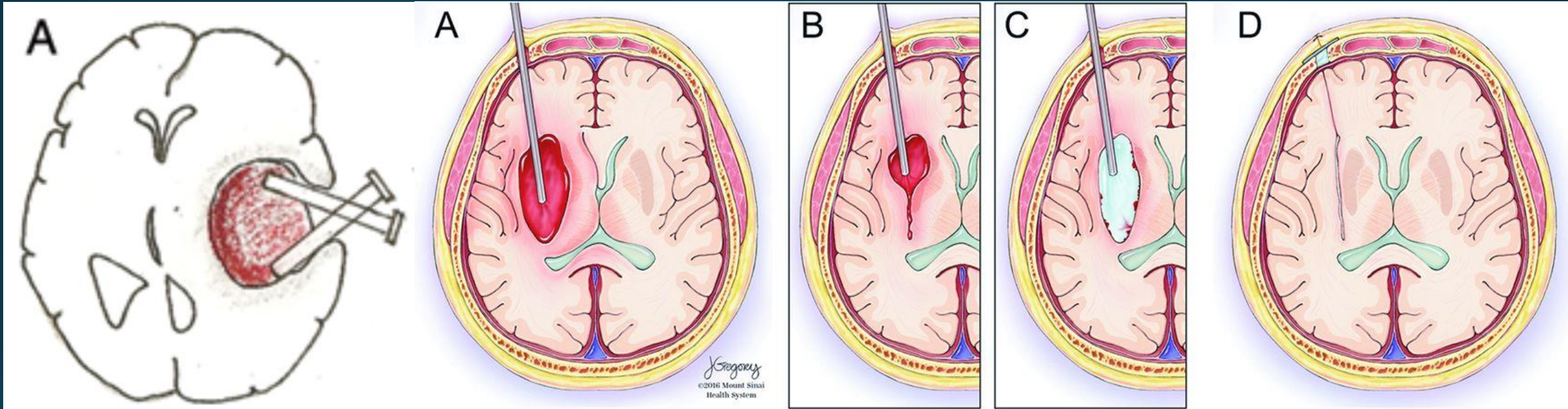
To je nastavení moderní NCH

Eloquentní kortex, dráhy, plánování, navigace

Minimalizace kortikální incize

Šetření okolí ICH

Minimalizace koagulace



§Source: Kellner et al., JNIS 2018

§§Source: Kuo et al, Neurosurg Focus 2011

ESO a EANS 2024/25 ICH

Co se změnilo?

Více studií, více doporučení k NCH

Hlavní pozitivní faktory: časná operace, lobární ICH, GCS 8-13

Hlavní negativní faktory: pozdní operace, thalamické ICH, GCS 3-7

Další studie na MIS



Závěry I:

Pacienti: GCS 8-14, věk 50-70r

Načasování : 24h, 12h, 8h

Objem : 30-80ml

Lokalizace: lobární hematomy – evakuace
hluboké – dekomprese???

Závěry II:

ENRICH:

evidence

SWITCH :

mRS₄?



Maligní otok mozku

Key Points

- The terms cytotoxic and vasogenic edema do not capture all of the relevant mechanisms involved in edema formation after ischemic stroke.
- Frequent, serial assessment of level of arousal is the most important component of neurologic monitoring for patients with large stroke.
- The possibility of swelling should be considered in any patient with a National Institutes of Health Stroke Scale score of greater than 10 and a large vessel occlusion.
- Identification of patients at high risk for swelling after ischemia should be performed using early MRI prior to any neurologic deterioration.
- Reperfusion in large territory infarctions can lead to hemorrhagic transformation, which can exacerbate swelling and tissue shifts.
- High-risk patients should be transferred early after stroke onset to centers where a multidisciplinary team, including critical care neurologists and neurosurgeons, is available.

- Steroids, barbiturates, and hypothermia are strategies that should be avoided in **!!!** treating patients with hemispheric infarction and ischemic swelling.
- The osmolar gap should preferentially be used over the absolute serum osmolarity to guide osmolar therapy.
- Decompressive craniectomy should be considered in all patients under 60 years of age with decreased level of arousal that is attributable to swelling.
- Imaging biomarkers of swelling and novel approaches to prevent swelling are two important areas for further research.

TABLE 5-2 Considerations for Decompressive Craniectomy in Patients With Hemispheric Infarction and Ischemic Swelling

	Specific Examples
Search for confounders in setting of neurologic deterioration	Sedatives or other medications that may impact level of arousal Metabolic derangements Temperature elevation Inadequately treated infection Hydrocephalus Nonconvulsive seizures
Reference examinations (to be obtained in setting of neurologic deterioration)	
Imaging	Reference CT should be obtained irrespective of the examination
Examination	Performed in conjunction with reference CT, using Glasgow Coma Scale (GCS) and National Institutes of Health Stroke Scale (NIHSS) as guides
Proceed with decompressive craniectomy	
Scenario 1	If reference examination is a GCS score of <9 or NIHSS item 1a is >1 and CT shows evidence of increased midline shift
Scenario 2	If there is further neurologic deterioration from the reference examination on at least two hourly examinations New loss of following commands or cued stimuli No longer localizing to painful stimuli New pupillary abnormality (eg, anisocoria) Noticeably less brisk response to pain, ideally as assessed by two examiners Corroborating evidence of mass effect on CT or repeat CT

Methodology

Timing of decompressive craniectomy

Ideally performed within 48 hours of symptom onset (but may be performed after this point)

Performed within 3 hours of decision to proceed with decompressive craniectomy

Ideally at least 12 hours after IV tissue plasminogen activator

Hematology

If international normalized ratio (INR) is >1.3 , fresh-frozen plasma or prothrombin complex concentrate, in addition to vitamin K, are given to the patient prior to surgery

Technique

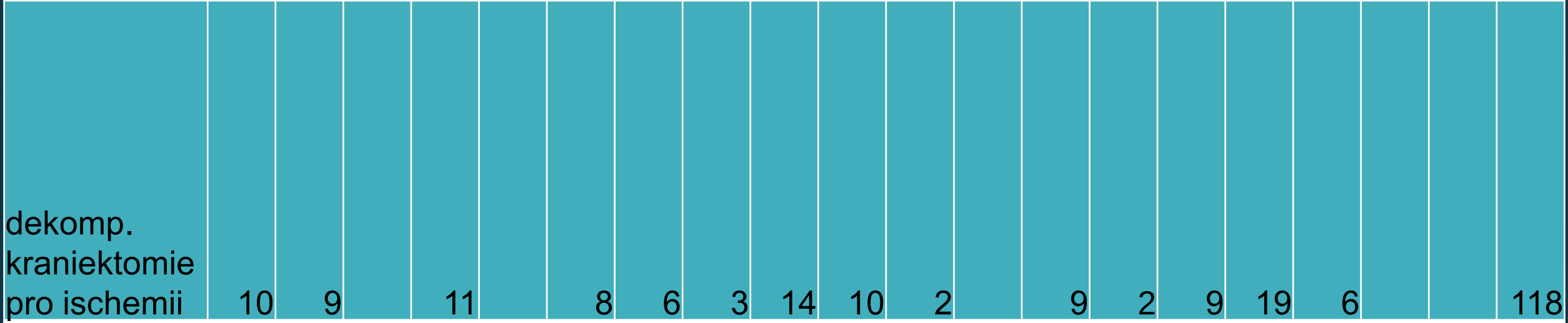
Large question mark incision from widow's peak to zygoma

Bone flap of at least 12-cm diameter

Medial limit of craniotomy should be 2 cm from midline

Expansive duraplasty

Resection of infarcted tissue is not recommended



1	4	6	3	12	8	0	4	4	5	7	6	4	59
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ÚSTŘEDNÍ VOJENSKÁ NEMOCNICE –
VOJENSKÁ FAKULTNÍ NEMOCNICE PRAHA
1. LÉKAŘSKÁ FAKULTA UNIVERZITY KARLOVY V PRAZE
ÚSTAV KLINICKÝCH NEUROBORŮ
NEUROCHIRURGICKÁ A NEUROONKOLOGICKÁ KLINIKA
prof. MUDr. David Netuka, Ph. D.
přednosta



Kuncův memoriál 2025

26. června od 15 hodin

Novotného lávka 201/1, Praha 1 – Staré Město

Program

15:00 – 15:20

Úvod

15:00 – 15:05

D. Netuka

15:05 – 15:10

M. Vokurka

15:10 – 15:15

V. Masopust

15:15 – 15:20

M. Sameš

15:20 – 16:00

Zvaná přednáška

prof. PhDr. Martin Kovář, Ph.D.: Trumpova Amerika a/versus Evropa

16:30 – 17:30

16:30 – 16:40

16:40 – 16:50

16:50 – 17:00

17:00 – 17:15

17:15 – 17:30

Odborné přednášky

D. Netuka: ÚKN

D. Netuka: Klinická randomizovaná studie v časopise s IF 93,7

R. Voldřich: Léčba intraneurálních peroneálních gangliových cyst

R. Kučera: Komplexní spinální program?

M. Májovský: AI a denní praxe

17:30 – 18:10

17:30 – 17:40

17:40 – 17:50

17:50 – 18:00

18:00 – 18:10

Kazuistiky

J. Kašík: Spinální případ

M. May: Kraniální případ

T. Moravec: Bolestivý případ

M. Černý: Elektrofyziologický případ

D. Netuka

SAH management

Key Points

- Subarachnoid hemorrhage is more frequent in women than men and more frequent in minority populations compared to white Americans.
- Case-fatality rates of hospitalized patients with subarachnoid hemorrhage have decreased with the advent of neurocritical care, endovascular therapy, and more refined microsurgical techniques.
- The most important points in the management of patients with subarachnoid hemorrhage are prompt evaluation and diagnosis, immediate transfer to appropriate centers, expeditious diagnosis and treatment of the bleeding source, and overall good neurocritical care adhering to available treatment guidelines.
- In some instances, diagnosis of subarachnoid hemorrhage can be elusive owing to atypical findings on presentation such as seizures at onset, acute encephalopathy, and concomitant subdural hematoma and head trauma.
- The sensitivity of CT for detection of subarachnoid blood may be 98% to 100% when obtained within 12 hours of onset of symptoms, compared to lumbar puncture.
- The diagnosis of subarachnoid hemorrhage is supported by the finding of xanthochromia in CSF.

- All patients with a diagnostic CT scan or with either equivocal or diagnostic lumbar puncture must undergo further imaging with CT angiography or digital subtraction angiography.
- Any of the following clinical factors should prompt a workup for subarachnoid hemorrhage in patients older than 40: neck pain or stiffness, witnessed loss of consciousness, and symptom onset during exertion plus thunderclap headache and pain on neck flexion.
- Mean arterial blood pressure should be maintained at less than 110 mm Hg or systolic blood pressure at less than 160 mm Hg until the ruptured aneurysm is secured, while avoiding hypotension.
- The severity of neurologic impairment and the amount of subarachnoid bleeding on admission are the strongest predictors of neurologic complications and outcome.

- Admission of patients with subarachnoid hemorrhage to low-volume centers is associated with higher 30-day mortality compared to admission to high-volume centers.
- ~~Overall, when considering treatment of unruptured aneurysms, endovascular coiling should be preferred over surgical clipping whenever possible.~~
- Patients with subarachnoid hemorrhage are at risk for several significant neurologic complications, including hydrocephalus, cerebral edema, delayed cerebral ischemia, rebleeding, seizures, and neuroendocrine abnormalities.
- The best measure to reduce the risk of rebleeding is the early treatment of unsecured aneurysms.
- About 60% of patients with subarachnoid hemorrhage who undergo external ventricular drain insertion will have successful weaning and the others may require chronic ventriculoperitoneal shunt insertion.
- Anticonvulsant administration (particularly phenytoin) has been associated with worse clinical outcome.
- Delayed cerebral ischemia is defined as any neurologic deterioration (focal or global) presumed secondary to cerebral ischemia that persists for more than 1 hour and cannot be explained by any other neurologic or systemic condition.
- Possible underlying conditions implicated in the pathogenesis of delayed cerebral ischemia include cerebral vasospasm, microcirculatory constriction, microthrombosis, cortical spreading depression, and delayed cellular apoptosis.

- Nimodipine should be administered to all patients with subarachnoid hemorrhage to decrease the risk of delayed cerebral ischemia and poor functional outcome.
- Euvolemia should be maintained at all times, while prophylactic hypervolemia should be avoided.
- Delayed cerebral ischemia must be suspected when patients with subarachnoid hemorrhage develop focal neurologic impairment or a decrease of at least 2 points on the Glasgow Coma Scale that lasts for more than 1 hour and cannot be explained by any other cause.
- Any new hypodensities on CT imaging 24 to 48 hours after aneurysm treatment should be regarded as cerebral infarctions from delayed cerebral ischemia.
- Transcranial Doppler thresholds for vasospasm include mean cerebral blood flow velocities of less than 120 cm/s for absence and more than 200 cm/s or a Lindegaard ratio of greater than 6 for presence.
- ~~• Digital subtraction angiography is the gold standard for detection of large artery vasospasm.~~
- CT perfusion findings of elevated mean transit time of greater than 6.4 seconds may be additive to CT angiography in predicting delayed cerebral ischemia and has been recommended as a threshold for decreased cerebral perfusion.
- Once patients experience neurologic deterioration suggestive of delayed cerebral ischemia, rescue therapies are initiated with induced hypertension as first-line modality.
- In high-risk patients with poor neurologic status, diagnosis and treatment of delayed cerebral ischemia may be somewhat subjective and mostly based on neuromonitoring findings.



- Cardiopulmonary alterations are among the most common systemic complications of subarachnoid hemorrhage.
- Pulmonary edema or acute respiratory distress syndrome in patients with subarachnoid hemorrhage should be treated with judicious use of diuretics and other standard heart failure therapies targeting euvolemia and normal cerebral perfusion pressure.
- Fever is the most common non-neurologic complication in patients with subarachnoid hemorrhage.
- Fever in patients with subarachnoid hemorrhage has been associated with poor clinical outcome.
- Deep venous thrombosis prophylaxis should be administered to all patients with subarachnoid hemorrhage.
- Fluid restriction should be avoided in patients with subarachnoid hemorrhage, and hyponatremia should be treated with oral free water restriction while maintaining euvolemia.
- Anemia in patients with subarachnoid hemorrhage has been associated with delayed cerebral ischemia and worse clinical outcome.

TABLE 1-1 Risk Factors for Subarachnoid Hemorrhage

► **Nonmodifiable Risk Factors**

Age

Female sex

Prior history of aneurysmal subarachnoid hemorrhage

Family history of subarachnoid hemorrhage

History of aneurysm in first-degree relatives (especially in two or more relatives)

► **Modifiable Risk Factors**

Hypertension

Cigarette smoking

Heavy alcohol use

Sympathomimetic drug use (eg, cocaine)

► **Other**

Certain genetic disorders (eg, autosomal dominant polycystic kidney disease, type IV Ehlers-Danlos syndrome)

Anterior circulation aneurysms are more likely to rupture in patients who are younger than 55 years of age

Posterior circulation aneurysms are more likely to rupture in men

Significant financial or legal problems within the past 30 days

Cerebral aneurysms of more than 7 mm in diameter

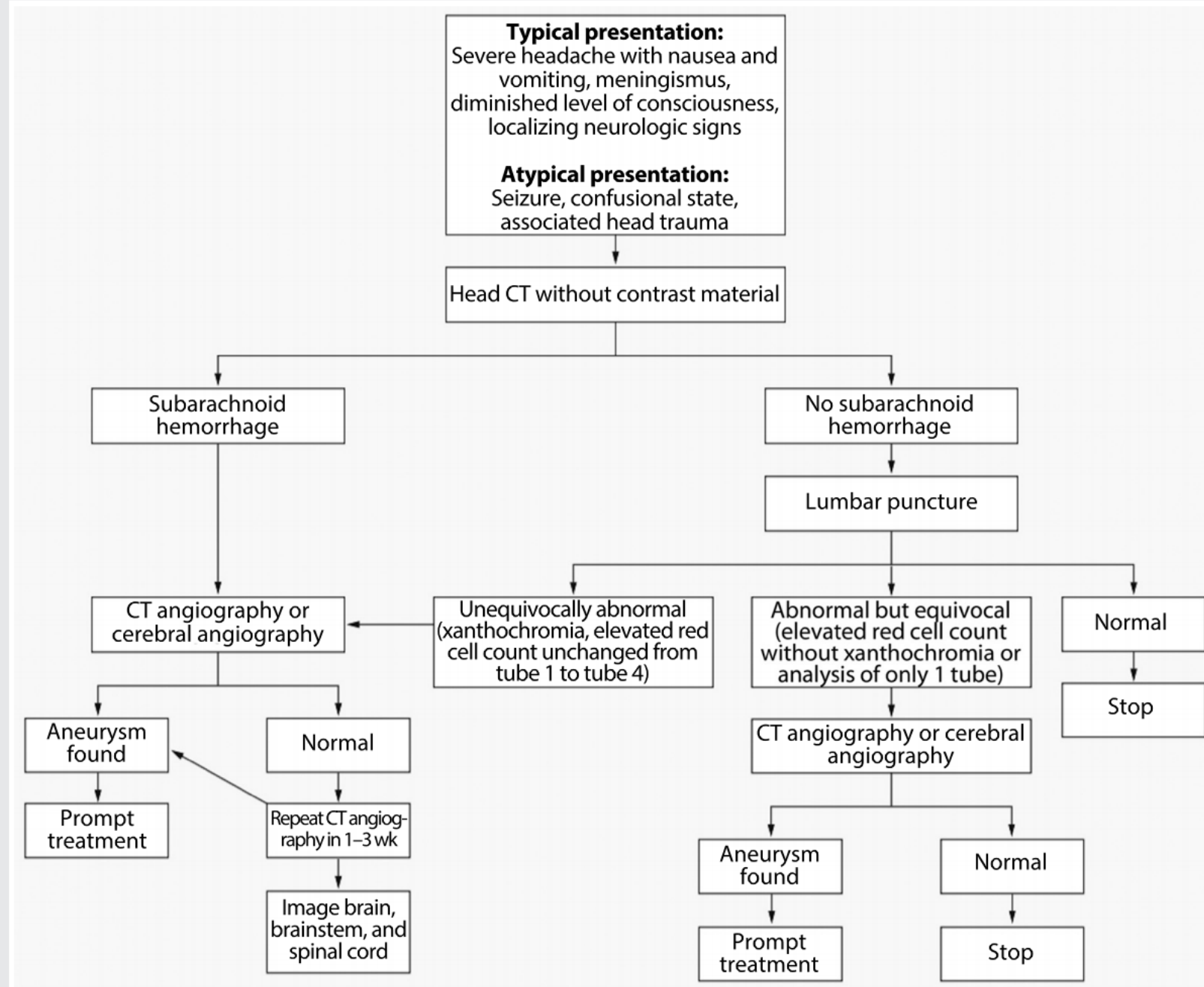


FIGURE 1-2

Diagnostic algorithm for subarachnoid hemorrhage.

TABLE 1-4 Clinical and Radiologic Grading Scales for Subarachnoid Hemorrhage^a

World Federation of Neurological Surgeons Scale ³⁴			Modified Fisher Scale ³⁵		
Grade	Glasgow Coma Scale	Neurologic Examination	Grade	Subarachnoid Hemorrhage	Intraventricular Hemorrhage
1	15	No motor deficit	0	Absent	Absent
2	13–14	No motor deficit	1	Minimal	Absent in both lateral ventricles
3	13–14	Motor deficit	2	Minimal	Present in both lateral ventricles
4	7–12	With or without motor deficit	3	Thick ^b	Absent in both lateral ventricles
5	3–6	With or without motor deficit	4	Thick ^b	Present in both lateral ventricles

TABLE 1-5 Summary of Key Recommendations for the Management of Patients With Subarachnoid Hemorrhage *Continued from page 1272*

Treatment Decision	American Heart Association/American Stroke Association ^{2,a}	Neurocritical Care Society ^{12,b}
Blood pressure control	Between the time of SAH symptom onset and aneurysm obliteration, blood pressure should be controlled with a titratable agent to balance the risk of stroke, hypertension-related rebleeding, and maintenance of cerebral perfusion pressure (Class I, Level B). The magnitude of blood pressure control to reduce the risk of rebleeding has not been established, but a decrease in systolic blood pressure to less than 160 mm Hg is reasonable (Class IIa, Level C).	Treat extreme hypertension in patients with an unsecured, recently ruptured aneurysm. Modest elevations in blood pressure (mean blood pressure of less than 110 mm Hg) do not require therapy. Premorbid baseline blood pressures should be used to refine targets and hypotension should be avoided (low quality of evidence, strong recommendation).
Intravascular volume status	Maintenance of euvolemia and normal circulating blood volume is recommended to prevent delayed cerebral ischemia (Class I, Level B).	Intravascular volume management should target euvolemia and avoid prophylactic hypervolemic therapy. In contrast, there is evidence for harm from aggressive administration of fluid aimed at achieving hypervolemia (moderate quality of evidence, strong recommendation).
Cardiopulmonary complications	No recommendations given.	Baseline cardiac assessment with serial enzymes, ECG, and echocardiography is recommended, especially in patients with evidence of myocardial dysfunction (low quality of evidence, strong recommendation). Monitoring of cardiac output may be useful in patients with evidence of hemodynamic instability or myocardial dysfunction (low quality of evidence, strong recommendation).
Seizures	The use of prophylactic anticonvulsants may be considered in the immediate posthemorrhagic period (Class IIb, Level B). The routine long-term use of anticonvulsants is not recommended (Class III, Level B).	Routine use of anticonvulsant prophylaxis with phenytoin is not recommended after SAH (low quality of evidence, strong recommendation). If anticonvulsant prophylaxis is used, a short course (3–7 days) is recommended (low quality of evidence, weak recommendation). Continuous EEG monitoring should be considered in patients with poor-grade SAH who fail to improve or who have neurologic deterioration of undetermined etiology (low quality of evidence, strong recommendation).

TABLE 1-5 **Summary of Key Recommendations for the Management of Patients With Subarachnoid Hemorrhage** *Continued from page 1273*

Treatment Decision	American Heart Association/American Stroke Association ^{2,a}	Neurocritical Care Society ^{12,b}
Fever treatment	Aggressive control of fever to a target of normothermia by use of standard or advanced temperature-modulating systems is reasonable in the acute phase of SAH (Class IIa, Level B).	During the period of risk for delayed cerebral ischemia, control of fever is desirable; intensity should reflect the individual patient's relative risk of ischemia (low quality of evidence, strong recommendation). Surface cooling or intravascular devices are more effective and should be employed when antipyretics fail in cases where fever control is highly desirable (high quality of evidence, strong recommendation).
Glucose control	Careful glucose management with strict avoidance of hypoglycemia may be considered as part of the general critical care management of patients with SAH (Class IIb, Level B).	Hypoglycemia (serum glucose of less than 80 mg/dL) should be avoided (high quality of evidence, strong recommendation). Serum glucose should be maintained below 200 mg/dL (moderate quality of evidence, strong recommendation).

Deep venous thrombosis prophylaxis

Heparin-induced thrombocytopenia and deep venous thrombosis are relatively frequent complications after SAH. Early identification and targeted treatment are recommended, but further research is needed to identify the ideal screening paradigms (Class I, Level B).

Measures to prevent deep venous thrombosis should be employed in all patients with SAH (high quality of evidence, strong recommendation).

The use of unfractionated heparin for prophylaxis could be started 24 hours after undergoing aneurysm obliteration (moderate quality of evidence, strong recommendation).

Delayed cerebral ischemia

Oral nimodipine should be administered to all patients with SAH (Class I, Level A).

Maintenance of euvolemia and normal circulating blood volume is recommended to prevent delayed cerebral ischemia (Class I, Level B).

Prophylactic hypervolemia or balloon angioplasty before the development of angiographic spasm is not recommended (Class III, Level B).

Transcranial Doppler is reasonable to monitor for the development of arterial vasospasm (Class IIa, Level B).

Perfusion imaging with CT or MRI can be useful to identify regions of potential brain ischemia (Class IIa, Level B).

Oral nimodipine (60 mg every 4 hours) should be administered after SAH for a period of 21 days (high quality of evidence, strong recommendation).

The goal should be maintaining euvolemia, rather than attempting hypervolemia (moderate quality of evidence, strong recommendation).

Transcranial Doppler may be used for monitoring and detection of large artery vasospasm with variable sensitivity (moderate quality of evidence, strong recommendation).

Digital subtraction angiography is the gold standard for detection of large artery vasospasm (high quality of evidence, strong recommendation).

TABLE 1-5 Summary of Key Recommendations for the Management of Patients With Subarachnoid Hemorrhage *Continued from page 1274*

Treatment Decision	American Heart Association/American Stroke Association ^{2,a}	Neurocritical Care Society ^{12,b}
	Induction of hypertension is recommended for patients with delayed cerebral ischemia unless blood pressure is elevated at baseline or cardiac status precludes it (Class I, Level B).	Patients clinically suspected of delayed cerebral ischemia should undergo a trial of induced hypertension (moderate quality of evidence, strong recommendation).
	Cerebral angioplasty and/or selective intra-arterial vasodilator therapy is reasonable in patients with symptomatic vasospasm, particularly those who are not responding to hypertensive therapy (Class IIa, Level B).	Endovascular treatment using intra-arterial vasodilators and/or angioplasty may be considered for vasospasm-related delayed cerebral ischemia (moderate quality of evidence, strong recommendation).
Anemia and transfusion	The use of packed red blood cell transfusion to treat anemia might be reasonable in patients with SAH who are at risk of cerebral ischemia. The optimal hemoglobin goal is still to be determined (Class IIb, Level B).	Patients should receive packed red blood cell transfusions to maintain hemoglobin concentration above 8–10 g/dL (moderate quality of evidence, strong recommendation).
Hyponatremia	The use of fludrocortisone acetate and hypertonic saline solution is reasonable for preventing and correcting hyponatremia (Class IIa, Level B).	Fluid restriction should not be used to treat hyponatremia (weak quality of evidence, strong recommendation). Early treatment with hydrocortisone or fludrocortisone may be used to limit natriuresis and hyponatremia (moderate quality of evidence, weak recommendation). Mild hypertonic saline solutions can be used to correct hyponatremia (very low quality of evidence, strong recommendation).

TABLE 1-6 Preferences for Treatment of Unsecured Aneurysms

Characteristics	Preferred Treatment Modality
Advanced age	Endovascular coiling
Poor clinical grade	Endovascular coiling
Multiple underlying systemic conditions	Endovascular coiling
Aneurysms with wide neck-to-body ratio	Surgical clipping
Normal arterial branches arising from dome or body of aneurysm	Surgical clipping
Middle cerebral artery aneurysm	Surgical clipping
Top-of-the-basilar aneurysm	Endovascular coiling
Aneurysm associated with large parenchymal hematoma	Surgical clipping
High surgical risk	Endovascular coiling
Patient preference	Endovascular coiling
Clinical equipoise ^a	Endovascular coiling

^a Unsecured aneurysm is considered equally suitable for either endovascular coiling or surgical clipping.

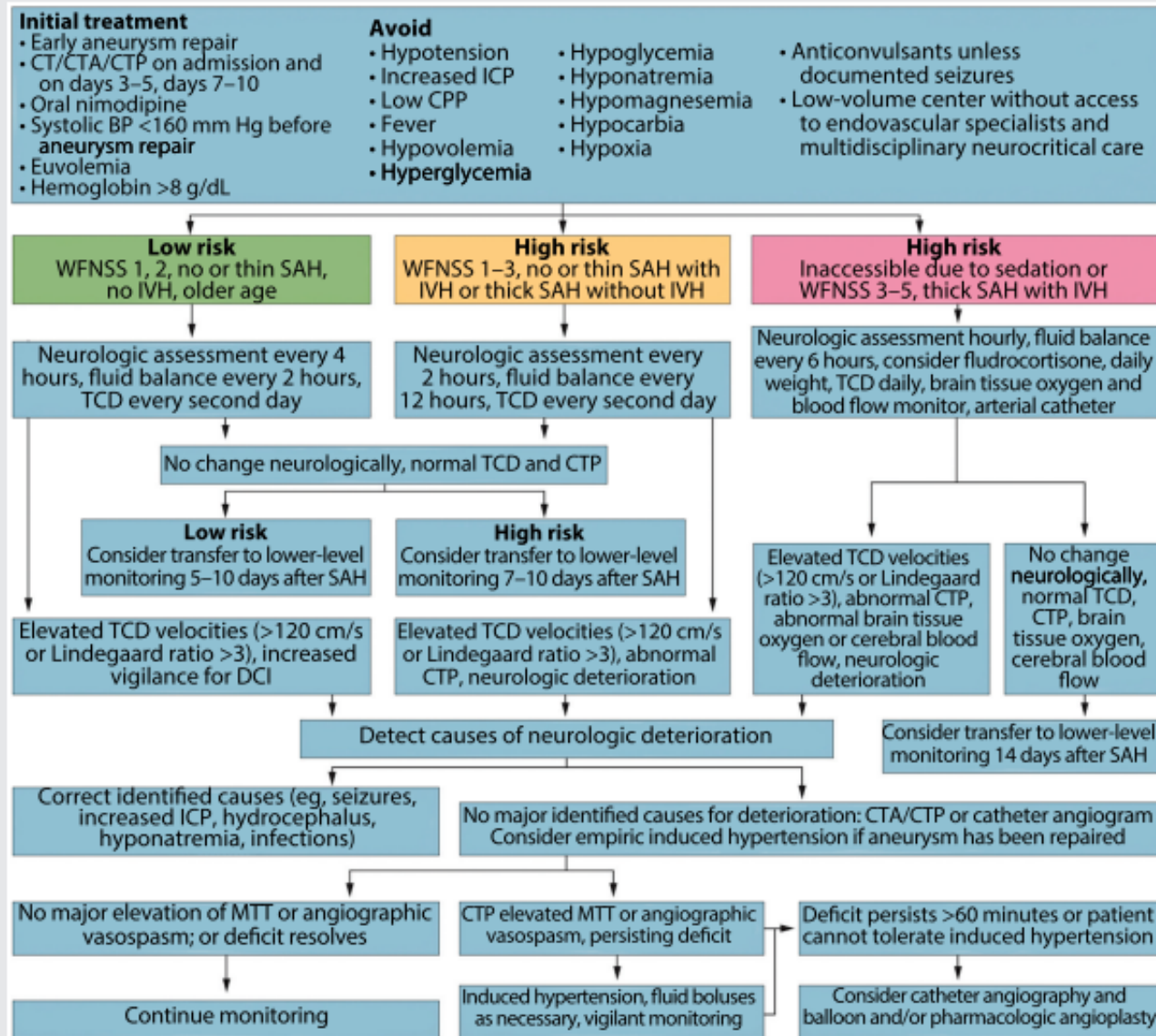


FIGURE 1-5 Management approach to delayed cerebral ischemia.

BP = blood pressure; CPP = cerebral perfusion pressure; CT = computed tomography; CTA = computed tomography angiography; CTP = computed tomography perfusion; DCI = delayed cerebral ischemia; ICP = intracranial pressure; IVH = intraventricular hemorrhage; MTT = mean transit time; SAH = subarachnoid hemorrhage; TCD = transcranial Doppler; WFNSS = World Federation of Neurological Surgeons Scale.

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Lancet. 2005 Sep 3-9;366(9488):809-17.

International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion.

Molyneux AJ¹, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, Sandercock P; International Subarachnoid Aneurysm Trial (ISAT) Collaborative Group.

Author information

FINDINGS:

.....250 (23.5%) of 1063 patients allocated to endovascular treatment were dead or dependent at 1 year, compared with 326 (30.9%) of 1055 patients allocated to neurosurgery, an absolute risk reduction of 7.4% (95% CI 3.6-11.2, $p=0.0001$).

The early survival advantage was maintained for up to 7 years and was significant (log rank $p=0.03$)......

INTERPRETATION:

In patients with ruptured intracranial aneurysms suitable for both treatments, endovascular coiling is more likely to result in independent survival at 1 year than neurosurgical clipping; the survival benefit continues for at least 7 years. The risk of late rebleeding is low, but is more common after endovascular coiling than after neurosurgical clipping.

Risk of recurrent subarachnoid haemorrhage, death, or dependence and standardised mortality ratios after clipping or coiling of an intracranial aneurysm in the International Subarachnoid Aneurysm Trial (ISAT): long-term follow-up



Andrew J Molyneux, Richard S C Kerr, Jacqueline Birks, Najib Ramzi, Julia Yarnold, Mary Sneade, Joan Rischmiller, for the ISAT collaborators

Summary

Background Our aim was to assess the long-term risks of death, disability, and rebleeding in patients randomly assigned to clipping or endovascular coiling after rupture of an intracranial aneurysm in the follow-up of the International Subarachnoid Aneurysm Trial (ISAT).

Methods 2143 patients with ruptured intracranial aneurysms were enrolled between 1994 and 2002 at 43 neurosurgical centres and randomly assigned to clipping or coiling. Clinical outcomes at 1 year have been previously reported. All UK and some non-UK centres continued long-term follow-up of 2004 patients enrolled in the original cohort. Annual follow-up has been done for a minimum of 6 years and a maximum of 14 years (mean follow-up 9 years). All deaths and rebleeding events were recorded. Analysis of rebleeding was by allocation and by treatment received. ISAT is registered, number ISRCTN49866681.

Findings 24 rebleeds had occurred more than 1 year after treatment. Of these, 13 were from the treated aneurysm (ten in the coiling group and three in the clipping group; log rank $p=0.06$ by intention-to-treat analysis). There were 8447 person-years of follow-up in the coiling group and 8177 person-years of follow-up in the clipping group. Four rebleeds occurred from a pre-existing aneurysm and six from new aneurysms. At 5 years, 11% (112 of 1046) of the patients in the endovascular group and 14% (144 of 1041) of the patients in the neurosurgical group had died (log-rank $p=0.03$). The risk of death at 5 years was significantly lower in the coiling group than in the clipping group (relative risk 0.77, 95% CI 0.61–0.98; $p=0.03$), but the proportion of survivors at 5 years who were independent did not differ between the two groups: endovascular 83% (626 of 755) and neurosurgical 82% (584 of 713). The standardised mortality rate, conditional on survival at 1 year, was increased for patients treated for ruptured aneurysms compared with the general population (1.57, 95% CI 1.32–1.82; $p<0.0001$).

Interpretation There was an increased risk of recurrent bleeding from a coiled aneurysm compared with a clipped aneurysm, but the risks were small. The risk of death at 5 years was significantly lower in the coiled group than it was in the clipped group. The standardised mortality rate for patients treated for ruptured aneurysms was increased compared with the general population.

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See *Reflection and Reaction*
page 414

See *In Context* page 423

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The durability of endovascular coiling versus neurosurgical clipping of ruptured cerebral aneurysms: 18 year follow-up of the UK cohort of the International Subarachnoid Aneurysm Trial (ISAT)



Andrew J Molyneux, Jacqueline Birks, Alison Clarke, Mary Sneade, Richard S C Kerr

Summary

Background Previous analyses of the International Subarachnoid Aneurysm Trial (ISAT) cohort have reported on the risks of recurrent subarachnoid haemorrhage and death or dependency for a minimum of 5 years and up to a maximum of 14 years after treatment of a ruptured intracranial aneurysm with either neurosurgical clipping or endovascular coiling. At 1 year there was a 7% absolute and a 24% relative risk reduction of death and dependency in the coiling group compared with the clipping group, but the medium-term results showed the increased need for re-treatment of the target aneurysm in the patients given coiling. We report the long-term follow-up of patients in this UK cohort.

Methods In ISAT, patients were randomly allocated to either neurosurgical clipping or endovascular coiling after a subarachnoid haemorrhage, assuming treatment equipoise, between Sept 12, 1994, and May 1, 2002. We followed up 1644 patients in 22 UK neurosurgical centres for death and clinical outcomes for 10·0–18·5 years. We assessed dependency as self-reported modified Rankin scale score obtained through yearly questionnaires. Data for recurrent aneurysms and rebleeding events were collected from questionnaires and from hospital and general practitioner records. The Office for National Statistics supplied data on deaths. This study is registered, number ISRCTN49866681.

Findings At 10 years, 674 (83%) of 809 patients allocated endovascular coiling and 657 (79%) of 835 patients allocated neurosurgical clipping were alive (odds ratio [OR] 1·35, 95% CI 1·06–1·73). Of 1003 individuals who returned a questionnaire at 10 years, 435 (82%) patients treated with endovascular coiling and 370 (78%) patients treated with neurosurgical clipping were independent (modified Rankin scale score 0–2; OR 1·25; 95% CI 0·92–1·71). Patients in the endovascular treatment group were more likely to be alive and independent at 10 years than were patients in the neurosurgery group (OR 1·34, 95% CI 1·07–1·67). 33 patients had a recurrent subarachnoid haemorrhage more than 1 year after their initial haemorrhage (17 from the target aneurysm).

Interpretation Although rates of increased dependency alone did not differ between groups, the probability of death or dependency was significantly greater in the neurosurgical group than in the endovascular group. Rebleeding was more likely after endovascular coiling than after neurosurgical clipping, but the risk was small and the probability of disability-free survival was significantly greater in the endovascular group than in the neurosurgical group at 10 years.

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See [Comment](#) page 666

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Improved Cognitive Outcomes With Endovascular Coiling of Ruptured Intracranial Aneurysms

Neuropsychological Outcomes From the International Subarachnoid Aneurysm Trial (ISAT)

Richard B. Scott, PhD; Fiona Eccles, DPhil; Andrew J. Molyneux, MBBChir; Richard S.C. Kerr, MS;
Peter M. Rothwell, FMedSci; Katherine Carpenter, Dip Psych

Conclusions—Cognitive impairment occurred in approximately one third of patients who were not otherwise disabled according to the modified Rankin Scale in N-ISAT and was more frequent in the neurosurgery group. These results have implications for management of ruptured intracranial aneurysms and more generally for interpretation of the outcomes of clinical trials that use the modified Rankin Scale. (*Stroke*. 2010;41:1743-1747.)

The Barrow Ruptured Aneurysm Trial

Clinical article

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Object. The purpose of this ongoing study is to compare the safety and efficacy of microsurgical clipping and endovascular coil embolization for the treatment of acutely ruptured cerebral aneurysms and to determine if one treatment is superior to the other by examining clinical and angiographic outcomes. The authors examined the null hypothesis that no difference exists between the 2 treatment modalities in the setting of subarachnoid hemorrhage (SAH). The current report is limited to the clinical results at 1 year after treatment.

Methods. The authors screened 725 patients with SAH, resulting in 500 eligible patients who were enrolled prospectively in the study after giving their informed consent. Patients were assigned in an alternating fashion to surgical aneurysm clipping or endovascular coil therapy. Intake evaluations and outcome measurements were collected by nurse practitioners independent of the treating surgeons. Ultimately, 238 patients were assigned to aneurysm clipping and 233 to coil embolization. The 2 treatment groups were well matched. There were no anatomical exclusions. Crossing over was allowed, but primary outcome analysis was based on the initial treatment modality assignment. Posttreatment care was standardized for both groups. Patient outcomes at 1 year were independently assessed using the modified Rankin Scale (mRS). A poor outcome was defined as an mRS score > 2 at 1 year. The primary outcome was based on the assigned group; that is, by intent to treat.

Results. One year after treatment, 403 patients were available for evaluation. Of these, 358 patients had actually undergone treatment. The remainder either died before treatment or had no identifiable source of SAH. A poor outcome (mRS score > 2) was observed in 33.7% of the patients assigned to aneurysm clipping and in 23.2% of the patients assigned to coil embolization (OR 1.68, 95% CI 1.08–2.61; $p = 0.02$). Of treated patients assigned to the coil group, 124 (62.3%) of the 199 who were eligible for any treatment actually received endovascular coil embolization. Patients who crossed over from coil to clip treatment fared worse than patients assigned to coil embolization, but no worse than patients assigned to clip occlusion. No patient treated by coil embolization suffered a recurrent hemorrhage.

Conclusions. One year after treatment, a policy of intent to treat favoring coil embolization resulted in fewer poor outcomes than clip occlusion. Although most aneurysms assigned to the coil treatment group were treated by coil embolization, a substantial number crossed over to surgical clipping. Although a policy of intent to treat favoring coil embolization resulted in fewer poor outcomes at 1 year, it remains important that high-quality surgical clipping be available as an alternative treatment modality. (DOI: 10.3171/2011.8.JNS101767)

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The Barrow Ruptured Aneurysm Trial: 3-year results

Clinical article

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Object. The authors report the 3-year results of the Barrow Ruptured Aneurysm Trial (BRAT). The objective of this ongoing randomized trial is to compare the safety and efficacy of microsurgical clip occlusion and endovascular coil embolization for the treatment of acutely ruptured cerebral aneurysms and to compare functional outcomes based on clinical and angiographic data. The 1-year results have been previously reported.

Methods. Two-hundred thirty-eight patients were assigned to clip occlusion and 233 to coil embolization. There were no anatomical exclusions. Crossovers were allowed based on the treating physician's determination, but primary outcome analysis was based on the initial assignment to treatment modality. Patient outcomes were assessed independently using the modified Rankin Scale (mRS). A poor outcome was defined as an mRS score > 2 . At 3 years' follow-up 349 patients who had actually undergone treatment were available for evaluation. Of the 170 patients who had been originally assigned to coiling, 64 (38%) crossed over to clipping, whereas 4 (2%) of 179 patients assigned to surgery crossed over to coiling.

Results. The risk of a poor outcome in patients assigned to clipping compared with those assigned to coiling (35.8% vs 30%) had decreased from that observed at 1 year and was no longer significant (OR 1.30, 95% CI 0.83–2.04, $p = 0.25$). In addition, the degree of aneurysm obliteration ($p = 0.0001$), rate of aneurysm recurrence ($p = 0.01$), and rate of retreatment ($p = 0.01$) were significantly better in the group treated with clipping compared with the group treated with coiling.

When outcomes were analyzed based on aneurysm location (anterior circulation, $n = 339$; posterior circulation, $n = 69$), there was no significant difference in the outcomes of anterior circulation aneurysms between the 2 assigned groups across time points (at discharge, 6 months, 1 year, or 3 years after treatment). The outcomes of posterior circulation aneurysms were significantly better in the coil group than in the clip group after the 1st year of follow-up, and this difference persisted after 3 years of follow-up. However, while aneurysms in the anterior circulation were well matched in their anatomical location between the 2 treatment arms, this was not the case in the posterior circulation where, for example, 18 of 21 posterior inferior cerebellar artery aneurysms were in the clip group.

Conclusions. Based on mRS scores at 3 years, the outcomes of all patients assigned to coil embolization showed a favorable 5.8% absolute difference compared with outcomes of those assigned to clip occlusion, although this difference did not reach statistical significance ($p = 0.25$). Patients in the clip group had a significantly higher degree of aneurysm obliteration and a significantly lower rate of recurrence and retreatment. In post hoc analysis examining only anterior circulation aneurysms, no outcome difference between the 2 treatment cohorts was observed at any recorded time point. Clinical trial registration no.: NCT01593267 (ClinicalTrials.gov).

(<http://thejns.org/doi/abs/10.3171/2013.3.JNS12683>)

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The Barrow Ruptured Aneurysm Trial: 6-year results

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Shahram Partovi, MD,⁴ Peter Nakaji, MD,¹ and Robert C. Wallace, MD⁴

Divisions of ¹Neurological Surgery, and ⁴Neuroradiology, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, Phoenix, Arizona; and Departments of ²Neurology and ³Epidemiology and Biostatistics, University of California, San Francisco, California

OBJECT The authors report the 6-year results of the Barrow Ruptured Aneurysm Trial (BRAT). This ongoing randomized trial, with the final goal of a 10-year follow-up, compares the safety and efficacy of surgical clip occlusion and endovascular coil embolization in patients presenting with subarachnoid hemorrhage (SAH) from a ruptured aneurysm. The 1- and 3-year results of this trial have been previously reported.

METHODS In total, 500 patients with an SAH met the entry criteria and were enrolled in the study. Of these patients, 471 were randomly assigned to the treatments: 238 to surgical clipping and 233 to endovascular coiling. Six patients who died before treatment and 57 patients with nonaneurysmal SAHs were excluded, leaving a total of 408 patients who underwent clipping (209 assigned) or coiling (199 assigned). Whether to treat patients within the assigned group or to cross over patients to the other group was at the discretion of the treating physician; 38% (75/199) of the patients assigned to coiling were crossed over to clipping and 1.9% (4/209) assigned to clipping were crossed over to coiling. The outcome data were collected by a dedicated nurse practitioner. The primary outcome analysis was based on the assigned treatment group; poor outcome was defined as a modified Rankin Scale (mRS) score > 2 and was independently adjudicated. Six years after randomization, 336 (82%) of 408 patients who had been treated were available for examination.

RESULTS On the basis of an mRS score of > 2, and similar to the results at the 3-year follow-up, no significant difference in outcomes ($p = 0.24$) was detected between the 2 treatment groups. Complete aneurysm obliteration at 6 years was achieved in 96% (111/116) of the clipping group and in 48% (23/48) of the coiling group ($p < 0.0001$). In the period between the 3- and 6-year follow-ups, 3 additional patients assigned to coiling and none assigned to clipping received retreatment, for overall retreatment rates of 4.6% (13/280) for clipping and 16.4% (21/128) for coiling ($p < 0.0001$).

When aneurysm location was considered, the 6-year results continued to match the previously reported results, with no difference in outcome for anterior circulation aneurysms at most time points. Of the anterior circulation aneurysms assigned to coiling treatment, 42% (70/168) were crossed over to clipping treatment. The outcomes for posterior circulation aneurysms continued to favor coiling. The randomization process was unexpectedly skewed, with 18 of 21 treated aneurysms of the posterior inferior cerebellar artery (PICA) being assigned to clipping, but even when PICA aneurysms were removed from the analysis, outcomes for the posterior circulation aneurysms still favored coiling.

CONCLUSIONS Although BRAT was statistically underpowered to detect small differences, these results suggest little difference in outcome between the 2 treatments for anterior circulation aneurysms. This was not the case for the posterior circulation aneurysms, where coil embolization appeared to provide a sustained advantage over clipping. Aneurysm obliteration rates in BRAT were significantly lower and retreatment rates significantly higher in the patients undergoing coiling than in those undergoing clipping. However, despite the fact that retreatment rates were higher after coiling, no recurrent hemorrhages were known to have occurred in patients undergoing coiling in BRAT who were followed up for 6 years. Sufficient questions remain about the relative benefits of the 2 treatment modalities to warrant further well-designed randomized trials.

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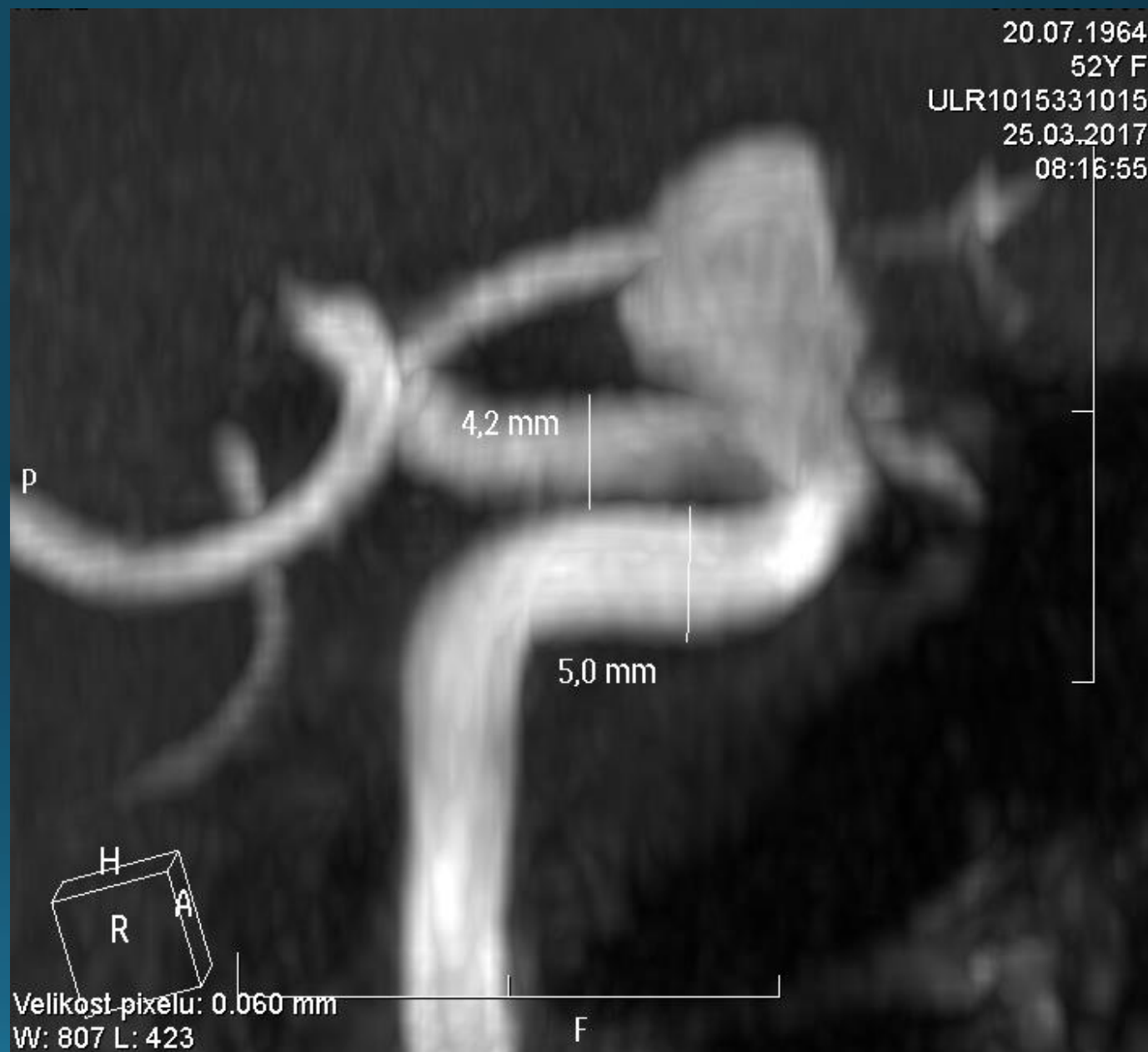
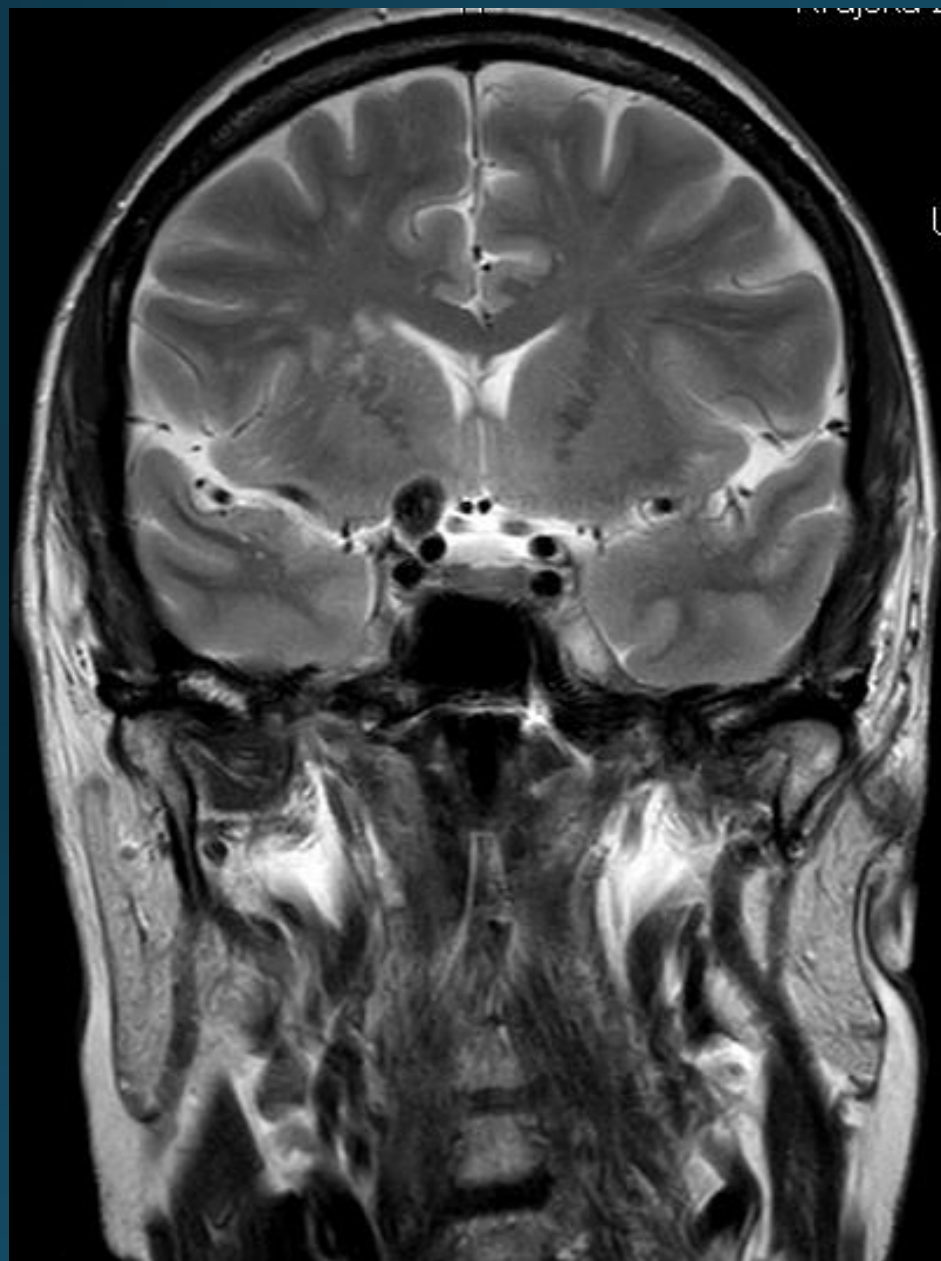
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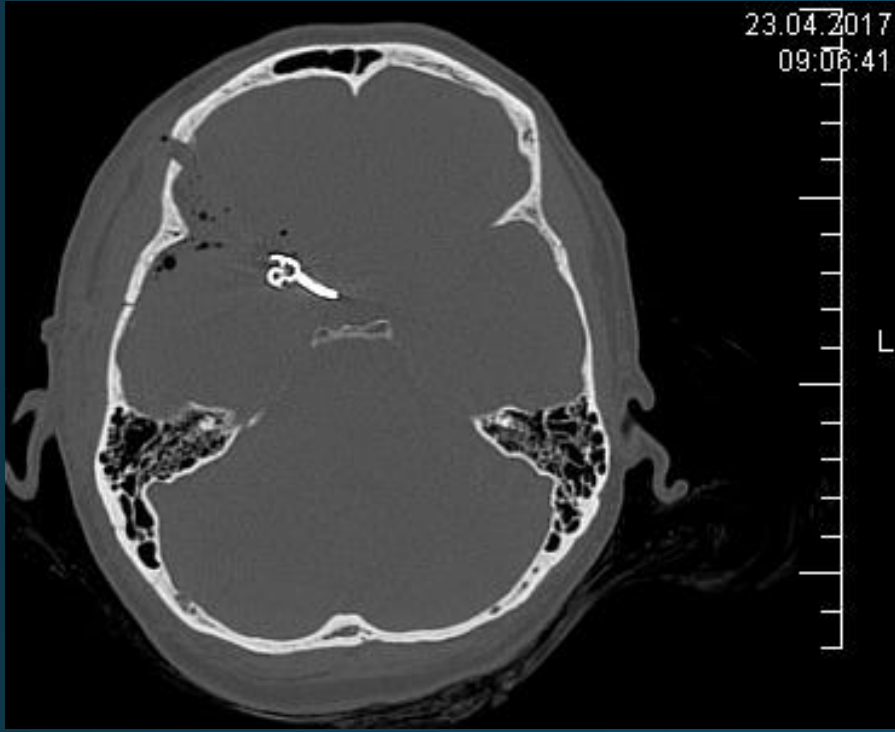
JUHA HERNESNIEMI

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NEUROKIRURGIAN KLINIKAN YLILÄÄKÄRI HELSINGIN TÖÖLÖN SAIRAALASSA

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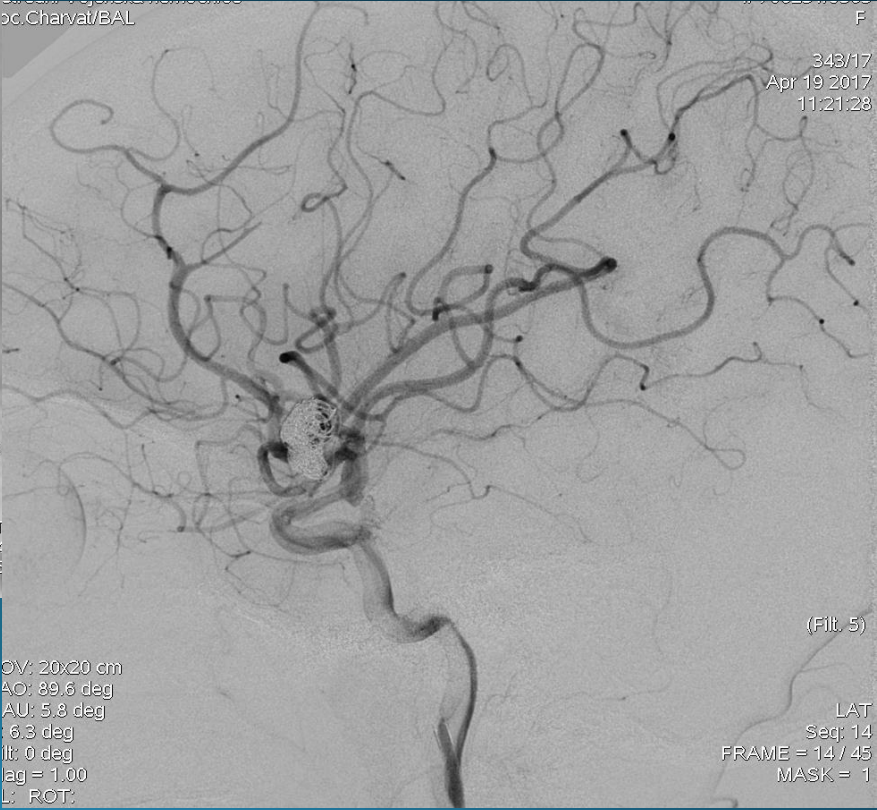
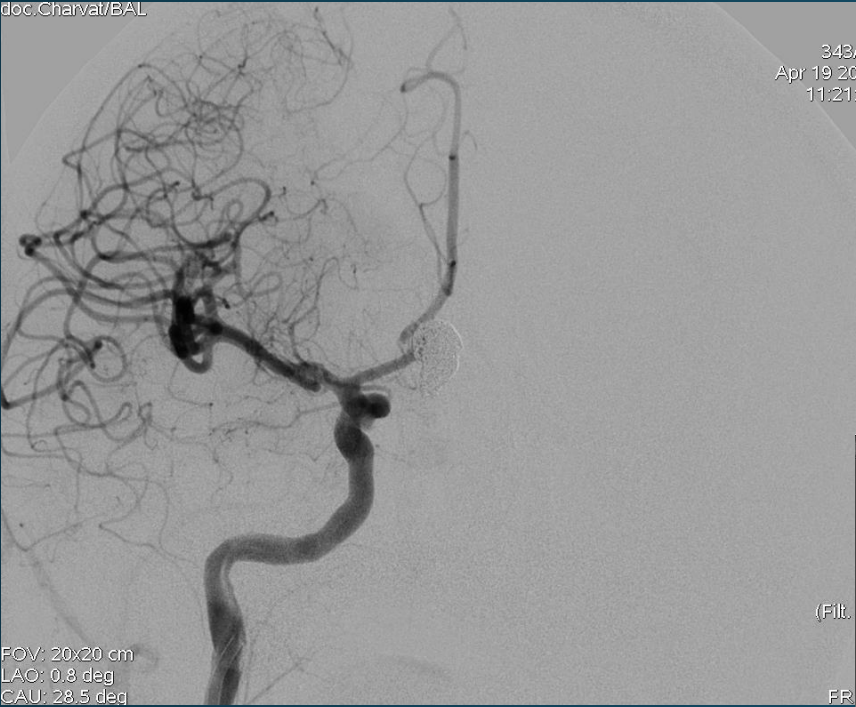






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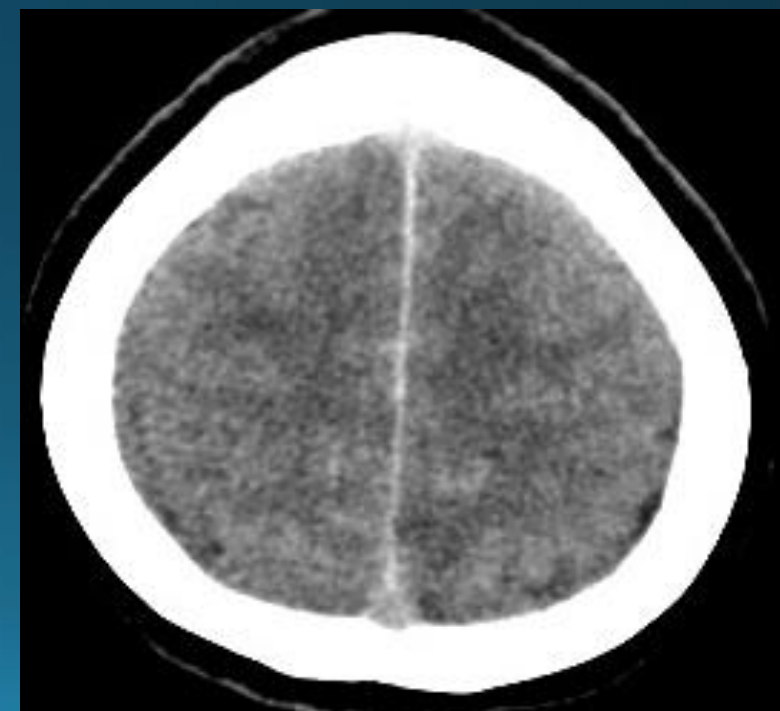


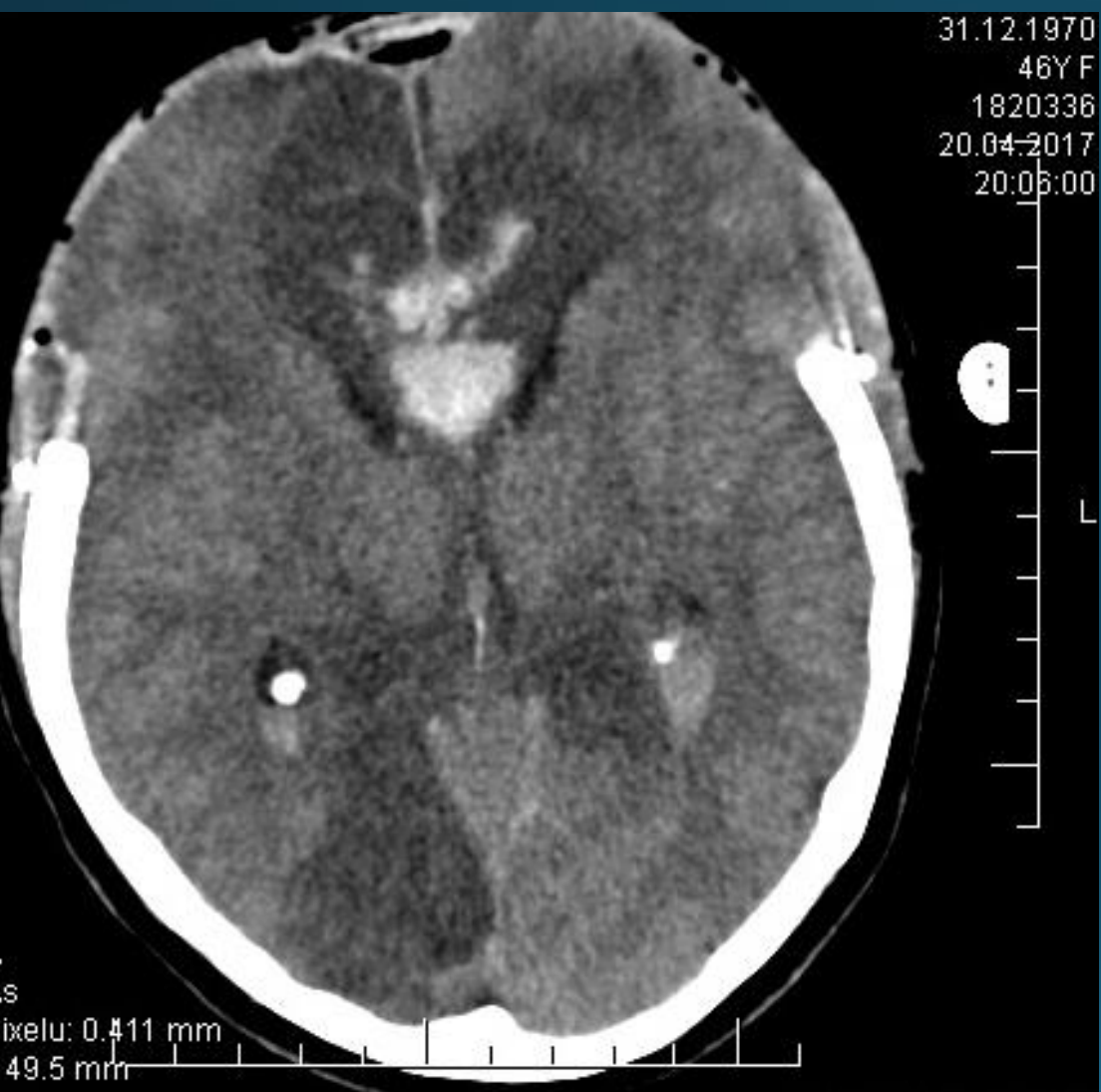
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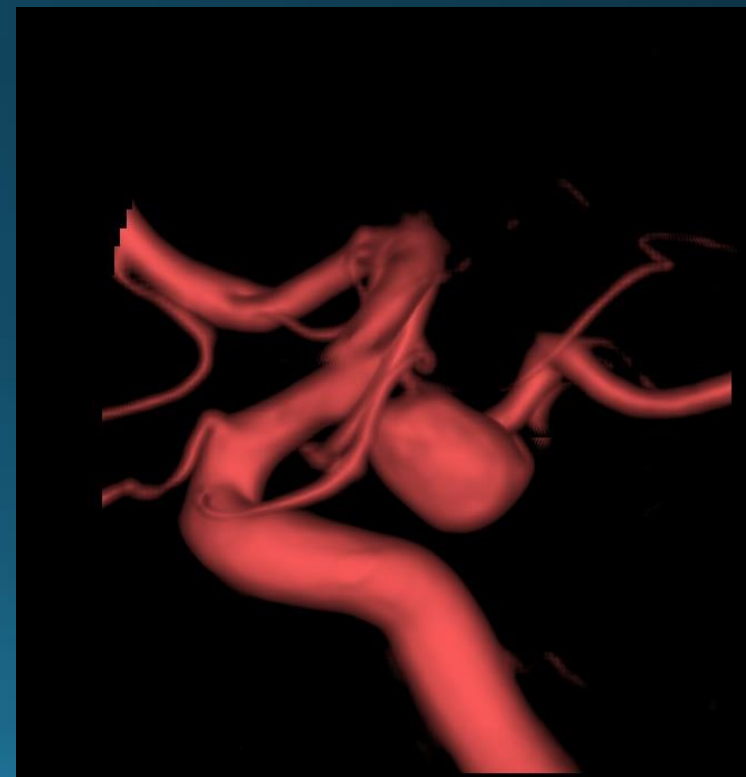
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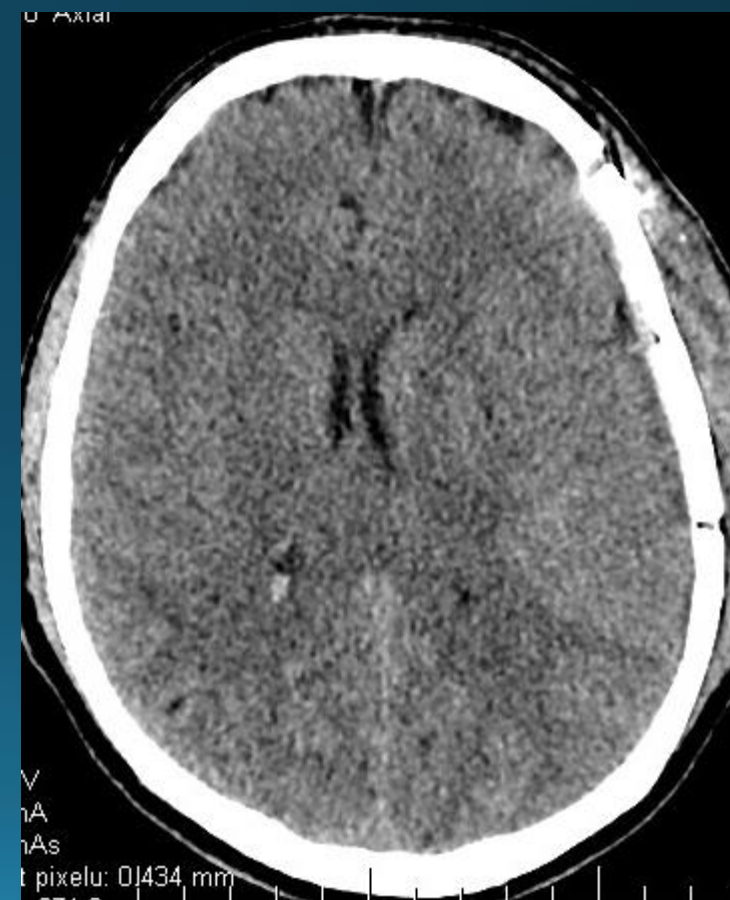
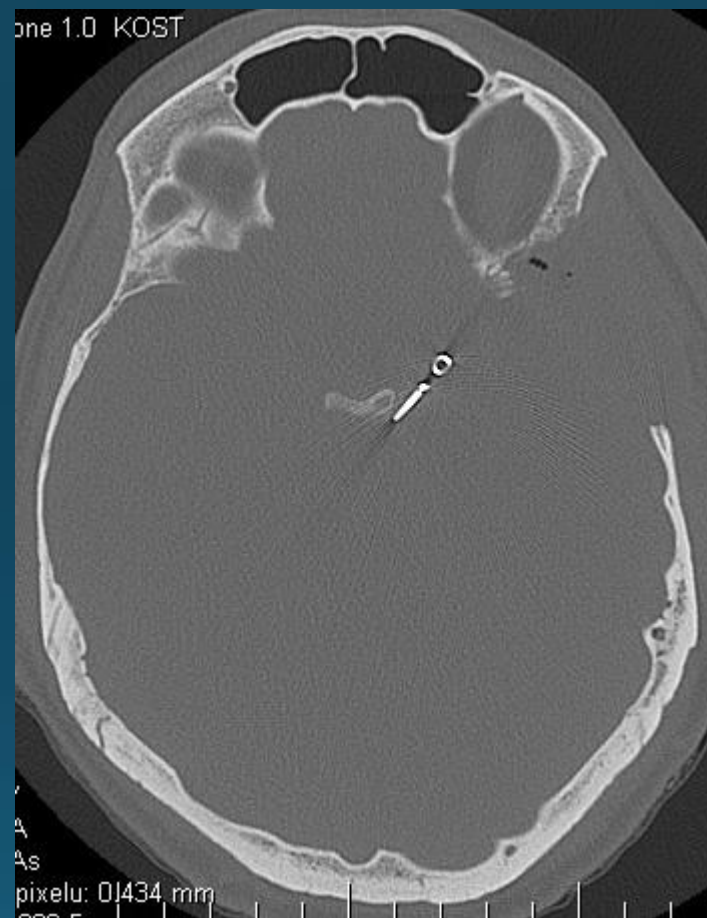
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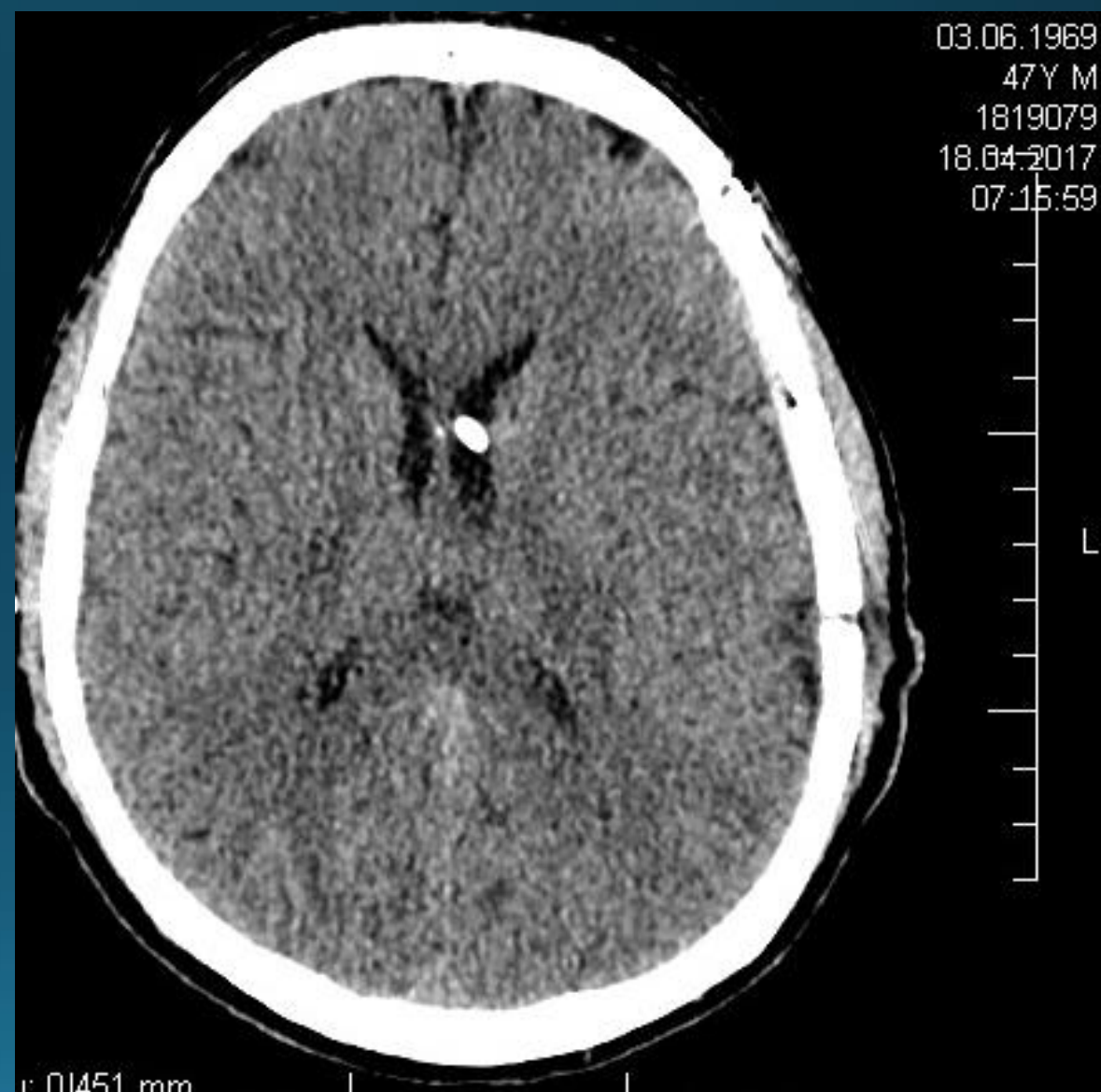
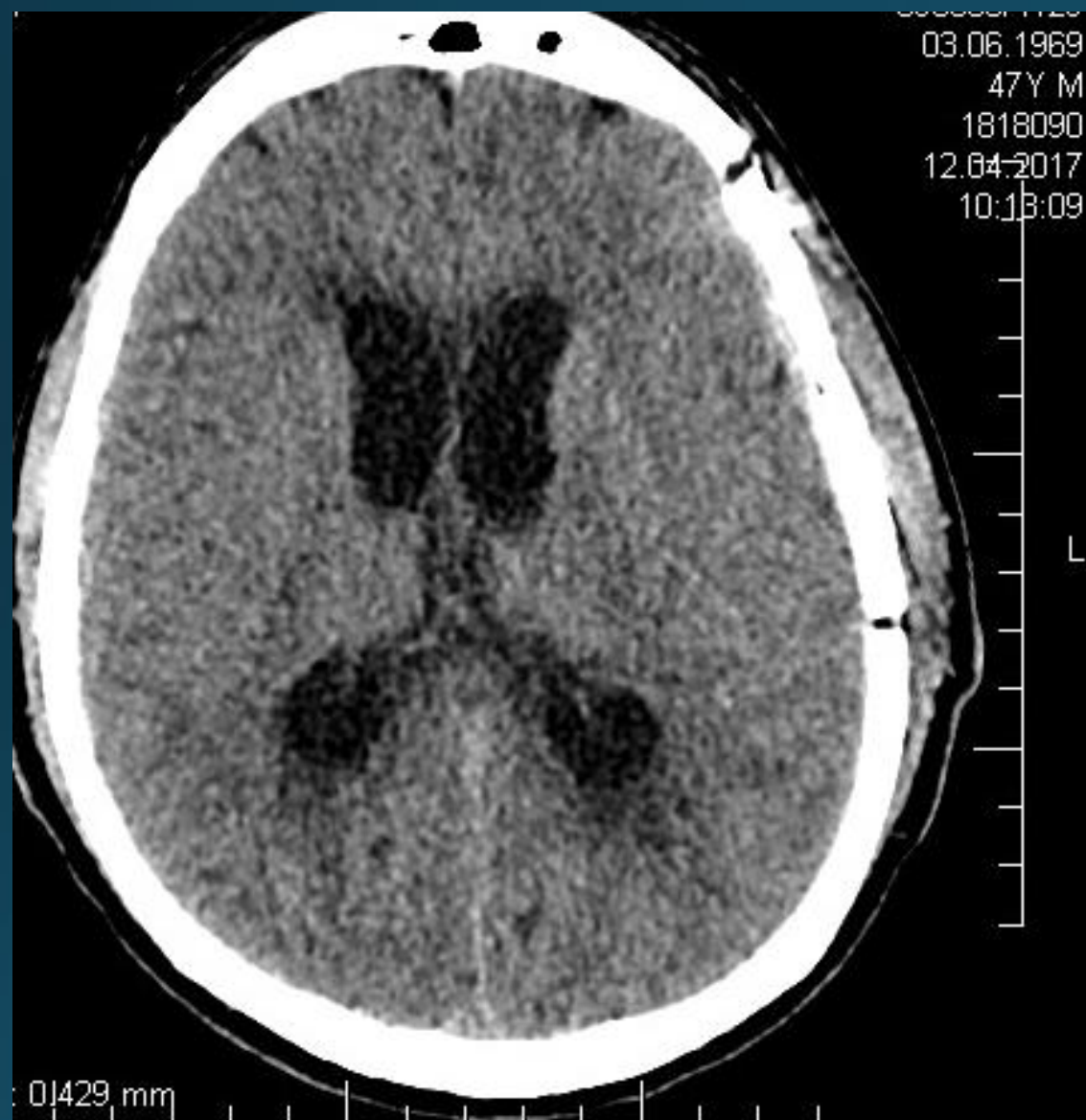












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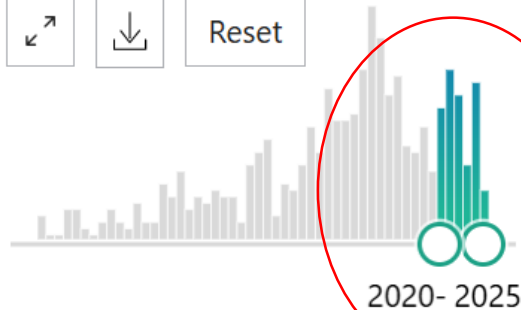
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81 results

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RESULTS BY YEAR


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2020- 2025


 Filters applied: in the last 5 years, Randomized Controlled Trial. [Clear all](#)


1

Asymptomatic Hemorrhagic Events and Functional Outcomes in Acute Stroke: A Secondary Analysis of the DIRECT-MI Randomized Clinical Trial.

[Cite](#)

Chen R, Hua W, Zhang Y, Zhang Y, Zhang H, Zhang Y, Liu J, Yang P, Zhang X, Zhang L.

JAMA Netw Open. 2025 Mar 3;8(3):e252411. doi: 10.1001/jamanetworkopen.2025.2411.

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PMID: 40152857

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[Clinical Trial.](#)

IMPORTANCE: Asymptomatic hemorrhagic infarction (HI) and **subarachnoid hemorrhage** (SAH) after endovascular treatment (EVT) for acute ischemic stroke are commonly considered low risk, but their long-term impact on functional outcomes is unclear. ...RESULTS: A total of ...

PUBLICATION DATE

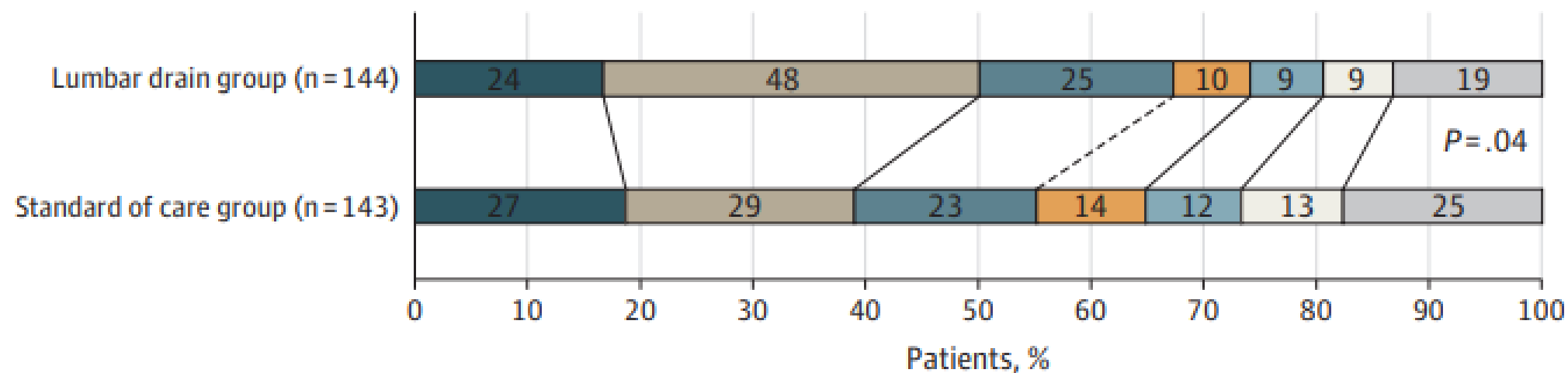
☐ 1 year

☒ 5 years

Effectiveness of Lumbar Cerebrospinal Fluid Drain Among Patients With Aneurysmal Subarachnoid Hemorrhage A Randomized Clinical Trial

INTERVENTION A total of 144 patients were randomized to receive an additional lumbar drain after aneurysm treatment and 143 patients to standard of care only. Early lumbar drainage with 5 mL per hour was started within 72 hours of the subarachnoid hemorrhage.

subarachnoid hemorrhage. At 6 months, 47 patients (32.6%) in the lumbar drain group and 64 patients (44.8%) in the standard of care group had an unfavorable neurological outcome (risk ratio, 0.73; 95% CI, 0.52 to 0.98; absolute risk difference, -0.12; 95% CI, -0.23 to -0.01; $P = .04$). Patients treated with a lumbar drain had fewer secondary infarctions at discharge (41 patients [28.5%] vs 57 patients [39.9%]; risk ratio, 0.71; 95% CI, 0.49 to 0.99; absolute risk difference, -0.11; 95% CI, -0.22 to 0; $P = .04$).



Key Points Question

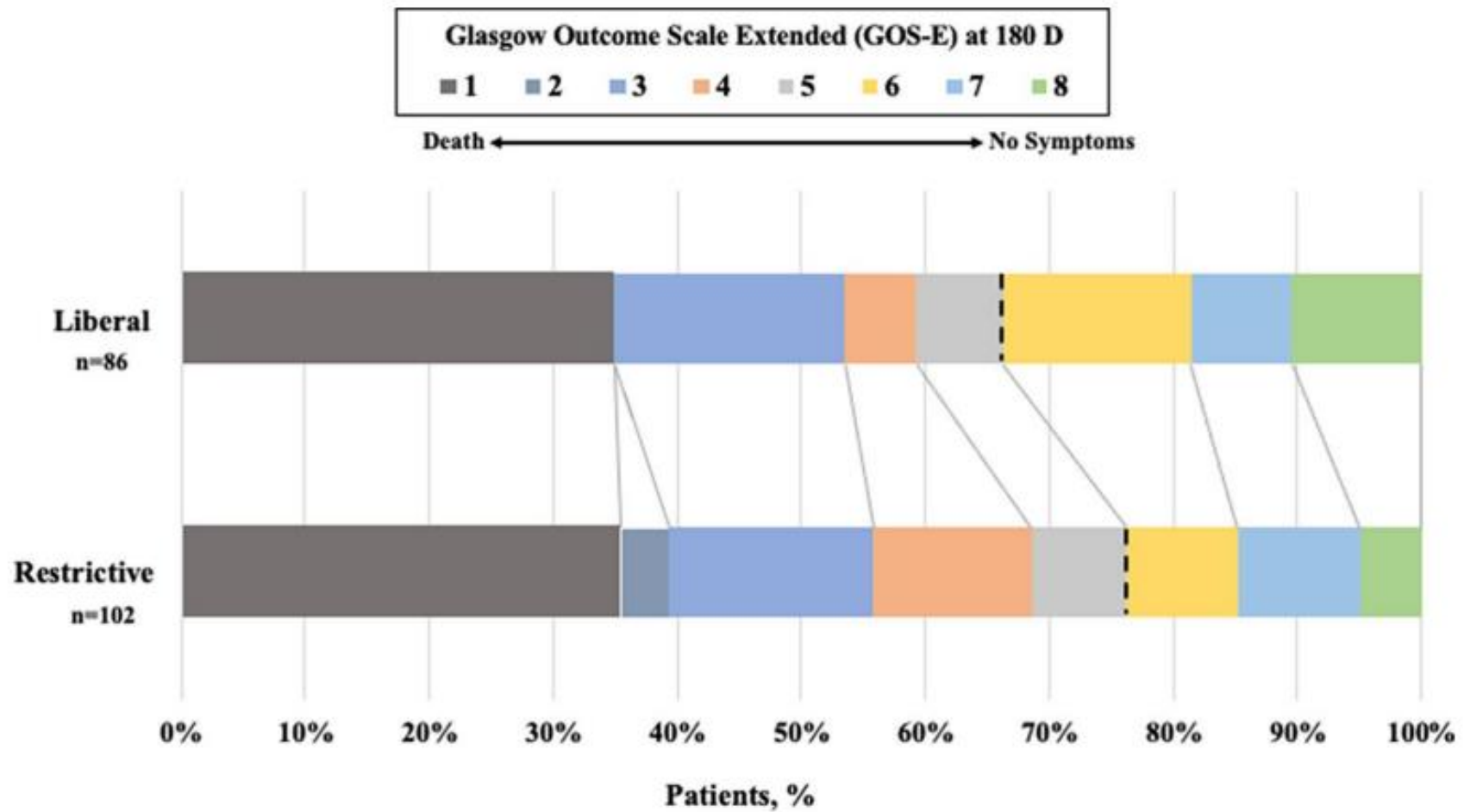
- Does prophylactic lumbar cerebrospinal fluid drainage improve clinical outcomes measured by the modified Rankin Scale score among patients with aneurysmal subarachnoid hemorrhage?
- Among patients with aneurysmal subarachnoid hemorrhage, lumbar drainage improved clinical neurological outcomes at 6 months.

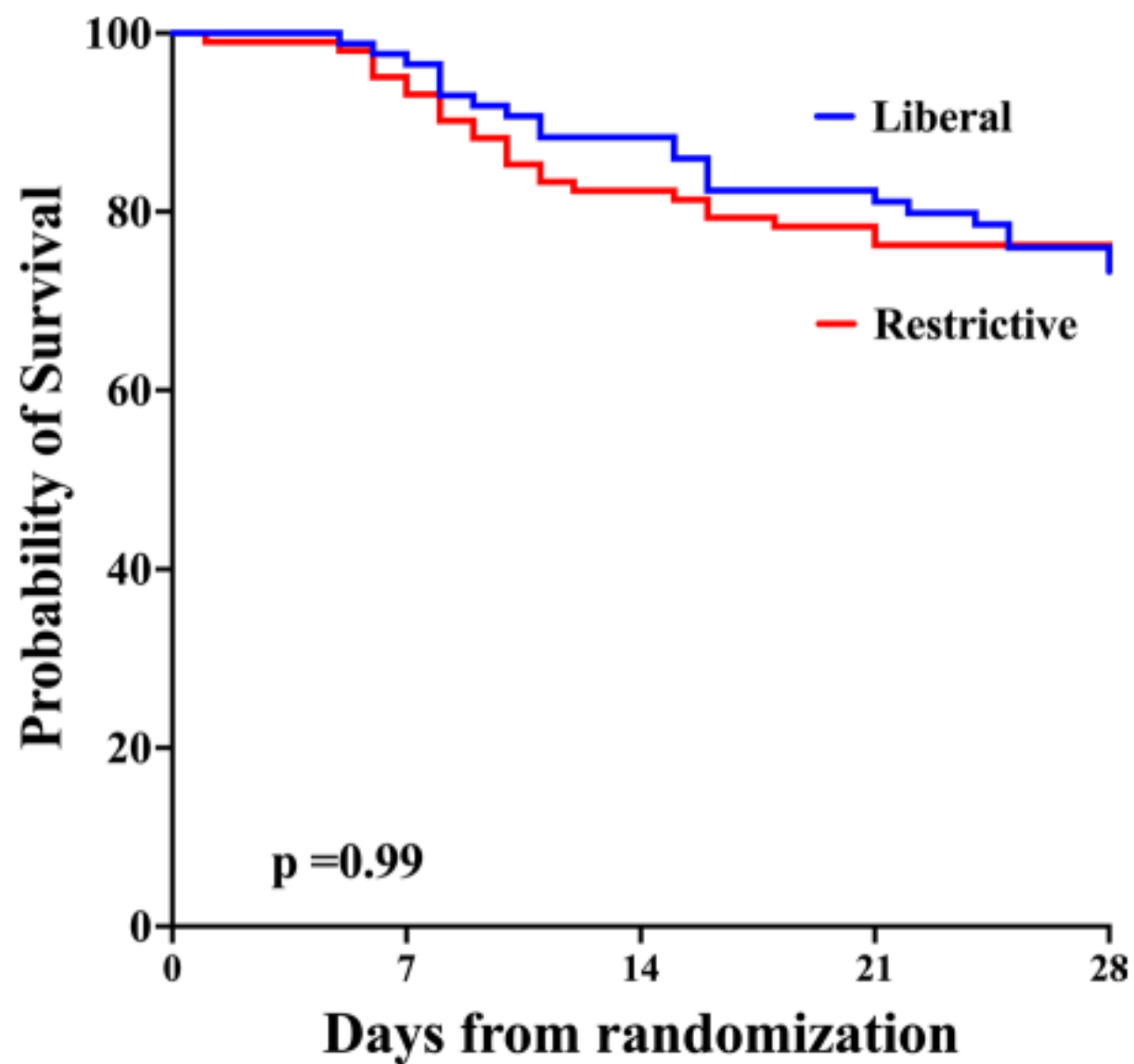
Taleb et al. Critical Care, 2025

Liberal versus restrictive transfusion strategies in subarachnoid hemorrhage: a secondary analysis of the TRAIN study

- TRAIN trial [26], a prospective, multi-center, phase 3, parallel-group, randomized, investigator-initiated, pragmatic, openlabel, outcome-assessor blinded study conducted in 72 ICUs across 22 countries (NCT02968654).

- a restrictive group: transfusions were given when Hb levels dropped below 7 g/dL
- liberal group: transfusions were administered at levels below 9 g/dL.



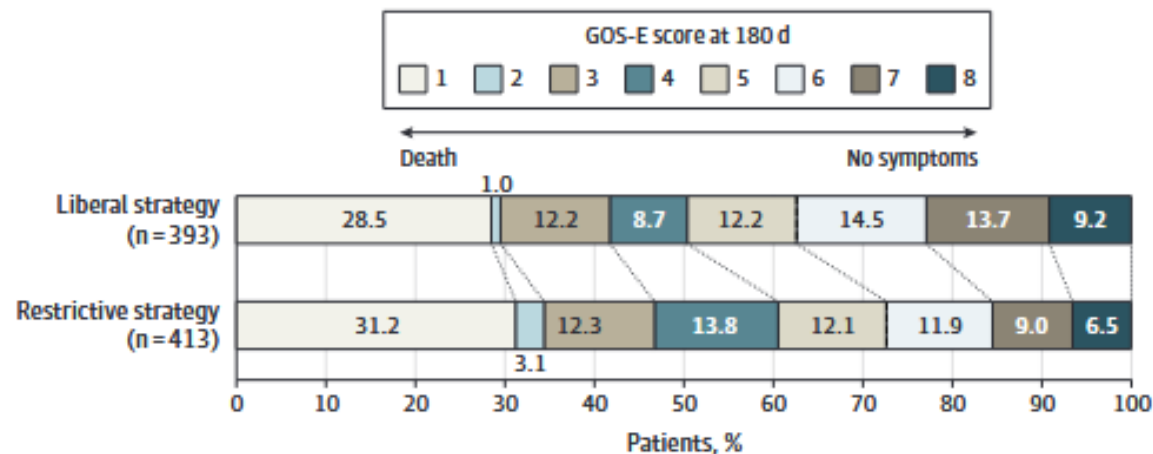


- a multivariable analysis indicated that being randomized to the liberal group was independently associated with higher rates of favorable outcome.
- Interestingly, patients that had a liberal transfusion strategy exhibited a lower incidence of cerebral ischemia of any cause.

Restrictive vs Liberal Transfusion Strategy in Patients With Acute Brain Injury The TRAIN Randomized Clinical Trial

- Patients with acute brain injury and anemia randomized to a liberal transfusion strategy were less likely to have an unfavorable neurological outcome than those randomized to a restrictive strategy.

Figure 4. Distribution of Glasgow Outcome Scale Extended (GOS-E) Scores 180 Days After Randomization (Secondary Outcome)



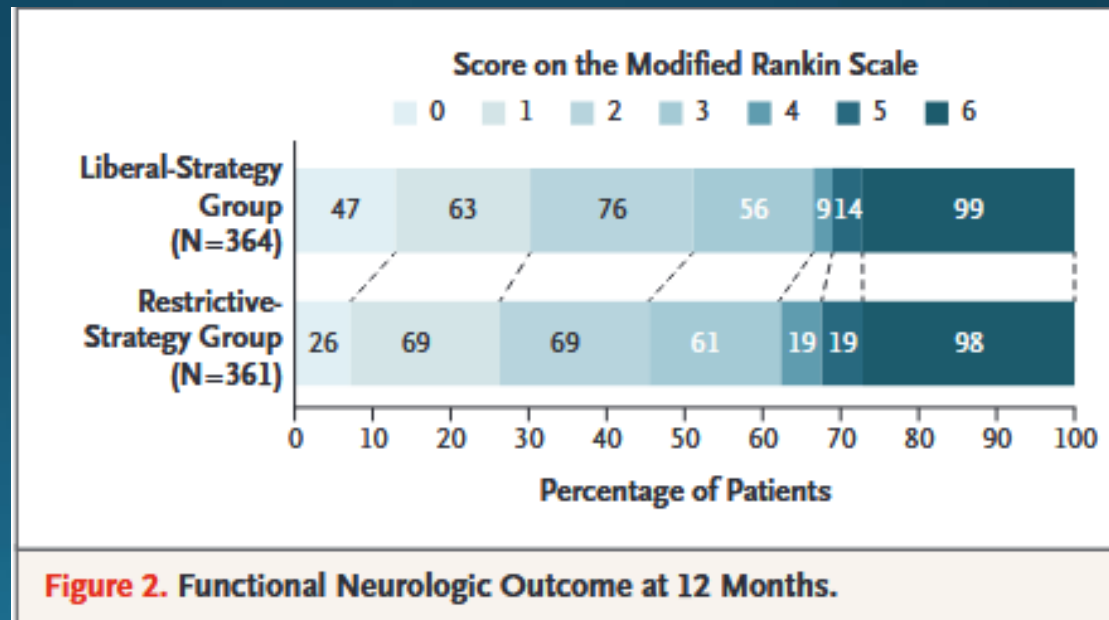
Each cell corresponds to a score on the scale; the width of each cell represents the percentage of patients with that score. The vertical dashed line indicates the GOS-E score used for dichotomization.

Liberal or Restrictive Transfusion Strategy in Aneurysmal Subarachnoid Hemorrhage

Shane W. English, et al.

N Engl J Med 2025;392:1079-1088

- In patients with aneurysmal subarachnoid hemorrhage and anemia, a liberal transfusion strategy did not result in a lower risk of an unfavorable neurologic outcome at 12 months than a restrictive strategy.



Localized Nicardipine Release Implants for Prevention of Vasospasm After Aneurysmal Subarachnoid Hemorrhage, Wessels L, et al., JAMA Neurol. 2024;81(10):1060-1065

- 39 patients were included in the primary efficacy analysis.
- In the control group, 11 of 19 patients (58%) developed moderate or severe aVS compared with 4 of 20 patients (20%) in the implant group ($P = .02$).
- a lower clinical need for vasospasm rescue therapy in the implant group (2 of 20 patients [10%]) compared with the control group (11 of 19 patients [58%]; $P = .002$).
- new cerebral infarcts were noted in 6 of 19 patients (32%) in the control group and in 2 of 20 patients (10%) in the implant group ($P = .13$).
- At 52 weeks, favorable outcomes were noted in 12 of 18 patients (67%) in the control group and 16 of 19 patients (84%) in the implant group ($P = .27$).

Ultra-Early and Short-Term Tranexamic Acid Treatment in Patients With Good- and Poor-Grade Aneurysmal Subarachnoid Hemorrhage, Tjerkstra MA, Neurology, 2024

- important argument against the use of TXA treatment in patients with aSAH, by showing worse clinical outcomes in patients with good-grade aSAH treated with TXA and no clinical benefit of TXA in patients with poor-grade aSAH,

14

Surg	AN prasklá	18	15	8	17	15	21	26	14	10	5	4	5	4	24	153
	AN neprasklá	20	25	4	2	19	28	14	19	11	21	3	14	3	8	146
Endo	AN prasklá	20	22	2		14	12	10	11	18	8		22	8	28	133
	AN neprasklá	30	26	1		4	13	5	14	47	19		12	9	10	134

Surg	AN prasklá	18	15	8	17	15	21	26	14	10	5	4	5	4	24
	AN neprasklá	20	25	4	2	19	28	14	19	11	21	3	14	3	8
Endo	AN prasklá	20	22	2		14	12	10	11	18	8		22	8	28
	AN neprasklá	30	26	1		4	13	5	14	47	19		12	9	10

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Surg	AN prasklá	18	15	8	15	21	26	14	10	5	5	4	24
	AN neprasklá	20	25	4	19	28	14	19	11	21	14	3	8
Endo	AN prasklá	20	22	2	14	12	10	11	18	8	22	8	28
	AN neprasklá	30	26	1	4	13	5	14	47	19	12	9	10

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Surg	AN prasklá	18	15	15	21	26	14	10	5	5	24
	AN neprasklá	20	25	19	28	14	19	11	21	14	8
Endo	AN prasklá	20	22	14	12	10	11	18	8	22	28
	AN neprasklá	30	26	4	13	5	14	47	19	12	10

Surg	AN prasklá	18	15	15	21	26	14	10	5	5	24	
	AN neprasklá	20	25	19	28	14	19	11	21	14	8	
Endo	AN prasklá	20	22	14	12	10	11	18	8	22	28	
	AN neprasklá	30	26	4	13	5	14	47	19	12	10	

8

Surg	AN prasklá	18	15	15	21	26	14	10	24
	AN neprasklá	20	25	19	28	14	19	11	8
Endo	AN prasklá	20	22	14	12	10	11	18	28
	AN neprasklá	30	26	4	13	5	14	47	10

SAH management

- Centra versus KCC
- Chir i endo
- Neexistuje 3H
- Stále nimodipine p.o.
- TCD
- Hypertenze
- PTA
- iv + ia léky experimentálně/studie

Treatment of unruptured and ruptured intracranial aneurysms

D. Netuka, N. Svoboda

Department of Neurosurgery and Neurooncology
1st Medical Faculty, Charles University, Central Military
Hospital, Prague, Czech Republic

Unruptured Intracranial Aneurysms

- • Epidemiology:
 - Prevalence aprox. 3.2%
 - Symptoms:
 - Asymptomatic 50-85%
 - H/A 10-35%
 - CN palsy 4-6%
 - Epi/cognitive 1-2%
 - Annual rupture rate: 0,5-1,5%

Real Prevalence?

> [J Neurol Neurosurg Psychiatry](#). 2022 Aug;93(8):902-907. doi: 10.1136/jnnp-2022-329270.
Epub 2022 Jun 10.

Prevalence of unruptured intracranial aneurysms: impact of different definitions – the Tromsø Study

Liv-Hege Johnsen ^{1 2}, Marit Herder ^{3 2}, Torgil Vangberg ^{2 4}, Roar Kloster ^{2 5},
Tor Ingebrigtsen ^{2 5}, Jørgen Gjernes Isaksen ^{# 2 5}, Ellisiv B Mathiesen ^{# 2 6}

- 1862 adults , 40-84 years
- 3-dimensional time-of-flight 3 Tesla MR
- saccular aneurysms ≥ 2 mm was 6.6%

Indication for Treatment

- Increased risk of rupture
 - outweighs procedural M/M
- Symptomatic

Rupture – Risk Factors

- Patient-Specific Risk Factors

Risk Factor	Relative Risk Increase	Annual Rupture Rate (%)
Hypertension (High Blood Pressure)	2-3X	1.0-3.0%
Smoking (Current or Past Smoker)	3-4X	2.0-4.0%
Excess Alcohol Consumption	2X	1.5-3.0%
Family History of Aneurysm Rupture	4X	2.0-5.0%
Prior Aneurysm Rupture (History of SAH)	4-6X	3.0-6.0%

Rupture – Risk Factors

- Patient-Specific Risk Factors

Risk Factor	Relative Risk Increase	Annual Rupture Rate (%)
Multiple Aneurysms	2X	1.5-3.0%
Age > 60 Years	1.5-2X	1.0-3.0%
Female Sex	1.5-2X	1.0-3.0%
Japanese or Finnish Ethnicity	2-4X	2.0-4.0%
Connective Tissue Disorders (e.g., Ehlers-Danlos, Marfan's Syndrome, Polycystic Kidney Disease)	5-10X	5.0-10.0%

Aneurysm-Specific Risk Factors

Risk Factor	Relative Risk of Rupture	Annual Rupture Rate (%)
Aneurysm Size	Larger aneurysms rupture more often	
<5 mm	Low risk	0.1-0.5%
5-7 mm	Moderate risk	0.5-1.0%
7-10 mm	Increased risk	1.0-3.0%
10-25 mm	High risk	3.0-10%
>25 mm (Giant aneurysm)	Very high risk	10-30%

Aneurysm-Specific Risk Factors

Risk Factor	Relative Risk of Rupture	Annual Rupture Rate (%)
Aneurysm Location	Posterior circulation & communicating arteries at higher risk	
Middle Cerebral Artery (MCA)	Reference (baseline risk)	0.5%
Anterior Communicating Artery (ACommA)	2x higher risk than MCA	1.0-2.0%
Posterior Communicating Artery (PCommA)	2-3x higher risk than MCA	1.5-3.0%
Basilar Artery Tip	High rupture risk	3.0-5.0%
Vertebrobasilar Aneurysms	Very high risk	5.0-10.0%

Aneurysm-Specific Risk Factors

Risk Factor	Relative Risk of Rupture	Annual Rupture Rate (%)
Aneurysm Shape	Irregular shape or presence of a "daughter sac" increases risk	
Smooth & round aneurysm	Reference (baseline)	0.5%
Irregular shape or daughter sac	2-5x higher risk	1.0-5.0%
Aneurysm Growth	Growth increases rupture risk significantly	
Stable aneurysm	Reference (baseline)	0.1%
Growing aneurysm	10-20x higher risk	3.1%

Small Aneurysms

- Annual risk 0,36% (review, 2017)
- 35% of ruptured aneurysms < 5 mm!!
- Increased risk:
 - Hypertension
 - Smoking
 - Anterior communicating artery aneurysms
 - Daughter sacs
 - Aspect ratio
 - Size ratio

Risk Assessment, Scores

Scoring System	Purpose	Key Features
PHASES Score	Predicts 5-year rupture risk	Most widely used
UIATS Score	Helps decide treatment vs. observation	Patient-centered
ELAPSS Score	Predicts aneurysm growth risk	Useful for follow-up planning
ISUIA Study	Older rupture risk data	Less accurate today
UCAS Japan	Japanese population rupture risk	Confirms PHASES findings

PHASES Score

PHASES SCORE					
POPULATION:		HYPERTENSION:		AGE:	
-North American, European (other than Finnish):	0 points	-No:	0 points	- <70 years:	0 points
-Japanese:	3 points	-Yes:	1 point	- ≥70 years:	1 point
-Finnish:	5 points				
SIZE OF ANEURYSM:		EARLIER SUBARACHNOID HEMORRHAGE (from other aneurysm):		SITE OF ANEURYSM:	
- < 7 mm:	0 points	-No:	0 points	-Internal carotid artery:	0 points
- 7-9.9 mm:	3 points	-Yes:	1 point	-Middle cerebral artery:	2 points
- 10-19.9 mm:	6 points			-Anterior communicating/Posterior communicating/Posterior circulation:	4 points
- ≥20 mm:	10 points				
5-YEAR ABOSLUTE RISK OF RUPTURE					
- ≤ 2 points:	0.4%	- 6 points:	1.7%	- 10 points:	5.3%
- 3 points:	0.7%	- 7 points:	2.4%	- 11 points:	7.2%
- 4 points:	0.9%	- 8 points:	3.2%	- ≥ 12 points:	17.8%
- 5 points:	1.3%	- 9 points:	4.3%		

UIATS

UIATS SCORE

PATIENT:

- Age: _____ 0-4 points
- Risk factors incidence: _____ 1-19 points
Previous SAH, familial UIA or SAH, ethnicity, current smoking, hypertension, autosomal polycystic kidney disease, current drug abuse, current alcohol abuse
- Clinical symptoms from UIA: _____ 1-12 points
Cranial nerve deficit, clinical or radiological mass effect, thrombo-embolic events, epilepsy
- Other: _____ 1-3 points
Reduced quality of life due to fear of rupture, aneurysm multiplicity
- Life expectancy: _____ 1-4 points
- Comorbid disease: _____ 2-7 points

ANEURYSM:

- Maximum diameter: _____ 0-4 points
≤3.9 mm, 4-6.9 mm, 7-12.9 mm, 13-24.9 mm, ≥ 25 mm
- Morphology: _____ 1-4 points
Irregularity or lobulation, size ratio >3 or aspect ratio >1.6
- Location: _____ 2-11 points
Basilar bifurcation, vertebrobasilar artery, anterior/posterior communicating arteries
- Other: _____ 1-8 points
Aneurysm growth, de novo formation, contralateral stenooclusive vessel disease

TREATMENT:

- Age related risk: _____ 0-5 points
<40, 41-60, 61-70, 71-80, >80 years
- Aneurysm size-related risk: _____ 0-5 points
<6 mm, 6-10 mm, 10.1-20 mm, >20 mm
- Aneurysm complexity-related risk: _____ 0-3 points
High, low
- Intervention related risk (constant): _____ 5 points

UIATS SCORE

- Favors UIA repair: points from Patient (age, risk factor incidence, clinical symptoms and other) and Aneurysm.
- Favors conservative management: points from Patient (life expectancy, comorbid disease) and Treatment.
- ≥3 points difference between these two options will suggest an individual treatment recommendation

Patient	Age (single)	< 40 years	4	☐	
		40-60 years	3		
		61-70 years	2		
		71-80 years	1		
		> 80 years	0		
	Risk factor incidence (multiple)	Previous SAH from a different aneurysm	4	☐	
		Familial intracranial aneurysms or SAH	3		
		Japanese, Finnish, Inuit ethnicity	2		
		Current cigarette smoking	3		
		Hypertension (systolic BP > 140 mm Hg)	2		
		Autosomal-polycystic kidney disease	2		
		Current drug abuse (cocaine, amphetamine)	2		
		Current alcohol abuse	1		
	Clinical Symptoms related to UIA (multiple)	Cranial nerve deficit	4	☐	
		Clinical or radiological mass effect	4		
		Thromboembolic events from the aneurysm	3		
		Epilepsy	1		
	Other (multiple)	Reduced quality of life due to fear of rupture	2	☐	
Aneurysm multiplicity		1			
Life expectancy due to chronic and/or malignant Diseases (single)	< 5 years	4	☐		
	5 - 10 years	3			
	> 10 years	1			
Comorbid disease (multiple)	Neurocognitive disorder	3	☐		
	Coagulopathies, thrombophilic diseases	2			
	Psychiatric disorder	2			
Aneurysm	Maximum diameter (single)	≤ 3.9 mm	0	☐	
		4.0-6.9 mm	1		
		7.0-12.9 mm	2		
		13.0-24.9 mm	3		
		≥ 25 mm	4		
	Morphology (multiple)	Irregularity or lobulation	3	☐	
		Size ratio > 3 or aspect ratio > 1.6	1		
	Location (single)	BasA bifurcation	5	☐	
		Vertebral/basilar artery	4		
		AcomA or PcomA	2		
	Other (multiple)	Aneurysm growth on serial imaging	4	☐	
		Aneurysm de novo formation on serial imaging	3		
		Contralateral stenooclusive vessel disease	1		
	Treatment	Age-related risk (single)	< 40 years	0	☐
41-60 years			1		
61-70 years			3		
71-80 years			4		
> 80 years			5		
Aneurysm size-related risk (single)		< 6.0 mm	0	☐	
		6.0-10.0 mm	1		
		10.1-20.0 mm	3		
		> 20 mm	5		
Aneurysm complexity-related risk		High	3	☐	
	Low	0			
Intervention-related risk	Constant*		☐	☐	

ELAPPS Score

Factor	Criteria	Points	Total ELAPSS score	3-year growth risk (%)	Recommended management
Earlier SAH	Previous subarachnoid hemorrhage	1	0–4	~3–5% (Low risk)	Longer intervals between imaging (e.g., every 2–3 years)
Location of aneurysm	MCA (middle cerebral artery)	0			
	ACA/PCA/Posterior circulation	4			
	ICA (internal carotid artery)	0			
Age (years)	<40	0	5–9	~10–20% (Moderate risk)	Regular surveillance imaging (e.g., annually)
	40–60	1			
	≥60	2			
Population	Japanese	0	≥10	~30–50% (High risk)	Consider treatment (clipping/coiling); close imaging follow-up
	Other populations	1			
Size (mm)	<5	0			
	≥5	3			
Shape	Regular shape	0			
	Irregular shape (daughter sacs, lobules)	4			

AI PREDICTION?

- Review over 20.000 pts
- IA prediction useful
- Does not demonstrate superiority

- Retrospective
- Over 5000 pts treated conservatively
- 5 ruptured
- IA was able to detect growth before rupture in all cases

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Machine Learning Algorithms to Predict the Risk of Rupture of Intracranial Aneurysms: a Systematic Review

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New devices and techniques
Original research

Artificial intelligence aneurysm measurement tool finds growth in all aneurysms that ruptured during conservative management


PDF

European Stroke Organisation (ESO) guidelines on management of unruptured intracranial aneurysms

Nima Etminan¹ , Diana Aguiar de Sousa^{2,3} , Cindy Tiseo⁴,
Romain Bourcier⁵, Hubert Desal⁵, Antti Lindgren^{6,7,8} ,
Timo Koivisto^{7,8}, David Netuka⁹, Simone Peschillo^{10,11},
Sabrina Lémeret¹² , Avtar Lal¹², Mervyn DI Vergouwen¹³
and Gabriel JE Rinkel^{1,13}

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ESO - UIA

- a multidisciplinary setting (neurosurgery, neuroradiology and neurology) at centers consulting >100 UIA patients per year
- to repair UIA only in centres performing the proposed treatment in >30 patients with (ruptured or unruptured) aneurysms per year per neurosurgeon or neurointerventionalist.

30 per interventionalist

Surg	38	40	34	49	40	33	21	32	
Endo	50	48	18	25	15	25	65	38	

PICO 1: In adult patients with unruptured intracranial aneurysms does any type of microsurgical or endovascular aneurysm occlusion compared to no aneurysm occlusion improve outcomes?

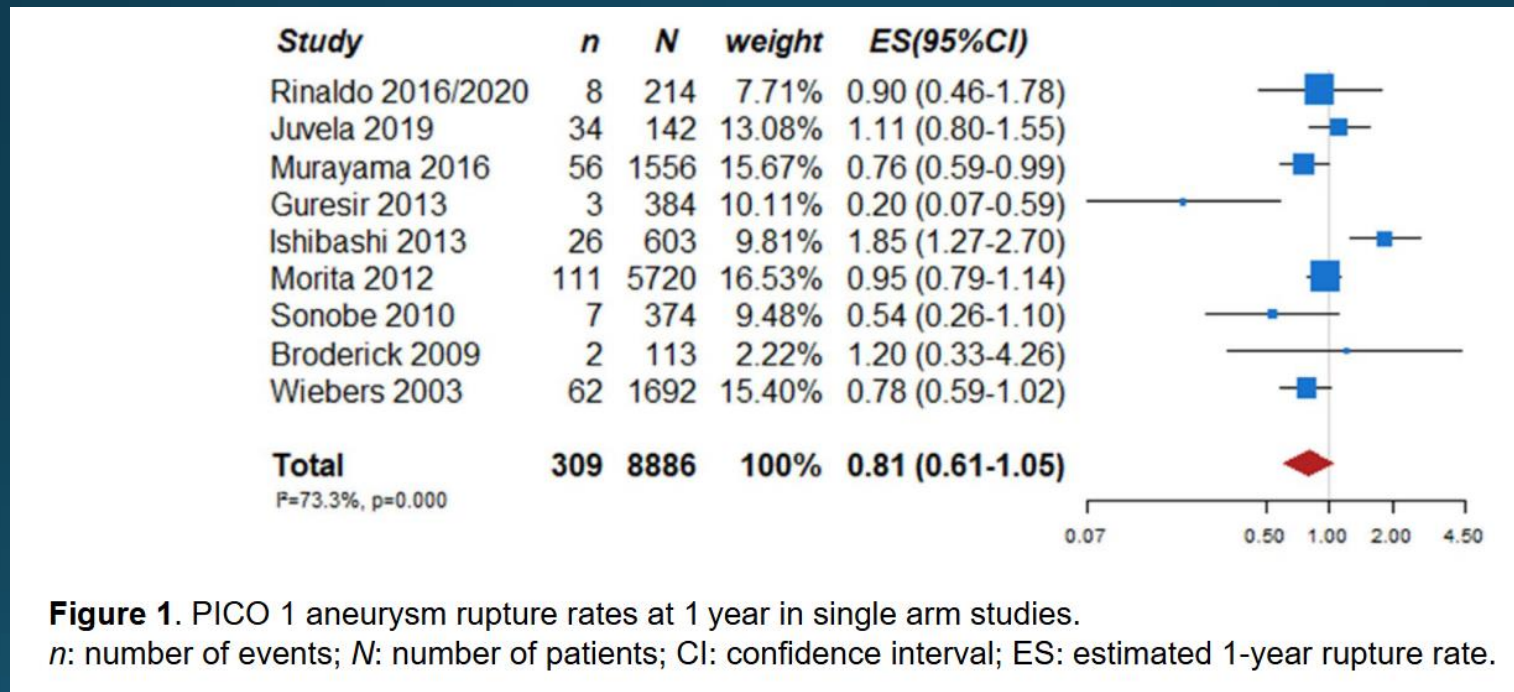


Figure 1. PICO 1 aneurysm rupture rates at 1 year in single arm studies.
n: number of events; *N*: number of patients; CI: confidence interval; ES: estimated 1-year rupture rate.

Evidence-based recommendation

In adult patients in whom the estimated 5-year risk of aneurysm rupture is higher than the risk of the preventive treatment modality, we suggest preventive aneurysm repair with the treatment modality that is most effective and safe for that particular aneurysm.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Weak for intervention** ↑?

In adult patients with growth of a UIA detected at follow up imaging, we suggest preventive aneurysm repair. However, despite an increased risk of rupture in such patients, this risk remains to be weighed against the risk of treatment complications.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Weak for intervention** ↑?

Expert opinion

For adult patients with UIA we suggest that the recommendation for versus against preventive aneurysm repair by the multidisciplinary team should be based on:

- aneurysm-related risk factors for rupture, that is, UIA size, location and lobulation,
- risk factors for rupture, that is, previous SAH from a different aneurysm, family history for UIA or SAH, smoking and hypertension,
- UIA growth (1 mm in any diameter) or de novo formation on serial imaging,
- life expectancy,
- risk factors for treatment complications, that is, patient age and comorbid disease, aneurysm morphology and complexity and estimated risk of treatment).

Expert opinion

In adult patients with UIA who present with clinical symptoms, such as cranial nerve deficits, mass effect and thromboembolic events, we suggest preventive aneurysm repair, taking into account life expectancy and risk of treatment complications.

In asymptomatic adult UIA patients with significant comorbid diseases and/or reduced life expectancy (<5 years), we suggest no preventive aneurysm repair.

Expert consensus statement

For adult patients with UIA we suggest assessing such patients within a multidisciplinary setting (i.e. neurosurgery, interventional neuroradiology neurology) at large volume centres (consulting at least 100 UIA patients per year).

For adult patients with UIA we suggest that the recommendation for versus against preventive aneurysm repair by the multidisciplinary team should be based on:

- aneurysm-related risk factors for rupture, that is, UIA size, location and lobulation,
- risk factors for rupture, that is, previous SAH from a different aneurysm, family history for UIA or SAH, smoking and hypertension,
- UIA growth (1 mm in any diameter) or de novo formation on serial imaging,
- life expectancy,
- risk factors for treatment complications, that is, patient age and comorbid disease, aneurysm morphology and complexity and estimated risk of treatment).

In adult patients with UIA who present with clinical symptoms, such as cranial nerve deficits, mass effect and thromboembolic events, we suggest preventive aneurysm repair, taking into account life expectancy and risk of treatment complications.

In asymptomatic adult UIA patients with significant comorbid diseases and/or reduced life expectancy (<5 years), we suggest no preventive aneurysm repair.

In adult patients with UIA we suggest that the final management decision is made in a shared decision-making process between the physician and the patient, based on the recommendation by the multidisciplinary team and patient-related psycho-sociological factors.

PICO 2: In adult patients with unruptured intracranial aneurysms does any type of microsurgical occlusion compared to any type of endovascular occlusion improve outcome?

Evidence-based recommendation

In adult patients with UIA, we cannot make an overall recommendation that states which UIA treatment modality (either endovascular or microsurgical) is preferred based on the current data.

Quality of evidence: **Very low** ⊕

Strength of recommendation: –

In adult patients with UIA, we suggest to take into account in the choice between endovascular and microsurgical treatment, the following conditions which impact on the risk/benefit profile of the procedures:

- increasing age (increased risk of complications for microsurgical treatment),
- female sex (slightly increased risk for endovascular therapy, strongly decreased risk for microsurgical treatment),
- indication for anticoagulation (strongly increased for microsurgical treatment),
- a broad neck of the aneurysm (increased risk for endovascular treatment), aneurysm calcification (increased risk for microsurgical treatment),
- location on the posterior circulation (slightly increased risk for endovascular therapy and strongly increased risk for microsurgical treatment).

PICO 2: In adult patients with unruptured intracranial aneurysms does any type of microsurgical occlusion compared to any type of endovascular occlusion improve outcome?

- FD only in very selected cases

In adult patients with UIA, we suggest flow diverting stents as a treatment option only if no other endovascular or microsurgical options to occlude the aneurysm (complete occlusion or neck remnant only) at a risk lower than the expected 5-year risk of rupture are available and if the risk of rupture outweighs the risk of treatment with flow diverting stents.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Weak against intervention**

↓?

PICO 3. In adult patients with unruptured intracranial aneurysms does any type and frequency of follow-up imaging followed by aneurysm occlusion in case of aneurysm growth or other change compared to no follow-up imaging improve outcome?

Evidence-based recommendation

In adult patients with a UIA in whom the risk of treatment complications is higher than the 5-year risk of rupture, we recommend radiological monitoring to detect future UIA growth or morphological change for patients in whom treatment remains an option that were initially observed.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Strong for intervention** ↑↑

In adult patients with a UIA that shows recent growth during radiological monitoring, we suggest preventive aneurysm repair. However, despite an increased risk of rupture in such patients, this risk remains to be weighed against the risk of treatment complications.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Weak for intervention** ↑?

Expert consensus statement

In adult patients with UIA undergoing radiological monitoring to detect potential aneurysm growth or morphological change, we suggest that the frequency and duration of follow-up imaging should be based on aneurysm- and patient-related risk factors of growth or rupture and risk of treatment. This should be agreed upon in a shared decision-making process between physician and patient based on the recommendation by the multidisciplinary team and patient-related psychosociological factors.

In adult patients with UIA undergoing radiological monitoring to detect potential aneurysm growth or morphological change, we suggest that radiological follow-up should be continued as long as preventive treatment remains an option.

In adult patients with UIA undergoing radiological monitoring to detect potential aneurysm growth or morphological change, we suggest that radiological follow-up should be performed with MRA or CTA.

PICO 4: In adult patients with unruptured intracranial aneurysms does any life-style modification or any medical treatment (e.g. anti-inflammatory drugs, antihypertensive drugs, statins) in comparison to no treatment improve outcome?

Evidence-based recommendation

In adult patients with UIA who smoke, we recommend smoking cessation.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Strong for intervention** ↑↑

In adult patients with UIA and hypertension, we recommend treatment of increased blood pressure.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Strong for intervention** ↑↑

In adult patients with UIA, we suggest to not start treatment with acetylsalicylic acid to decrease the risk of aneurysm growth or rupture.

Quality of evidence: **Very low** ⊕

Strength of recommendation: —

In adult patients with UIA, we suggest to not start treatment with statins to decrease the risk of aneurysm growth or rupture.

Quality of evidence: **Very low** ⊕

Strength of recommendation: —

Expert consensus statement

For adult patients with an UIA who do not undergo preventive occlusion, we suggest that there is no contra-indication for platelet aggregation inhibitors if needed for another indication.

For adult patients with an UIA who do not undergo preventive occlusion, we suggest keeping blood pressure <130/80mm Hg.

For adult patients with an UIA who do not undergo preventive occlusion, we suggest that no restrictions should be imposed regarding sexual activity or any physical or sporting activity.

PICO 5: In adult patients with occluded unruptured aneurysms, does any type and frequency of follow-up imaging compared to no follow-up imaging improve outcome?

Recommendations:

For adult patients with a treated UIA in whom aneurysm re-treatment remains an option, we suggest an initial radiological follow-up 3 to 12 months after UIA repair to detect potential UIA remnants or recurrence.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Weak for intervention** ↑?

In adult patients with a treated UIA and recurrence of the aneurysm, we recommend that the pros and cons of re-treatment in the short-term versus a future radiological follow-up are agreed upon in a shared decision-making process between the physician and patient based on the recommendation by the multidisciplinary team and patient-related psycho-sociological factors.

Quality of evidence: **Very low** ⊕

Strength of recommendation: **Strong for intervention** ↑↑

Expert consensus statement

We suggest that MR-angiography should be the primary tool for follow up imaging of endovascularly treated aneurysms, CTA for microsurgically treated aneurysms and that DSA should only be considered if MRA and CTA are not conclusive

Ruptured Aneurysms

- Incidence: ~10 per 100,000 annually
- Mortality: 30-50% within 6 months, improved
- 30% of survivors remain dependent

Surgical treatment

Surgical Method	Indications	Advantages	Limitations
Microsurgical Clipping	First-line for anterior circulation aneurysms , wide-neck aneurysms	Definitive occlusion , low recurrence	Higher perioperative risk
Aneurysm Trapping	Fusiform, dissecting aneurysms , cases with vessel rupture	Eliminates risk of rupture completely	Requires bypass revascularization to maintain blood flow
Aneurysm Wrapping	Fragile aneurysm walls, non-clipable aneurysms	Reinforces the wall, prevents growth	Does not fully occlude the aneurysm , risk of late rupture
Aneurysm Bypass with Trapping	Large, fusiform aneurysms requiring parent artery occlusion	Maintains cerebral blood flow	Technically challenging, risk of graft failure
Aneurysm Direct Suturing	Small aneurysm neck, intraoperative rupture	Vessel preservation, no implant needed	Limited to rare cases , technically challenging

Neurosurgical Equipment

- Neuronavigation
- Brain Relaxation-positioning, Mannitol, CSF release, etc.
- Retraction?
- Temporary clipping
 - MEP, SSEP, *awake*
- Proximal Control
 - ICA occlusion, adenosin, rapid ventricular pacing
- Distal control

Blood-flow after clipping

- Indocyanine Green (ICG)
- Micro-Doppler Ultrasound
- Intraoperative DSA

Endovascular treatment

- **Endovascular Coiling**
 - Indications: Small-medium aneurysms, high surgical risk patients
 - Limitations: Higher recurrence, incomplete occlusion in wide-neck aneurysms
- **Flow Diversion Stents (Pipeline, Surpass)**
 - Indications: Large, giant, and fusiform aneurysms
 - Limitations: Requires dual antiplatelet therapy, delayed aneurysm occlusion
- **Stent-Assisted Coiling**
 - Indications: Wide-neck or complex bifurcation aneurysms
 - Limitations: Higher thrombosis risk, requires antiplatelet therapy
- **Intrasaccular Flow Disruptors (WEB Device)**
 - Indications: Bifurcation aneurysms
 - Limitations: Limited to certain locations



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ÚSTAV KLINICKÝCH NEUROBORŮ
NEUROCHIRURGICKÁ A NEUROONKOLOGICKÁ KLINIKA
prof. MUDr. David Netuka, Ph. D.
přednosta



Kuncův memoriál 2025

26. června od 15 hodin

Novotného lávka 201/1, Praha 1 – Staré Město

Program

15:00 – 15:20

Úvod

15:00 – 15:05

D. Netuka

15:05 – 15:10

M. Vokurka

15:10 – 15:15

V. Masopust

15:15 – 15:20

M. Sameš

15:20 – 16:00

Zvaná přednáška

prof. PhDr. Martin Kovář, Ph.D.: Trumpova Amerika a/versus Evropa

16:30 – 17:30

16:30 – 16:40

16:40 – 16:50

16:50 – 17:00

17:00 – 17:15

17:15 – 17:30

Odborné přednášky

D. Netuka: ÚKN

D. Netuka: Klinická randomizovaná studie v časopise s IF 93,7

R. Voldřich: Léčba intraneurálních peroneálních gangliových cyst

R. Kučera: Komplexní spinální program?

M. Májovský: AI a denní praxe

17:30 – 18:10

17:30 – 17:40

17:40 – 17:50

17:50 – 18:00

18:00 – 18:10

Kazuistiky

J. Kašík: Spinální případ

M. May: Kraniální případ

T. Moravec: Bolestivý případ

M. Černý: Elektrofyziologický případ