



2025 Intracranial Hypotension

The origins of PDPH

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XVI.

Aus der Königlichen chirurgischen Klinik zu Kiel.

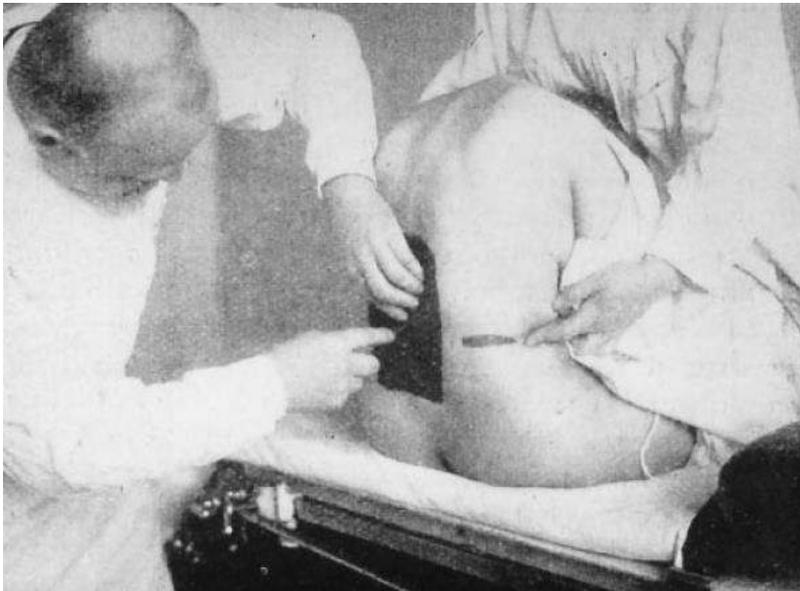
Versuche über Cocainisirung des Rückenmarkes.

Von

Prof. Dr. August Bier.

... Wir gingen beide ohne irgend welche Beschwerden nach diesen Versuchen am eigenen Körper zum Essen, tranken Wein und rauchten mehrere Cigarren. Ich ging um 11 Uhr zu Bett, schlief die ganze Nacht durch, erwachte am anderen Morgen frisch und gesund und machte einen einstündigen Spaziergang. Gegen das Ende desselben hin empfand ich leichte Kopfschmerzen, welche sich im Laufe des Tages, während ich meiner gewohnten Beschäftigung nachging, steigerten. Des Nachmittags gegen 3 Uhr wurde mein Gesicht blass, der Puls ziemlich klein, blieb aber regelmässig. Er bewegte sich um 70 Schläge in der Minute. Ferner bekam ich das Gefühl eines sehr heftigen Druckes im Schädel und bei schnellem Aufstehen vom Stuhle leichten Schwindel. Alle diese Erscheinungen schwanden sofort, sobald ich mich wagerecht hinlegte, fingen aber wieder an, wenn ich mich erhob. Ich musste mich deshalb gegen Abend zu Bett legen und 9 Tage das Bett hüten, weil beim Aufstehen sich alle die beschriebenen Erscheinungen wiederholten. Sobald ich dagegen wagerecht lag, fühlte ich mich vollkommen gesund. Appetit und Schlaf waren ungestört. Bei längerem Lesen wurde ich schwindelig.

9 Tage nach der Punktion waren alle diese Erscheinungen verschwunden. Nach weiteren 3 Tagen konnte ich ohne jede Störung eine längere Eisenbahnfahrt machen und zeigte mich den grossen Anstrengungen einer sich unmittelbar an die Fahrt anschliessenden achttägigen Jagd im Gebirge vollkommen gewachsen.



PDPH according to ICHD-3 (2018)

Symptoms within five days of a lumbar puncture
It remits spontaneously or after autologous epidural lumbar patch
Headache fulfills criteria for 7.2

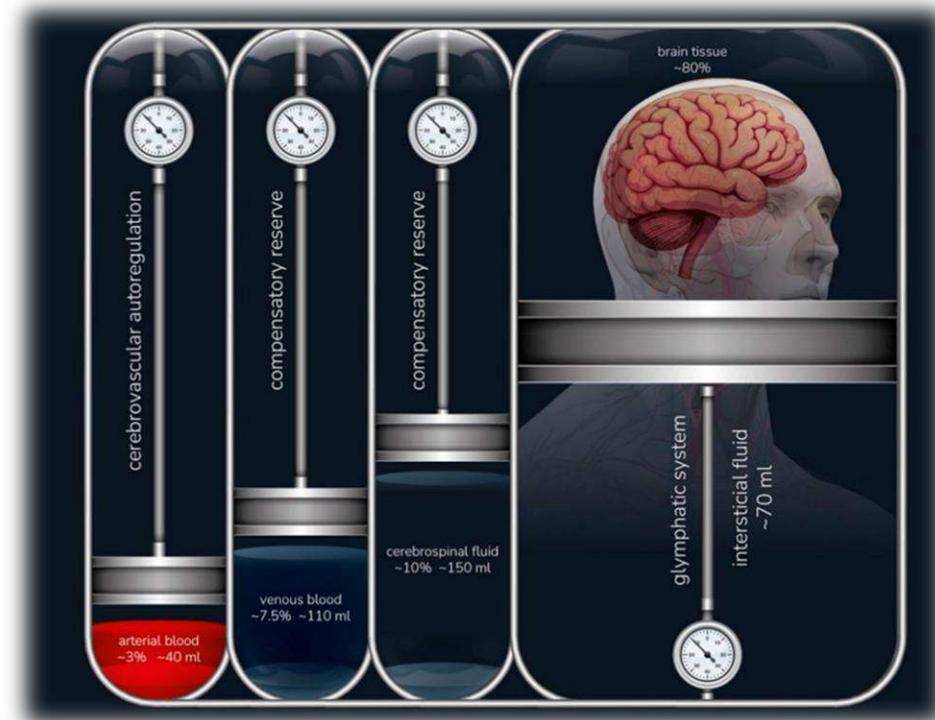
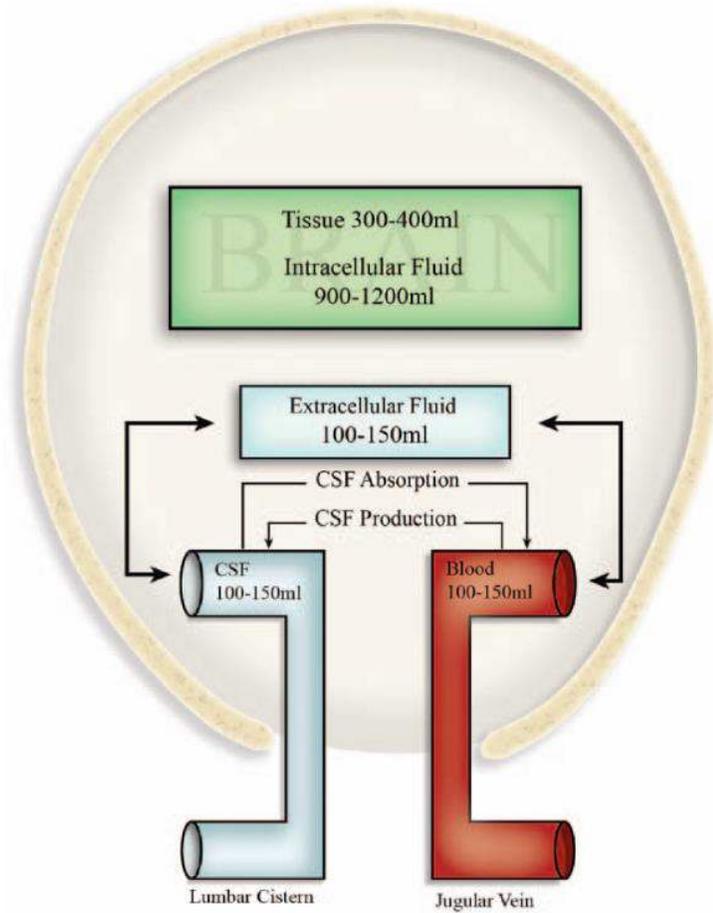
7.2 Headache attributed to low cerebrospinal fluid (CSF) pressure

Either or both of the following:

1. low cerebrospinal fluid (CSF) pressure (<60 mm CSF)
2. evidence of CSF leakage on imaging

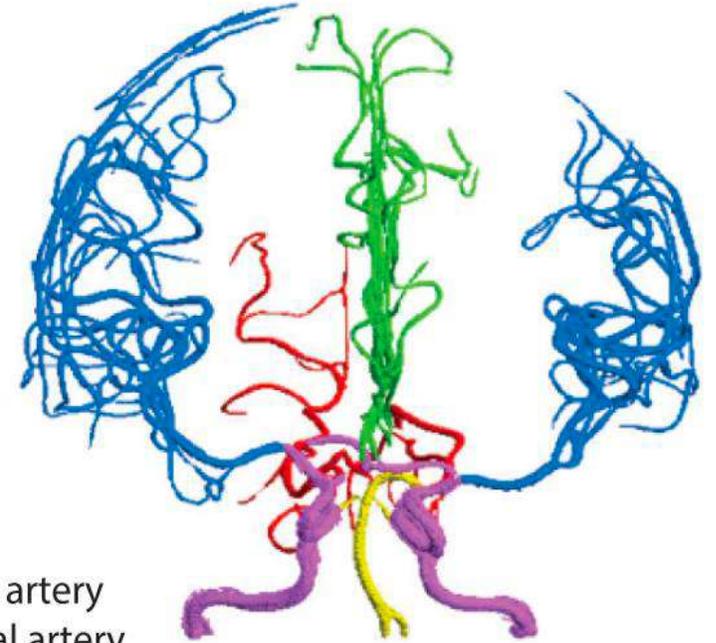


Monro-Kellie doctrine evolution



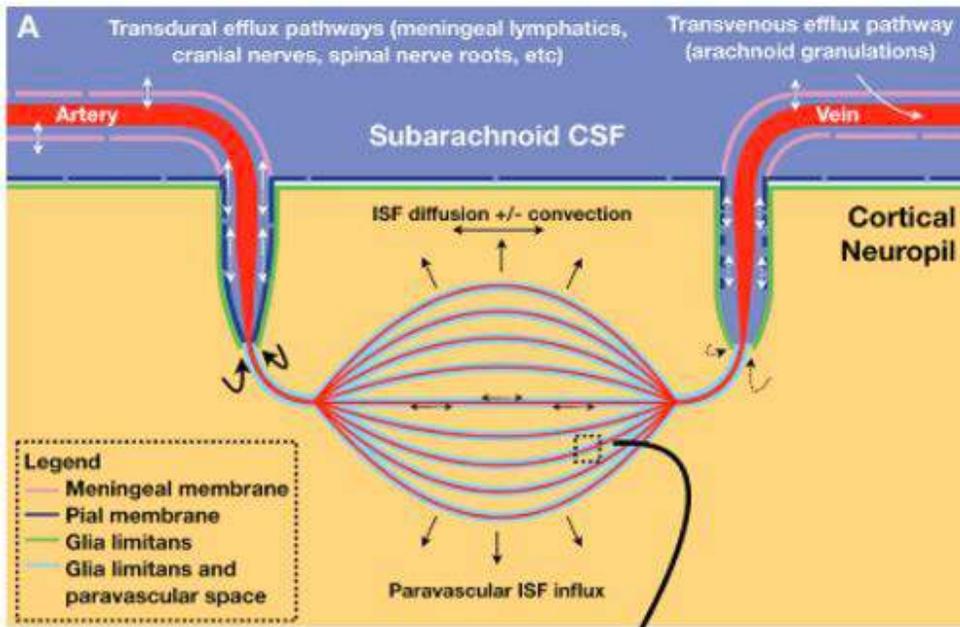
Cerebral Blood Flow Regulation

- Immediate response to changes of CPP
- Local response to vasoactive substances, CO₂, H⁺, adenosine, hypocapnia and hypercapnia
- Innervation with Autonomic Nervous System fibres and fibres from Trigeminovascular system



- Middle cerebral artery
- Anterior cerebral artery
- Posterior cerebral artery

Glymphatics





PDPH in obstetrics

- Often iatrogenic cause: ADP
- A severe headache with additional symptoms
- Affects postpartum maternal well-being
- Not always self-limiting
- Chronic consequences



Evidence-based clinical practice guideline on PDPH: A consensus report from a multisociety international working group

B

Regular multimodal analgesia including acetaminophen and NSAIDs should be offered to all patients with PDPH (if not contraindicated).



B

Focal neurological deficits, visual changes, alterations in consciousness, or seizures, especially in the postpartum period, should prompt neuroimaging to evaluate alternative diagnoses.

B

When PDPH is refractory to conservative therapy and impairs activities of daily living, an EBP should be considered to treat headache and other neurological sequelae of intracranial hypotension.



Long-term psychological and physical outcomes of women after postdural puncture headache

A retrospective, cohort study

Sharon Orbach-Zinger*, Leonid A. Eidelman*, Michal Y. Livne, Olya Matkovski, Eitan Mangoubi, Adi Borovich, Susan A. Wazwaz, Alexander Ioscovich, Zoya Haitov Ben Zekry, Karin Ariche and Carolyn F. Weiniger

Eur J Anaesthesiol 2021

	PDPH (132)	No PDPH (276)	95% CI	P
• Postpartum depression	67 (52.3%)	31 (11.2%)	0.315 - 0.52	<0.0001
• Possible PTSD	17 (12.8%)	1 (0.4%)	0.076 - 0.195	<0.0001
• Breastfeeding initiation	74 (54.5%)	212 (78.8%)	0.331 - 0.552	<0.0001
• Current headache	42 (32.6%)	42 (15.2%)	0.085 - 0.266	<0.0001
• Current backache	58 (43.9%)	58 (21.0%)	0.141 - 0.335	<0.0001

Management practices for postdural puncture headache in obstetrics: a prospective, international, cohort study

Anil Gupta^{1,*}, Christian von Heymann², Anders Magnuson³, Seppo Alahuhta⁴, Roshan Fernando⁵, Marc Van de Velde⁶, Frédéric J. Mercier⁷, Alexandra M. J. V. Schyns-van den Berg⁸, and the EPiMAP collaborators[†]

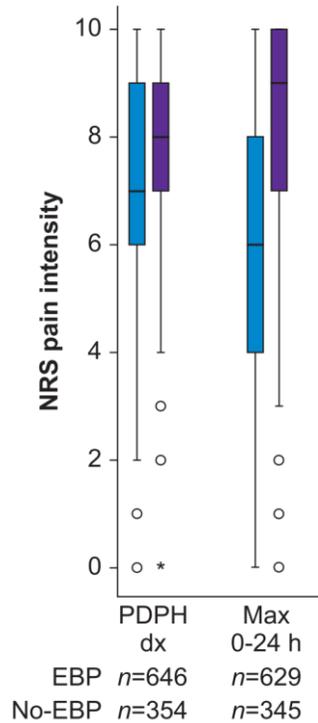


How was ADP determined

CSF in epidural needle	51%
CSF in catheter/positive aspiration test	11%
Spinal anesthesia after test dose	10%
Only classical signs of PDPH postpartum	41%



Management practices for postdural puncture headache in obstetrics



Association with EBP

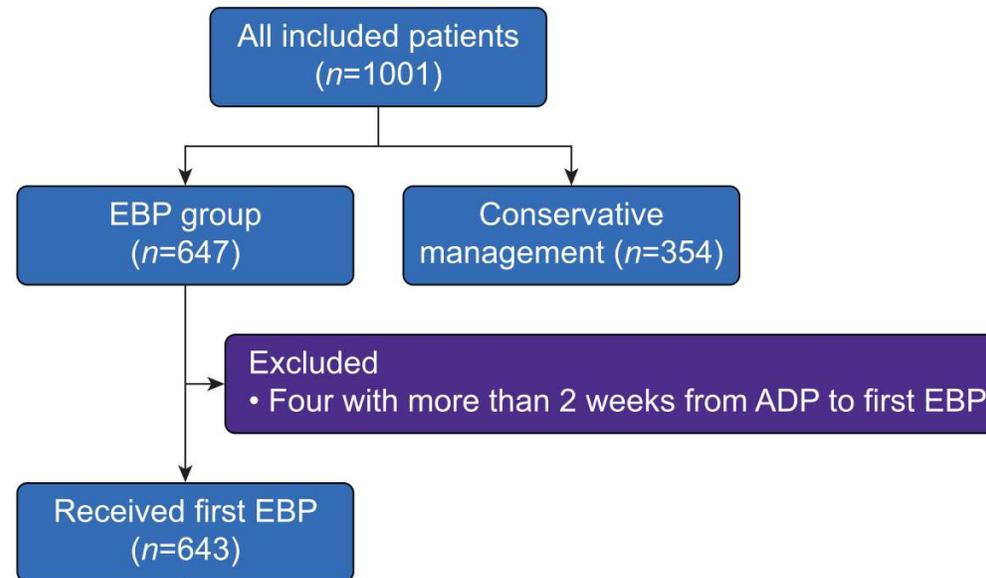
- More analgesics used
- Greater headache intensity
- Presence of auditory symptoms
- Multipara
- Pain location – frontal, temporal, neck
- Epidural at L2-3 (compared to L3-4)

with conservative management

- Use of air for LOR
- Use of intrathecal catheter
- Can continue breast feeding
- Lower educational status

Factors associated with failed epidural blood patch after accidental dural puncture in obstetrics: a prospective, multicentre, international cohort study

Anil Gupta^{1,*}, Marc Van de Velde^{2,3}, Anders Magnuson⁴, Christian von Heymann⁵, Emilia Guasch⁶, Seppo Alahuhta⁷, Frédéric J. Mercier⁸, Alexandra M. J. V. Schyns-van den Berg^{9,10}



Factors associated with failed epidural blood patch after accidental dural puncture in obstetrics

Patient

- Young vs. old (< 30 years vs. > 30 years)
- BMI (< 35 vs. > 35)
- Previous history of headache vs. no previous history
- Primi vs. multigravida
- Mode of delivery

EDA

- Air vs. saline for detection of loss of resistance

PDPH

- Time to onset of PDPH after ADP (< 24h vs. > 24 h)

EBP

- Volume of blood injected (< 15 vs. > 15 ml)
- Timing of EBP
- Experience of performer EBP (< 5 EBP vs. > 5 EBP)
- Position during EBP
- Level EBP
- Mobilisation time after EBP

P-value<0.01



Used definition of failed EBP

Failure

NRS ≥ 7 upright at 4,
24, and/or 48h or a
second EBP

Partial success

$0 > \text{NRS} > 7$
Upright at
4, 24, and/or 48h

Success

NRS=0 upright at 4,
24, and/or 48h,
no second EBP



643 pts with an EBP (not classified 52 pts)

Failure

NRS ≥ 7 upright at 4, 24, and/or 48h or a second EBP

167 pts; 28.3%

Partial success

$0 > \text{NRS} > 7$
Upright at 4, 24, and/or 48h

229 pts ; 38.7%

Success

NRS=0 upright at 4, 24, and/or 48h, no second EBP

195 pts; 33.0%



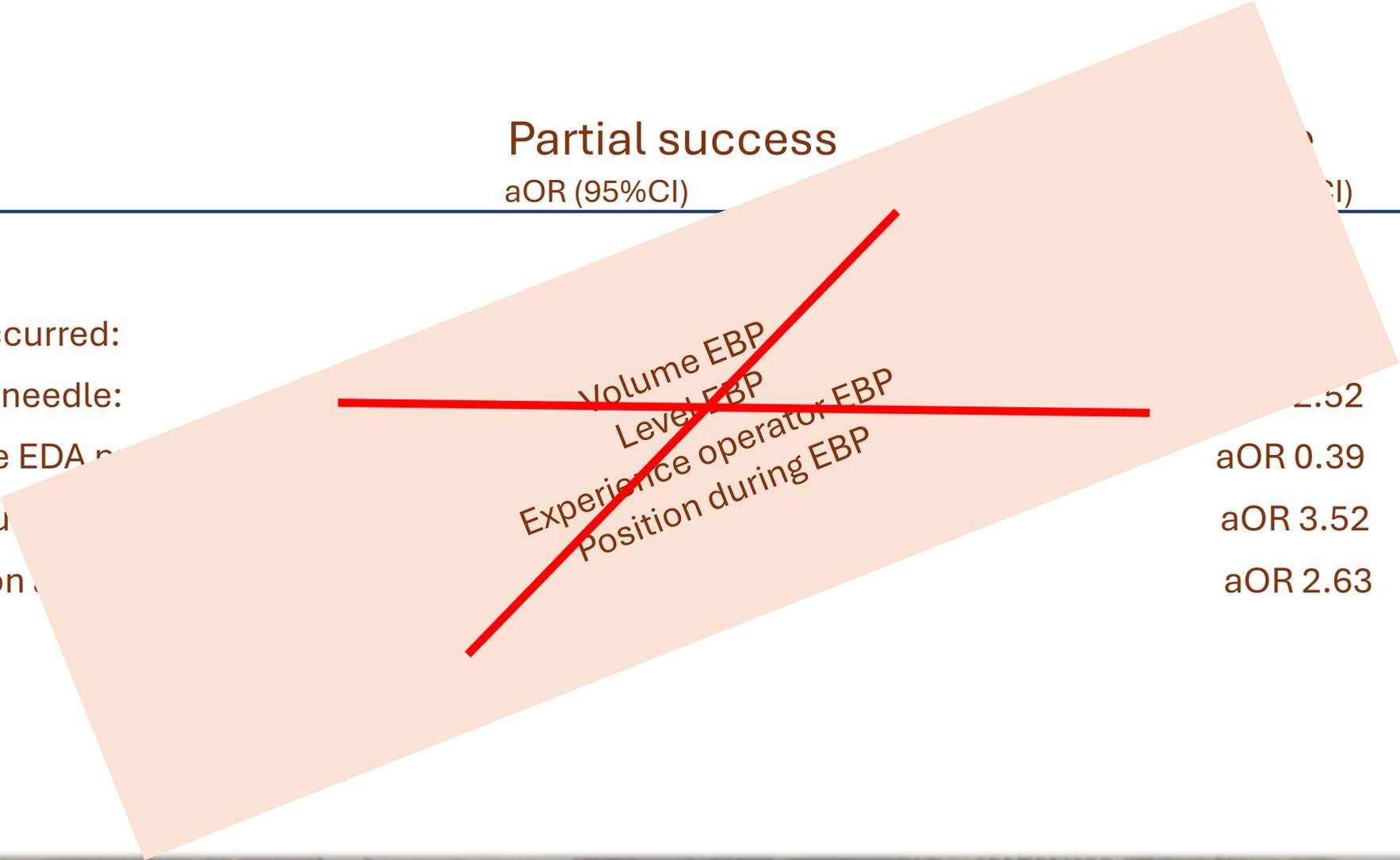
Factors associated with EBP partial success or failure, $P < 0.01$

		Partial success aOR (95%CI)		Failure aOR (95%CI)	
Previous history of migraine headache					
	No	Reference		Reference	
	Yes	1.25 (0.61-2.56)	$P = 0.55$	3.16 (1.48-6.78)	$P = 0.0032$
Level of accidental dural puncture					
	L3/L5	Reference		Reference	
	L1/L3	2.69 (1.47-4.94)	$P = 0.0014$	3.28 (1.64-6.53)	$P = 0.0008$
Time from ADP to EBP (h)					
	<48	Reference		Reference	
	48 to <72	0.60 (0.30-1.19)	$P = 0.14$	0.37 (0.18-0.77)	$P = 0.0073$
	≥ 72	0.36 (0.19-0.70)	$P = 0.0022$	0.08 (0.04-0.16)	$P < 0.0001$



Factors associated with EBP partial success or failure, $P < 0.05$

	Partial success aOR (95%CI)	Failure aOR (95%CI)	P
Second ADP occurred:			
Bigger size EDA needle:		2.52	$P=0.04$
<1 yr experience EDA n		aOR 0.39	$P=0.0131$
Technical difficulty		aOR 3.52	$P=0.0183$
First mobilization		aOR 2.63	$P=0.02$



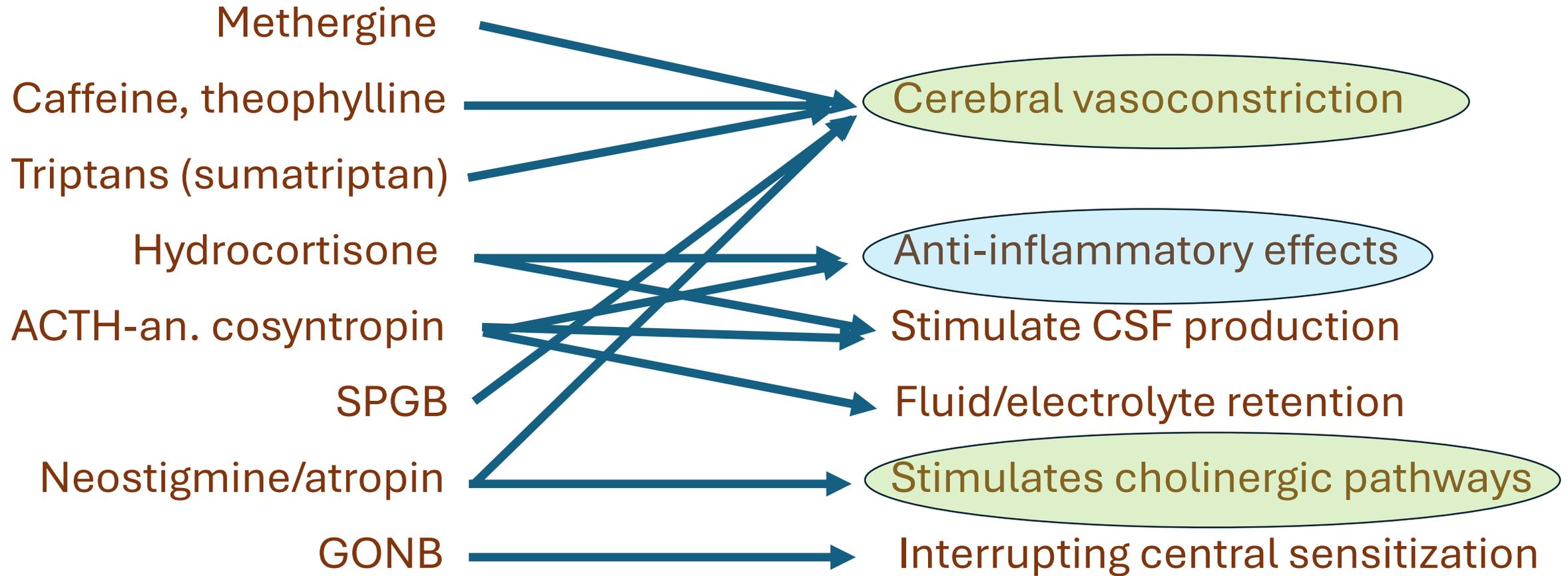
	Previous history of Migraine (n=98)					No previous history of Migraine (n=545)					P ^a
		None NRS 0	Mild NRS 1-3	Moderate NRS 4-6	Severe NRS 7-10		None NRS 0	Mild NRS 1-3	Moderate NRS 4-6	Severe NRS 7-10	
	n	n (%)	n (%)	n (%)	n (%)	n	n (%)	n (%)	n (%)	n (%)	
6-12hrs before EBP	94	0 (0.0)	0 (0.0)	13 (13.8)	81 (86.2)	536	1 (0.2)	3 (0.6)	61 (11.4)	471 (87.9)	0.66
After EBP	98	44 (44.9)	32 (32.6)	16 (16.3)	6 (6.1)	543	206 (37.9)	217 (40.0)	81 (14.9)	39 (7.2)	0.36
4hrs after EBP	85	44 (51.8)	29 (34.1)	9 (10.6)	3 (3.5)	490	232 (47.4)	178 (36.3)	62 (12.6)	18 (3.7)	0.44
24hrs after EBP	97	50 (51.6)	21 (21.6)	15 (15.5)	11 (11.3)	539	294 (54.6)	146 (27.1)	45 (8.3)	54 (10.0)	0.33
48hrs after EBP ^b	35	1 (2.9)	3 (8.6)	11 (31.4)	20 (57.1)	164	6 (3.7)	15 (9.1)	43 (26.2)	100 (61.0)	0.77
Having a second EBP		31.6% (31 of 98)					17.4% (95 of 545)				<0.01
Hours from first to second EBP, median (IQR)	31	49 (44-69)				95	50 (44-69)				0.58
Second EBP within 24hrs		6.4% (2 of 31)					6.3% (6 of 95)				>0.99
Second EBP within 48hrs		45.2% (14 of 31)					40.0% (38 of 95)				0.61

	Level of ADP L1 / L3 (n=221)					Level of ADP L3 / L5 (n=421)					P ^a
		None NRS 0	Mild NRS 1-3	Moderate NRS 4-6	Severe NRS 7-10		None NRS 0	Mild NRS 1-3	Moderate NRS 4-6	Severe NRS 7-10	
	n	n (%)	n (%)	n (%)	n (%)	n	n (%)	n (%)	n (%)	n (%)	
6-12hrs before EBP	218	0 (0.0)	0 (0.0)	21 (9.6)	197 (90.4)	411	1 (0.2)	3 (0.7)	53 (12.9)	354 (86.1)	0.12
After EBP	220	67 (30.4)	92 (41.8)	36 (16.4)	25 (11.4)	420	183 (43.6)	156 (37.1)	61 (14.5)	20 (4.8)	<0.01
4hrs after EBP	204	75 (36.8)	80 (39.2)	38 (18.6)	11 (5.4)	370	201 (54.3)	126 (34.1)	33 (8.9)	10 (2.7)	<0.01
24hrs after EBP	216	99 (45.8)	61 (28.2)	24 (11.1)	32 (14.8)	419	244 (58.2)	106 (25.3)	36 (8.6)	33 (7.9)	<0.01
48hrs after EBP ^b	84	4 (4.8)	7 (8.3)	25 (29.8)	48 (57.1)	115	3 (2.6)	11 (9.6)	29 (25.2)	72 (62.6)	0.46
Having a second EBP		21.3% (47 of 221)					18.8% (79 of 421)				0.45
Hours from first to second EBP, median (IQR)	47	49 (45-64)				79	52 (43-72)				0.33
Second EBP within 24hrs		10.6% (5 of 47)					3.8% (3 of 79)				0.15
Second EBP within 48hrs		44.7% (21 of 47)					39.2% (31 of 79)				0.55

Relationship between level of ADP and EBP

		Partial Success				Failure			
		Unadjusted ^a		Adjusted ^b		Unadjusted ^a		Adjusted ^b	
		OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Level of ADP	EBP								
L3/L5	L3/L5	Reference		Reference		Reference		Reference	
L1/L3	L3/L5	2.19 (1.10-4.37)	0.03	2.78 (1.28-6.04)	0.0097	2.46 (1.20-5.04)	0.014	3.68 (1.55-8.70)	0.0031
L3/L5	L1/L3	1.09 (0.56-2.12)	0.80	0.89 (0.42-1.88)	0.76	0.88 (0.41-2.91)	0.80	0.89 (0.34-2.30)	0.81
L1/L3	L1/L3	1.66 (0.92-3.00)	0.09	2.31 (1.17-4.57)	0.016	1.78 (0.93-3.43)	0.09	2.42 (1.10-5.34)	0.03
Classified as L1 to L5									
Same level		Reference		Reference		Reference		Reference	
EBP lower than ADP		1.42 (0.87-2.31)	0.16	1.31 (0.77-2.22)	0.32	1.13 (0.69-1.87)	0.63	1.02 (0.57-1.83)	0.95
EBP higher than ADP		0.96 (0.57-1.63)	0.88	0.70 (0.38-1.27)	0.24	0.55 (0.29-1.03)	0.06	0.40 (0.18-0.85)	0.018

PDPH therapeutics, beyond the evidence



PDPH according to ICHD-3 (2018)

Symptoms within five days of a lumbar puncture
It remits spontaneously or after autologous epidural lumbar patch
Headache fulfills criteria for 7.2

7.2 Headache attributed to low cerebrospinal fluid (CSF) pressure

Either or both of the following:

1. low cerebrospinal fluid (CSF) pressure (<60 mm CSF)
2. evidence of CSF leakage on imaging



PDPH

CSF loss through a leak in the spinal meninges

1. Traction on pain-sensitive meningeal structures and intracranial vessels
2. Intracranial vasodilation
3. Activation of the trigeminovascular system



PDPH

results from disruption of normal CSF homeostasis

CSF loss through a leak in the spinal meninges?

- Persistent?

1. Traction on pain-sensitive meningeal structures and intracranial vessels?
2. Intracranial vasodilation, secondary?
3. Activation of the trigeminovascular system?



?????

- EBP?
- Bloody taps?
- Patient related factors
- PDPH without signs of CSF leakage
- CSF leakage without PDPH
- Skull base CSF leaks?
- Orthostatic headaches unrelated to CSF loss?
- PDPH after LP in IIH?



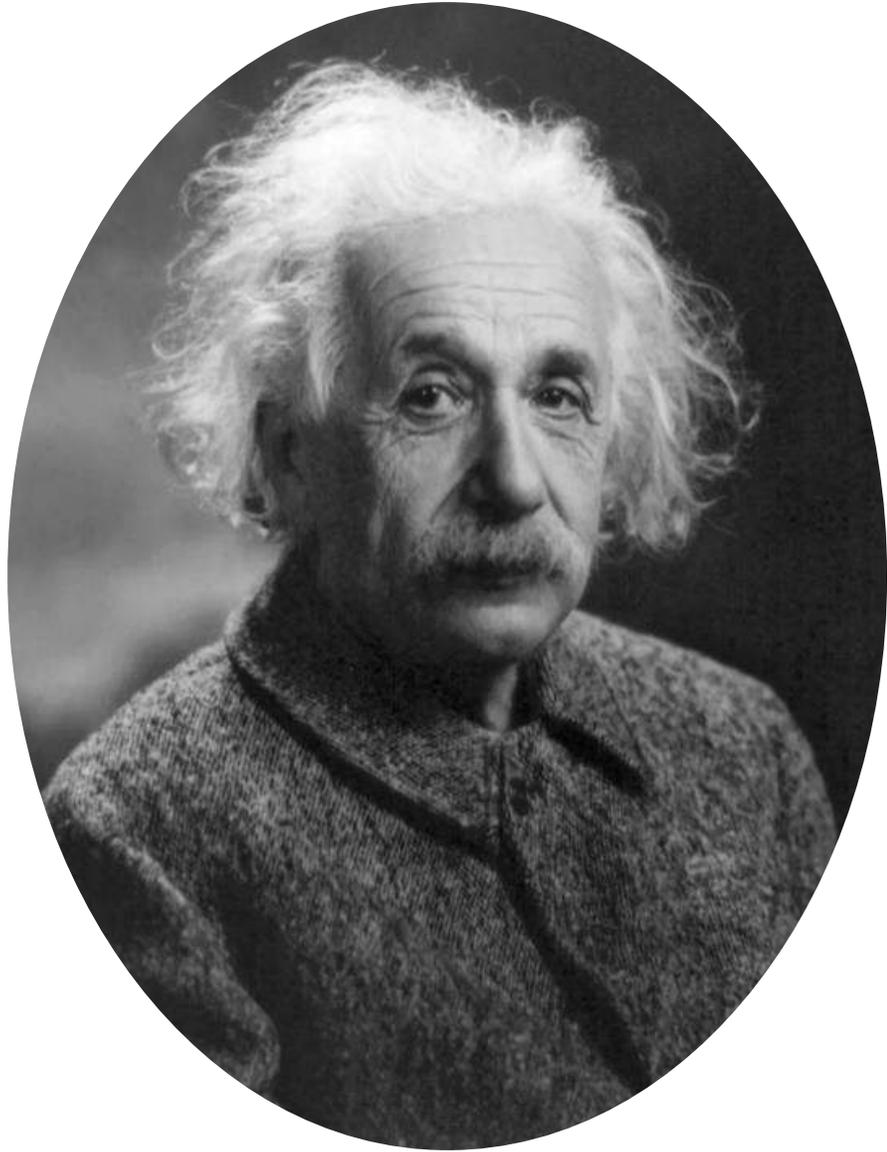
Current definitions are inadequate

Pathophysiology is way more complex than CSF leakage

Treatment responses are unpredictable

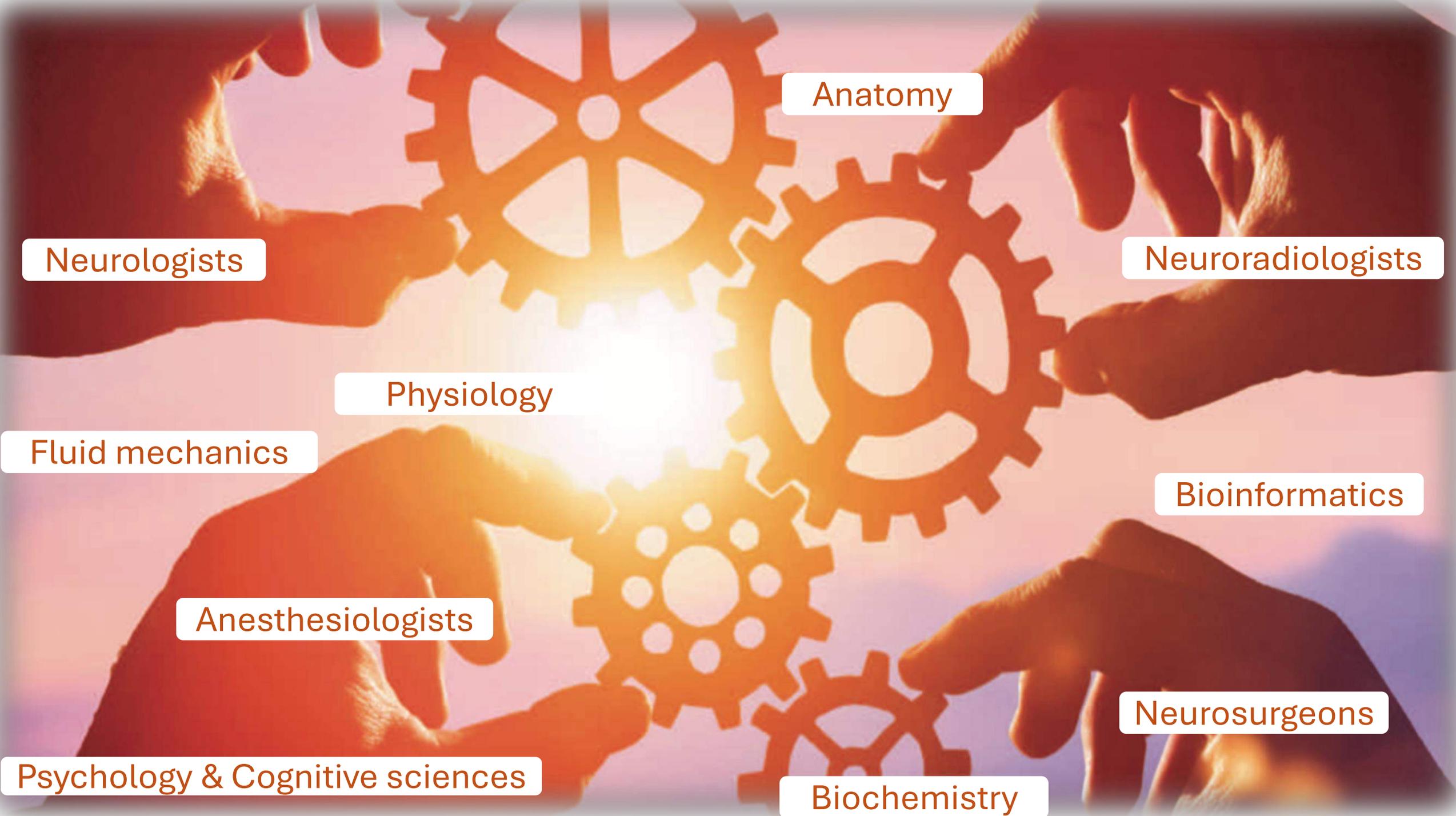
Individual variation is the rule, not exception





What we don't know
is much more
than what we know





Anatomy

Neurologists

Neuroradiologists

Physiology

Fluid mechanics

Bioinformatics

Anesthesiologists

Neurosurgeons

Psychology & Cognitive sciences

Biochemistry

A black and white photograph of a man in a suit and hat standing in a forest. He is looking towards the camera. A dog is sitting on the ground to his right. The background consists of trees and foliage.

A professor is a gentleman with a
different point of view