

Thunderstruck: How not to Miss Subarachnoid Hemorrhage

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CONFLICT OF INTEREST:

None to declare.

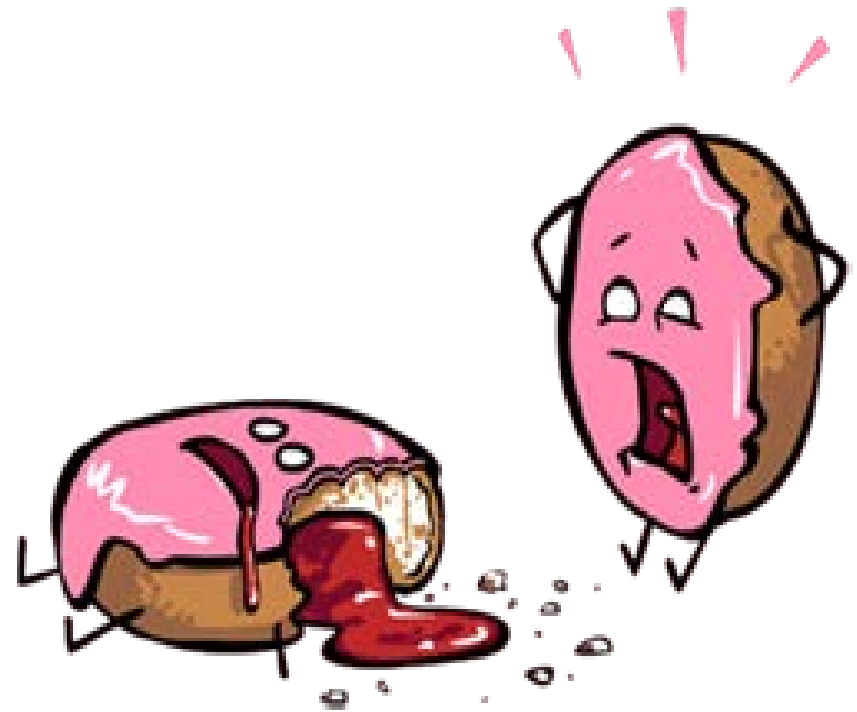
As a rule, I don't even attend Pharma sponsored CME because I consider myself easily influenced.

And because I feel guilty eating drug company food.

OBJECTIVES:

- Establish why Subarachnoid Hemorrhage (SAH) is an important diagnosis not to miss
- Review the differential diagnosis of sudden onset headache
- Review decision memory aids (SNOOP, SUM) and decision rules for SAH
- Discuss the evidence for investigations to rule out SAH (CT, LP, etc.)
- Review the treatment of SAH

SAH: THE DONUT OF DEATH



TALK NERDY TO ME



SUBARACHNOID HEMORRHAGE:

- Traumatic (tSAH)
- Aneurysmal (aSAH)
Saccular/berry
aneurysms
- Paramesencephalic
(pSAH) 10-15% usually
from venous bleed,
better prognosis

WHY IS SAH IMPORTANT?

- Headache is 1-2% of ER visits
- 1-3% of headaches presenting to the ER are SAH
- 8-10% of the “worst headache of my life” are SAH
- Incidence 2- 25%/100,000: 11/100,000 for Canadian women and 8/100,000 for men
- Mortality has decreased from 57% to 35% over 30 years
- 15% die before hospital
- 8-20% dependence after aSAH
- 5% of SAH are misdiagnosed and sent home on first presentation
- Rebleed rate is 9-17% in first 24 hours, 20-30% in 30 days
- 70% mortality for rebleeds

IF ONLY IT WERE THIS EASY...



UNUSUAL CAUSES OF HEADACHE

EMERGENCY MEDICINE CASES
10 CAUSES OF WORRISOME HEADACHES:

1. Lesions on CT scan:

pus: MENINGITIS/ENCEPHALITIS
blood: SAH/ SDH/ CVA
TUMOUR: primary, mets, benign or malignant

2. Head:

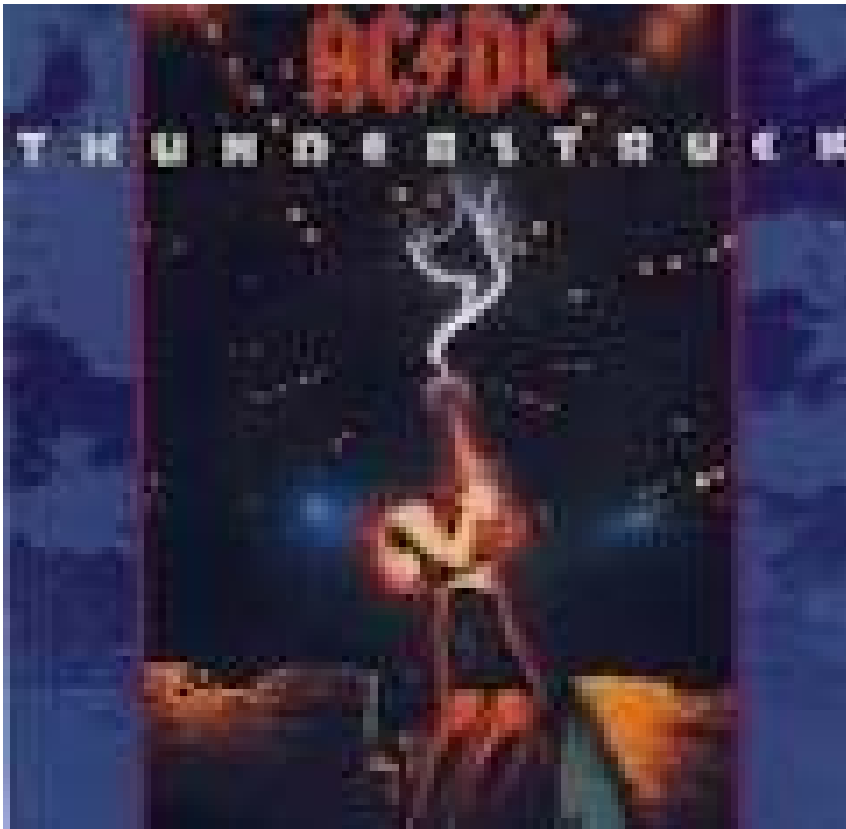
CERVICAL ARTERY DISSECTION
HYPERTENSIVE ENCEPHALOPATHY
PREECLAMPSIA
CENTRAL VENOUS THROMBOSIS/IIH
GLAUCOMA
TEMPORAL ARTERITIS

3. Other:

CARBON MONOXIDE



THUNDERCLAP HEADACHES:



SUBARACHNOID
HEMORRHAGE

CERVICAL ARTERY
DISSECTION

CENTRAL VENOUS
THROMBOSIS

CERVICAL ARTERY DISSECTION:

- Present after trivial trauma/ neck extension
- Sudden or sub-acute
- Diagnosis with CTA head & neck
- Consider carotid doppler
- Treatment: ASA +/- heparin
- Vertebral: post neck or Occiput pain + 5 Ds (dizziness, diplopia, dysarthria, dysphagia, dysmetria)
- Carotid: associated Horner's (ptosis/miosis)
- TIA symptoms hours to days after



CEREBRAL VENOUS THROMBOSIS

- Thunderclap to subacute headache, CVA or seizures
- Risk factors for VTE
- Papilledema
- Age < 40
- CNS/ENT infections
- Best test: MRV
- Real life: CT + on 30%
- Followed by CT venogram if negative
- LP to r/o other diagnoses – high OP with CVT
- Treatment: LMWH or heparin

IDIOPATHIC INTRACRANIAL HYPERTENSION

- On spectrum with CVT
- Refractory headache with blurred vision and visual field defects
- Young obese women on OCP

Signs:

Papilledema

Visual field defects

Diagnosis:

- CT head to r/o other dx
- LP: Very high opening pressure

• Treatment:

CSF drainage & diuretics to prevent permanent visual field loss

COMMON CAUSES OF HEADACHE:

TENSION HEADACHE



MIGRAINE



POUND

- P : Pulsatile
- O: 4-72 hOurs
- U: Unilateral pattern
- N: Nausea
- D: Disabling Quality

- Study in GP clinics: 4/5 factors predicts likelihood of migraine to 92%. 3/5 64% and 2/5 17%.

• Ebell MH. Diagnosis of Migraine Headache. *American Family Physician* 2006;74 (12):2087-2088



DISTINGUISHING VISUAL SYMPTOMS IN MIGRAINE AND DETACHMENTS:

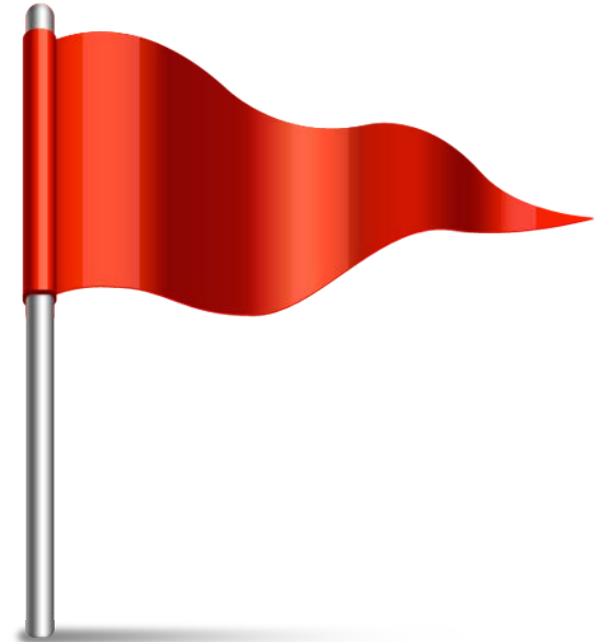
- Retinal and vitreous detachment (unilateral, white, descending curtain)
- Migraine (bilateral, coloured, tunnel vision or scintillating scotoma)

SSNOOP



SSNOOP RED FLAGS

- S: SYSTEMIC SIGNS: fever, weight loss
- S: SECONDARY SIGNS: HIV, immunocompromise
- N: NEUROLOGICAL SIGNS: speech deficit, CN abnormalities
- O: ONSET: abrupt
- O: OLDER age (>40)
- P: PROGRESSION of symptoms



SUBARACHNOID HEMORRHAGE: SUM it up!

- S: SUDDEN in onset
- U: UNLIKE previous headache
- M: MAXIMAL at onset

RISK FACTORS FOR SAH:

- Family history of aneurysm, SAH, PCKD, CVD
- Hypertension
- Binge drinking, smoking, cocaine use
- History of similar headache (sentinel bleed)
- Female sex
- Non-caucasian race

YOUR MOM WAS RIGHT!

Vegetable consumption is associated with a lower risk of SAH.



FACTORS ASSOCIATED WITH SAH:

- Onset during exertion
- Syncope or presyncope
- ECG changes
- Cranial nerve palsies (3rd & 6th - diplopia)
- Seizure
- Stroke like symptoms
- Meningismus, neck pain or stiffness

BEWARE!

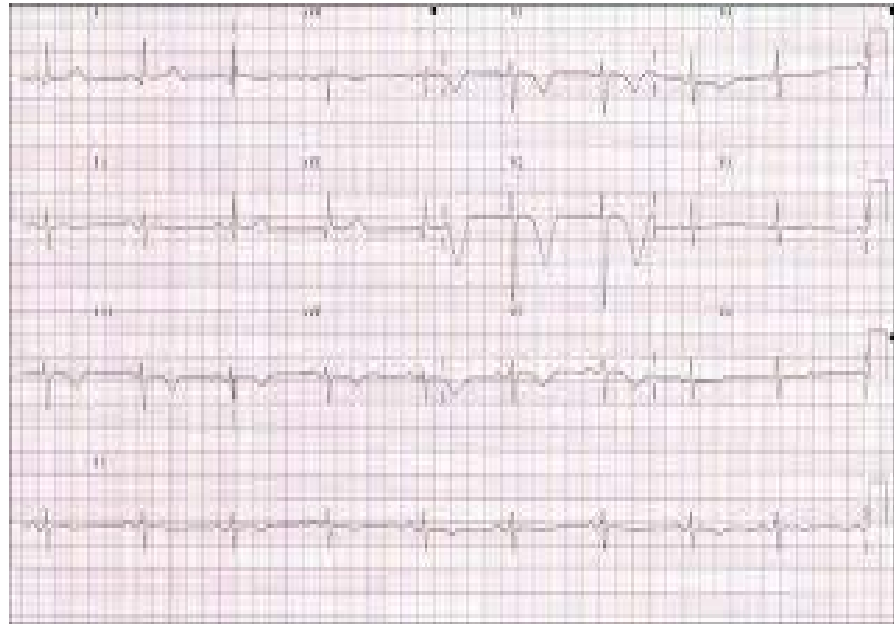
- Headache onset not always abrupt
- Responds well to narcotics and migraine medications
- May resolve spontaneously within hours
- 40-50% have normal neuro exam
- False negative CT with anemia, low volume SAH , older generation scanners, poor scan





ECG CHANGES ASSOCIATED WITH SAH:

- Deep wide precordial T wave inversion
- Bradycardia
- Prolonged QT
- Seen in 50-100% of cases of SAH





Headache associated with a cranial nerve palsy needs urgent angiography to rule out an aneurysm that has increased in size and is at risk of imminent rupture

3rd



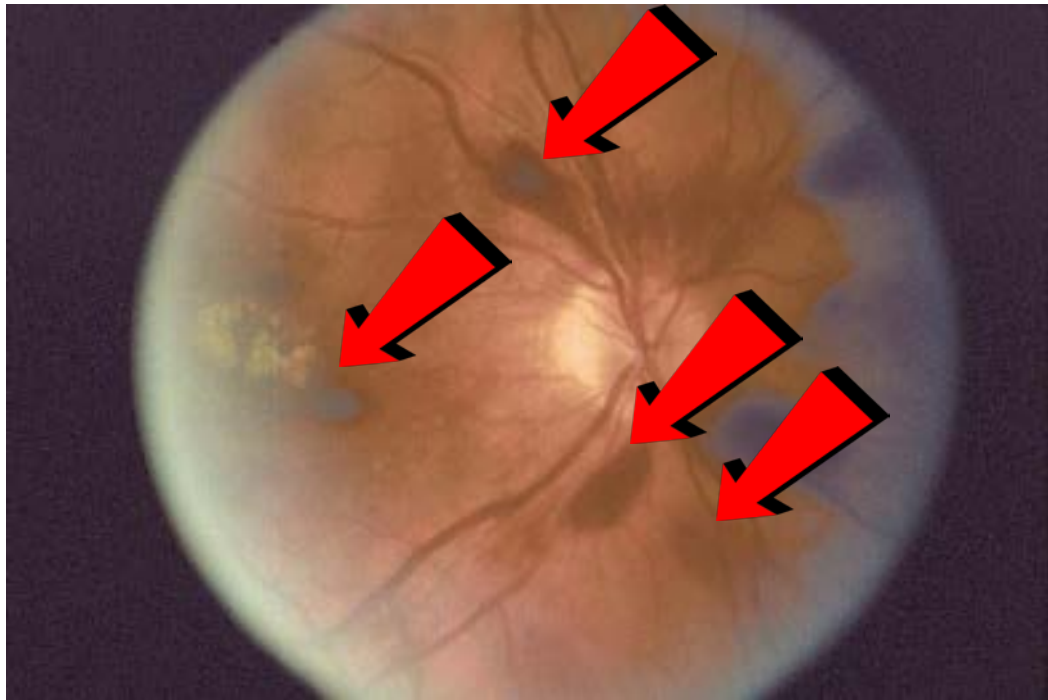
6th



- JJ Perry, Ian Stiell et al Clinical Decision Rules to Rule out SAH for Acute Headache. JAMA 2013 (12):1248-1255.



TERSON'S SYNDROME: 8-19% of SAH have retinal hemorrhages



Drs. Ian Stiell and Jeff Perry: Canadian Decision Rule Kings



THE OTTAWA SAH DECISION RULE

ANY OF:

- Age $>$ or $=40$
- Neck stiffness/neck pain
- Onset of headache with exertion
- Witnessed loss of consciousness
- BP $>$ 160/100 (d/c'd in 2013 decision rule)
- Thunderclap (explosive onset)*
- Limited neck flexion on exam *

Perry JJ, Stiell IG, Sivilotti MLA et al High risk Clinical Characteristics for SAH inpatients with acute headache: a prospective cohort study. BMJ 2010; 341:c5204

Perry, JJ, Stiell IG Clinical Decision Rules to Rule out SAH for Acute Headache. JAMA 2013;310(12):1248-1255.

TALK NERDY TO ME



CLINICAL DECISION RULES TO RULE OUT SAH FOR ACUTE HEADACHE

Perry et al JAMA 2013; 310 (12):1248-1255.

Prospective multicentre RCT of 2131 patients at 10 Canadian academic ERs

Adults with nontraumatic headache peak within 60 min and N neuro exams

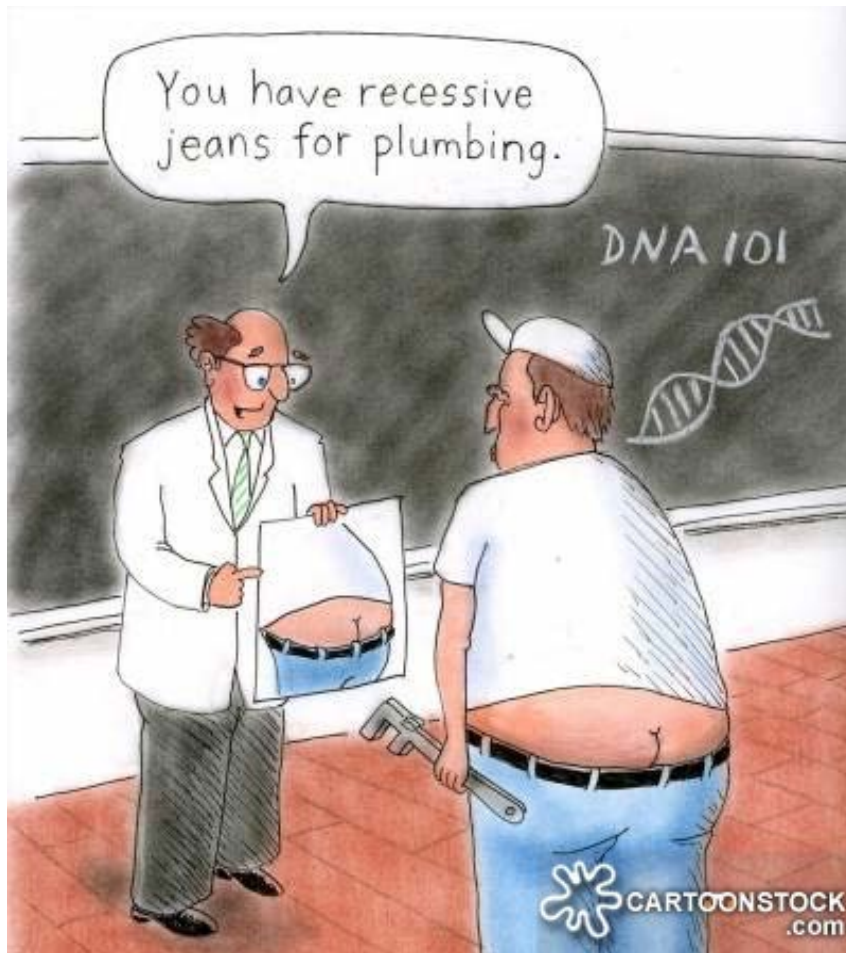
132 with SAH (6.2%)

Bootstrap analysis – retrospective fitting of data

3 rules – best fit was Ottawa SAH Rule 100 % sensitivity (CI 97.3%-100%) and 15.3% specificity for SAH requiring intervention (99.2% for all SAH)

Needs validation studies outside of data set (one published study)

BOTTOM LINE

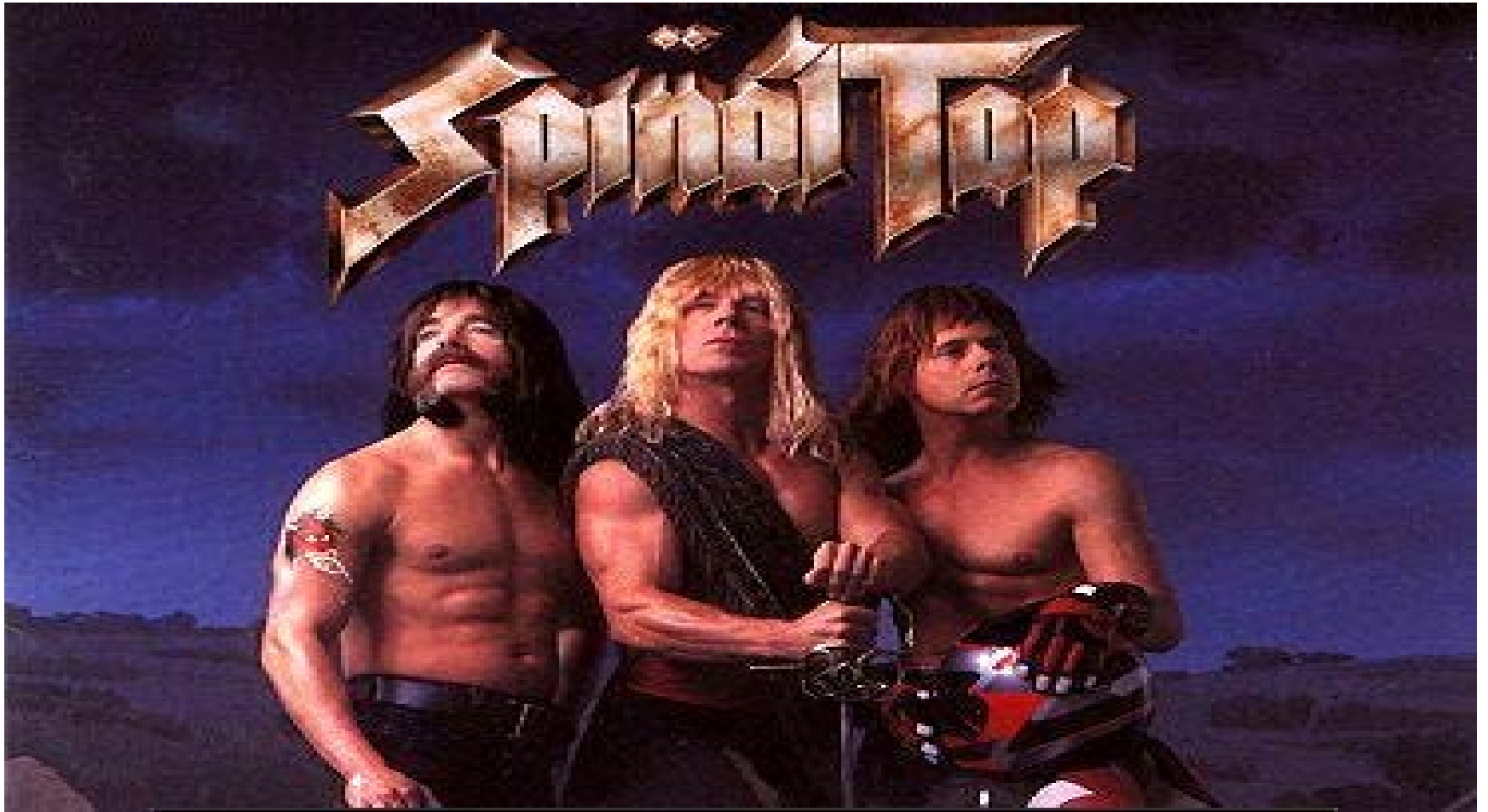


- The Ottawa SAH Decision Rule has excellent sensitivity to rule in SAH and poor sensitivity to rule out SAH
- May increase investigations, downstream effects

DIAGNOSIS OF SAH:

- Noncontrast CT < 6 hours from symptom onset: sensitivity of 99-100%
- Noncontrast CT 6-12 hours
- Sensitivity of Noncontrast CT > 24 hours < 85%
- Need for LP after CT controversial
- MRI an option if available but still need LP if neg
- If CT + or LP + need immediate CTA

THIS IS SPINAL TAP



LUMBAR PUNCTURE

*"To LP or not LP?
That is the question.
Tis nobler in the
mind
to suffer the slings
and
arrows of uncertainty
or to take up a
spinal
needle against a sea
of
troubles..."*



LP IN WORKUP OF SAH:

- LP looking for RBC count and xanthochromia, neuro damage, infection
- LP risks: 5-25% risk of post LP headache >> neuro damage, infection
- FP from traumatic tap, overlap of +result and traumatic tap in LP performed between 6-12 hours of headache onset
- Xanthochromia takes 12 hours to develop

TALK NERDY TO ME



- Typical findings of SAH on spinal fluid analysis are:
 1. Usually some RBCs: 1 or 2
 2. < 5 WBCs
 3. WBC:RBC ratio $< 1:700$
 4. Xanthochromia is present
 5. Minimal clearing of RBCs between tubes 1 and 4
- Traumatic tap:
 1. clearing of RBCs from tube 1 to 4
 2. Xanthochromia is absent, and the LP was done more than 12 hours following the onset of headache
- Excessive WBCs (ratio WBC:RBC $> 1:700$) suggesting meningitis or encephalitis



TIPS TO DECREASE FALSE POSITIVE LP:

1. check opening pressure:

OP+ increases risk of SAH, helps rule in IIH, CVT

OP- with traumatic tap

CSF used for OP decreases RBC runoff

2. Delay LP to > 12 hours: no xanthochromia
rules out SAH, but risk of rebleed highest in
first 24hours



TIPS TO DECREASE POST LP HEADACHE:

- Use smaller needle (25G)
- Use 16G needle as a trochar to penetrate skin then insert 25G needle through this
- Blunt tip needles
- IV prehydration does NOT prevent post LP headache
- Tx: autologous blood transfusion by anesthesia

NO LP?

- If pt refuses LP or can't get CSF do CT angiogram
- Risk of false positive as CTA doesn't identify if aneurysm if culprit lesion (2-6% baseline risk)
- MRI helpful to pick up SAH if > 72 hours since onset

TALK NERDY TO ME



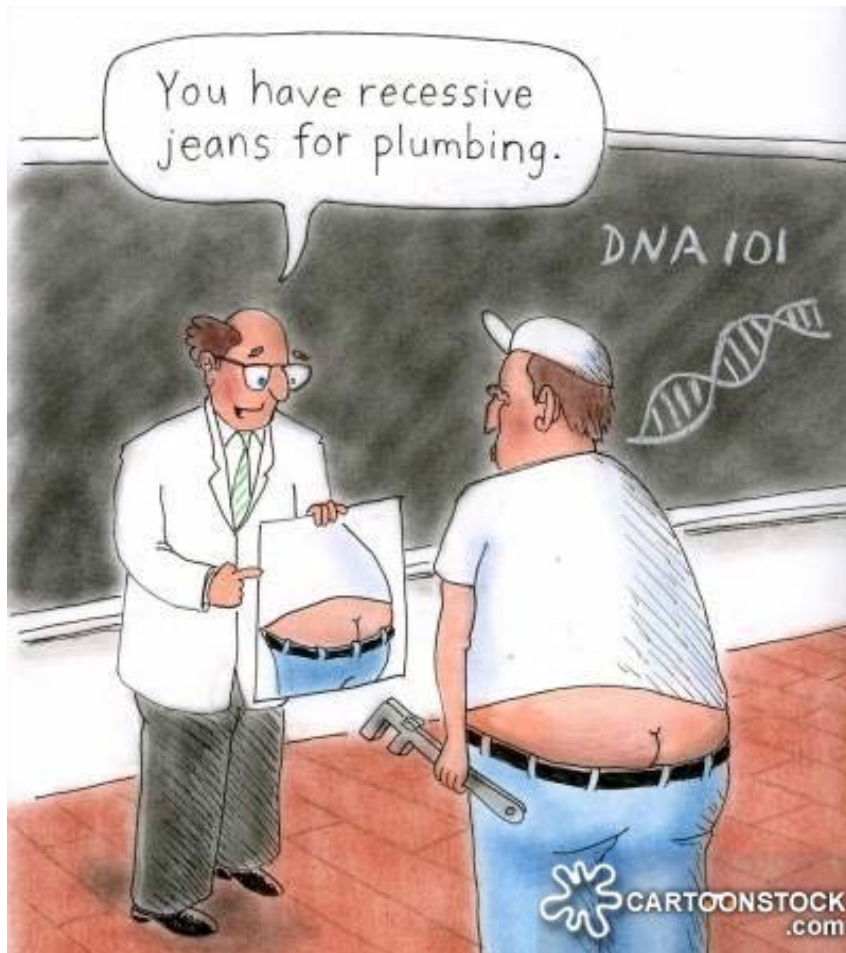
META-ANALYSIS

Carpenter et al *Acad Emer Med* 2016:
Sep 23(9):963-1003

Dubosh et al *Stroke* 2016:47(3):750-5.

- Neck pain - LR + 4.1
- Neck stiffness on physical exam – LR +6.6
- Noncontrast CT <6 hours LR+ 230 LR- 0.01
Miss rate < 0.1-0.2%
- Noncontrast CT >6 hours LR- 0.07
- CSF analysis:
RBC 1000 X 10(6) LR+ 5.7, LR – 0.21
- Xanthochromia less accurate

BOTTOM LINE



- Negative CT has highest benefit in ruling out SAH
- Look for symptoms of neck pain/stiffness
- CT more accurate < 6 hours than > 6 hours after headache onset

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- Xanthochromia is the staining of CSF by heme breakdown products (chiefly bilirubin) by ependymal xanthine oxidase.
- CSF xanthochromia spectrometry more accurate, but only visual inspection available In Canadian hospitals
- if the CSF protein exceeds 100 mg/dl this can be a false positive.

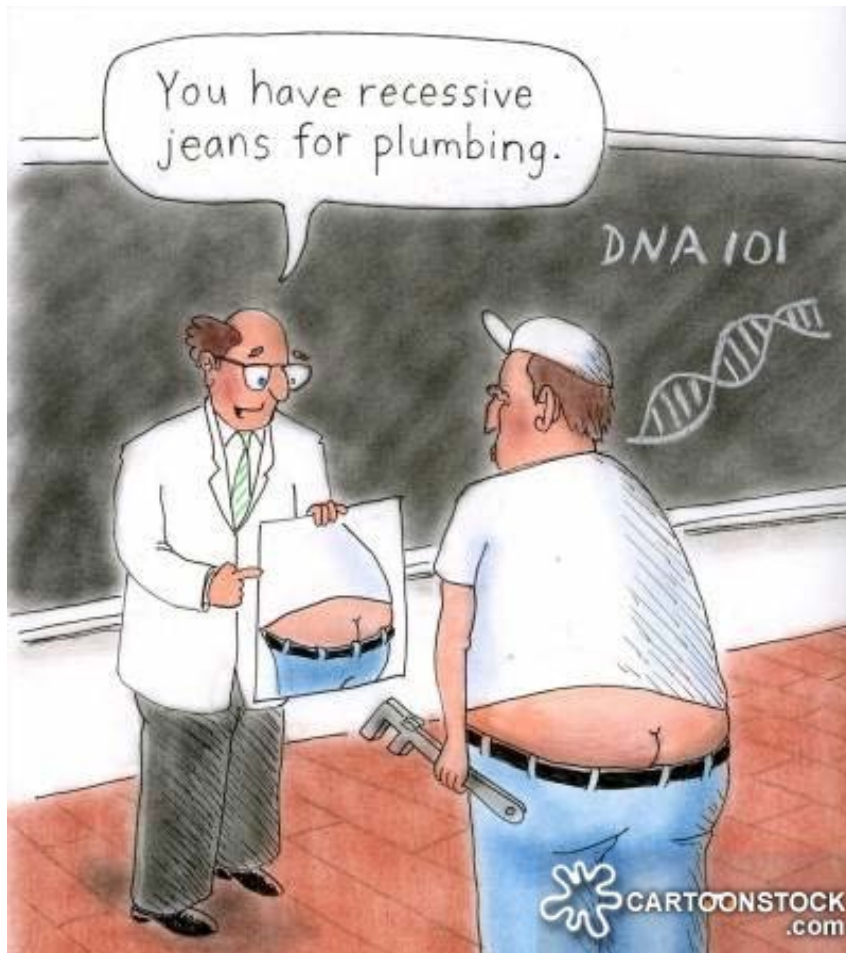


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- SENSITIVITY OF CT PERFORMED WITHIN 6 HOURS OF ONSET OF HEADACHE FOR DIAGNOSIS OF SAH: Perry et al BMJ 2011
- 121/953 pt has SAH
- > age 15, HA peak with 1 hour or syncope, N neuro exam
- Sens 100% (CI 97-100)
- >6 hours – sens 86%
- N neuro exam
- WORST CASE SCENARIO: risk of SAH after neg CT 1 in 300, 0/832 dead of SAH in 6mo
- Traumatic tap risk 5-25%
- Limitations: subset analysis, not all CT neg pts had an LP (6mo FU)

BOTTOM LINE



- RISK OF *significant* aSAH IF CT DONE WITHIN 6 HOURS IS NEGATIVE IS REALLY, REALLY LOW:
- < 1%
- RISK OF FALSE POSITIVE LP >> FALSE NEGATIVE CT

TALK NERDY TO ME



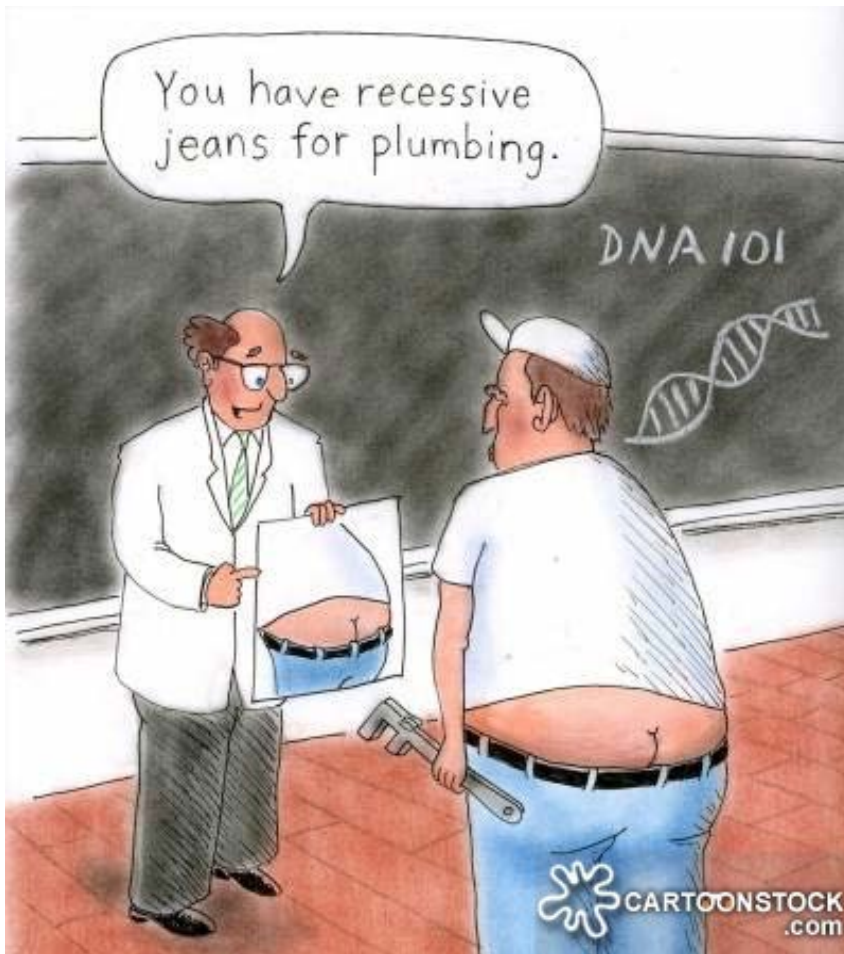
CT WITHIN 6 HOURS OF HEADACHE ONSET TO RULE OUT SAH NONACADMEIC HOSPITAL

Blok, et al
Neurology(2015):10-1212

Suspected SAH CT within 6 hours of onset, LP if CT neg

- NPV 99.9 (CI 99.3-100%)
- Retrospective (open to bias)
- nonacademic radiologists missed 1 pSAH, no intervention

BOTTOM LINE



- Community radiologists are as good at neuroradiologists at picking up significant aSAH
- CT in community hospitals is very sensitive at ruling out aSAH – this applies to us!

TALK NERDY TO ME



OBSERVATIONAL STUDIES OF 2248
PATIENTS SUGGESTIVE OF SAH WITH
LP AFTER NORMAL CT HEAD

Sayer et al, *Acade Emer Med* Nov 2015

UK urban ER pts with neg CT and positive
CSF on LP

4% TP, 13% inconclusive, 16%
uninterpretable, 67% negative

Limitations:

Measured by spectrophotometry

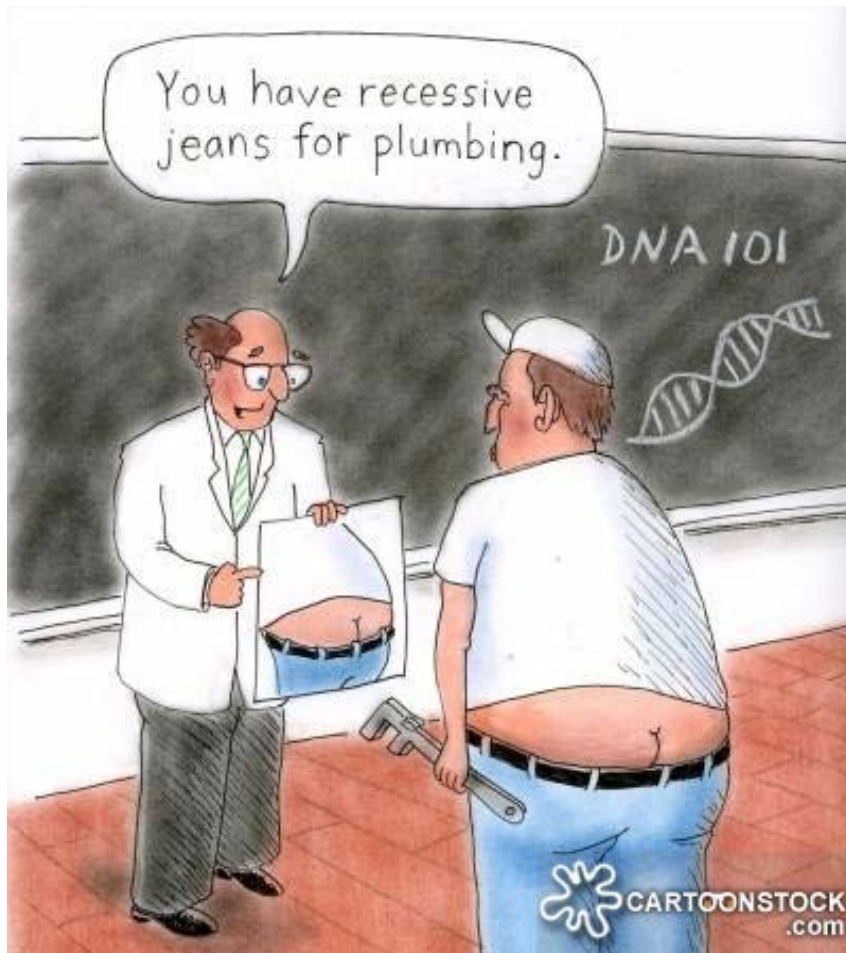
Retrospective chart review (open to bias)

Only TP were sent to CTA (differential
verification bias)

Timeline between headache onset, CT &
LP not specified

NNTap 250 to pick up one SAH not seen
on CT

BOTTOM LINE



- You need to perform 250 LPs after negative CT to pick up one true SAH
- NNTap = 250
- High rates of uninterpretable or inconclusive results with LP

PODCASTS – LP AFTER CT IN THE FIRST 6 HOURS?



- LP after CT ASAP



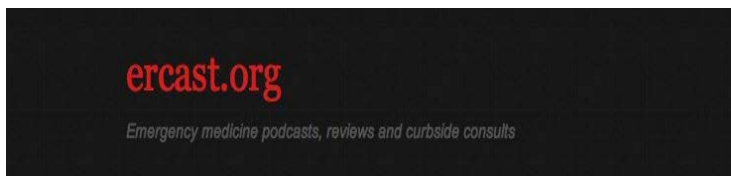
- LP after 12 hours if CT –



- Recommended “Shared decision making model”



- CT within 6 hours “sufficient to exclude SAH”



- “quagmire” between 6 & 12 hr



- Don't be part of the “700 Club”

GUIDELINES – LP AFTER NEGATIVE CT

- AHA GUIDELINES 2012



- ENLS GUIDELINES
MARCH 2016



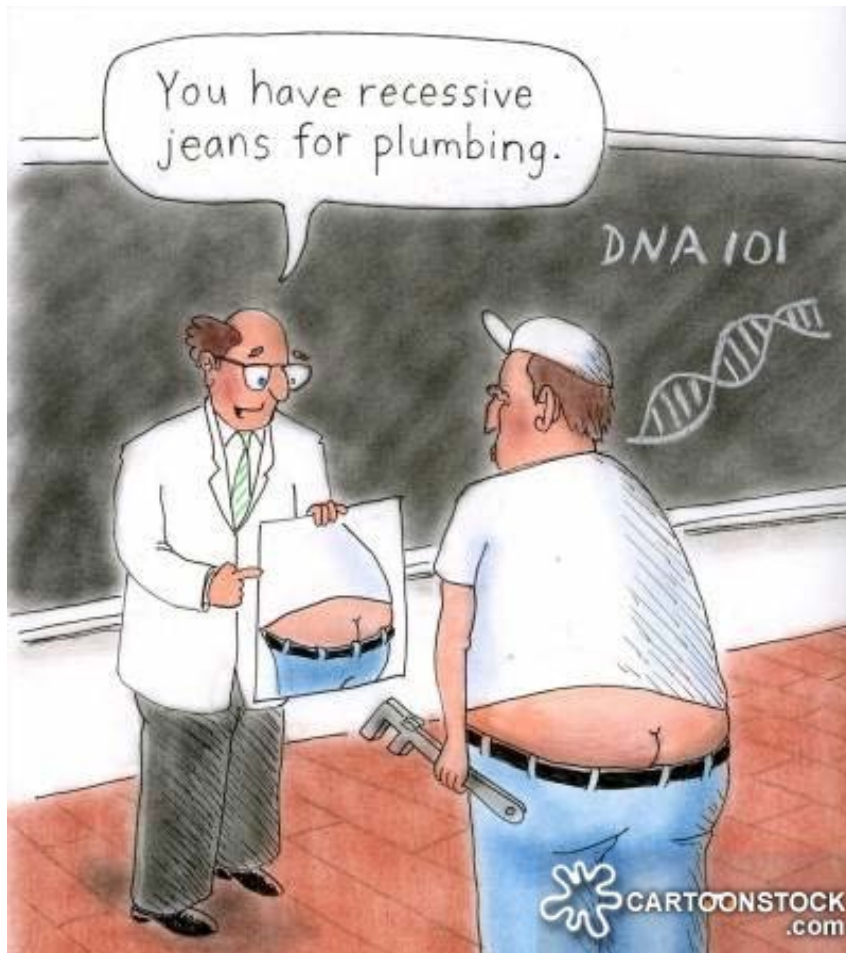
- Both Major Guidelines recommend LP to rule out blood or xanthochromia if CT negative for SAH

WHY THE DIFFERENCE OF OPINION?



- Confidence intervals (between 97-100%)
- Difference in perspective of risks of procedures
- Difference in risk tolerance for serious morbidity/ mortality
- Tolerance of uncertainty

BOTTOM LINE



LP AFTER NEGATIVE CT?

"It depends"...

...On the patient's (and MD's) risk tolerance...

...On the patient's age and comorbidities...

...On when the headache started...

...On how much the patient wants to avoid LP...

TREATMENT OF SAH: AHA GUIDELINES

EXCELLENT EVIDENCE:



- CCB: Nimodipine 60 mg po/NG q4-6h improves neuro outcomes

Connelly ES et al. AHA Guidelines for the treatment of Aneurysmal SAH.
Stroke 2012

TREATMENT OF SAH: AHA GUIDELINES



GOOD EVIDENCE:

- **SCALES:** WFNS or Hunt & Hess Scales predict outcomes
- **WORKUP:** Unenhanced CT followed by LP if negative, DSA if CT or LP positive
- **BLOOD PRESSURE:** Treat hypertension only if SBP >160 consistently in consultation with neurosurgery (consider labetalol 20 mg IV bolus +/- infusion)
- **TRANSFER:** Transfer from low volume hospital (<10 SAH/ year) to high volume hospital (>35 SAH/ year) or aneurysmal clipping or coiling ASAP improves outcomes
- **SEIZURE:** Consider antiepileptics: seizure risk up to 20% for 72 hours after aSAH

TREATMENT OF SAH: AHA GUIDELINES

FAIR EVIDENCE:

- FEVER: Treat fever aggressively
- GLUCOSE: Treat and prevent hypo & hyperglycemia
- VOLUME: Target euvolemia, isotonic fluids
- PAIN: Treat Pain and anxiety (fentanyl/benzos)
- COAGULOPATHY: Reverse coumadin, DOACs, clopidogrel, consider FFP
- OTHER: Consider transfusion for severe anemia
Tranexemic acid for delay to transfer
Drainage of hydrocephalus



SAH SCORING SYSTEMS:

HUNT & HESS SCALE:

1. Asymptomatic, mild headache, slight nuchal rigidity
2. Moderate to severe headache, nuchal rigidity, no neuro deficit (except CN palsy)
3. Drowsiness/confusion, mild focal neuro deficit
4. Stupor, moderate to severe hemiparesis
5. Coma, decerebrate posturing

SAH SCORING SYSTEMS:

World Federation of Neurologic Surgeons:

Grade 1 - GCS 15, no motor deficient

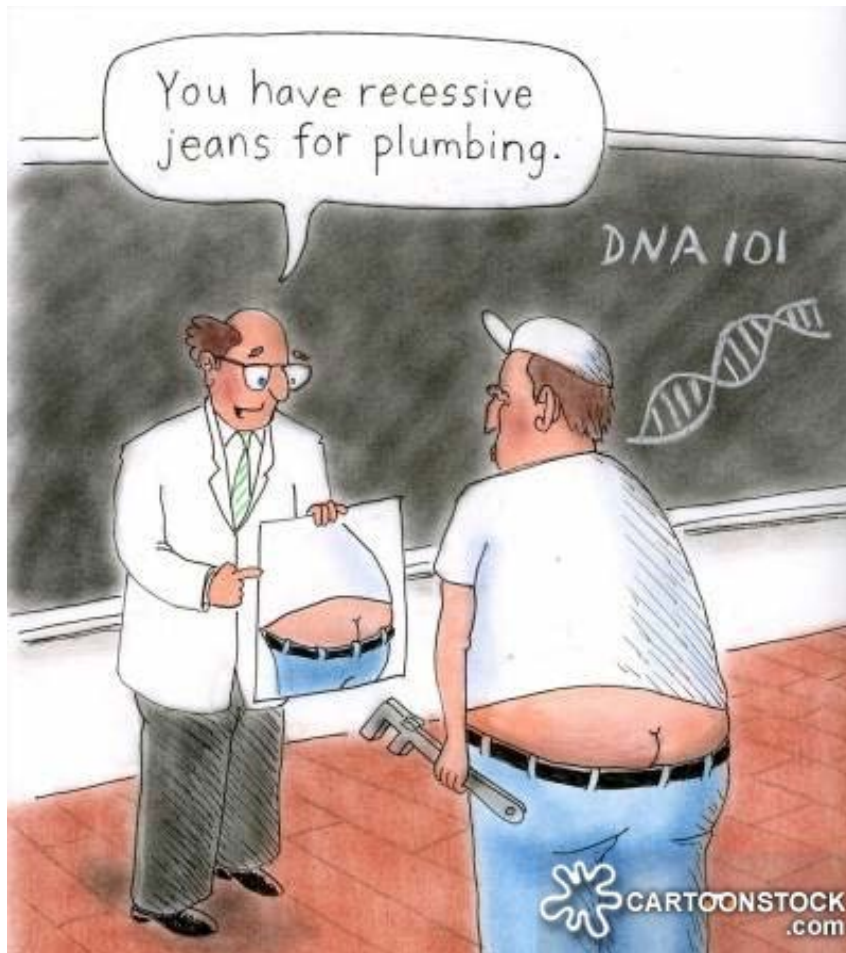
Grade 2 - GCS 13-14, no motor deficit

Grade 3 - GCS 13-14, +motor deficit

Grade 4 - GCS 7-12, +/- motor deficit

Grade 5 – GCS 3-7, +/- motor deficit

BOTTOM LINE

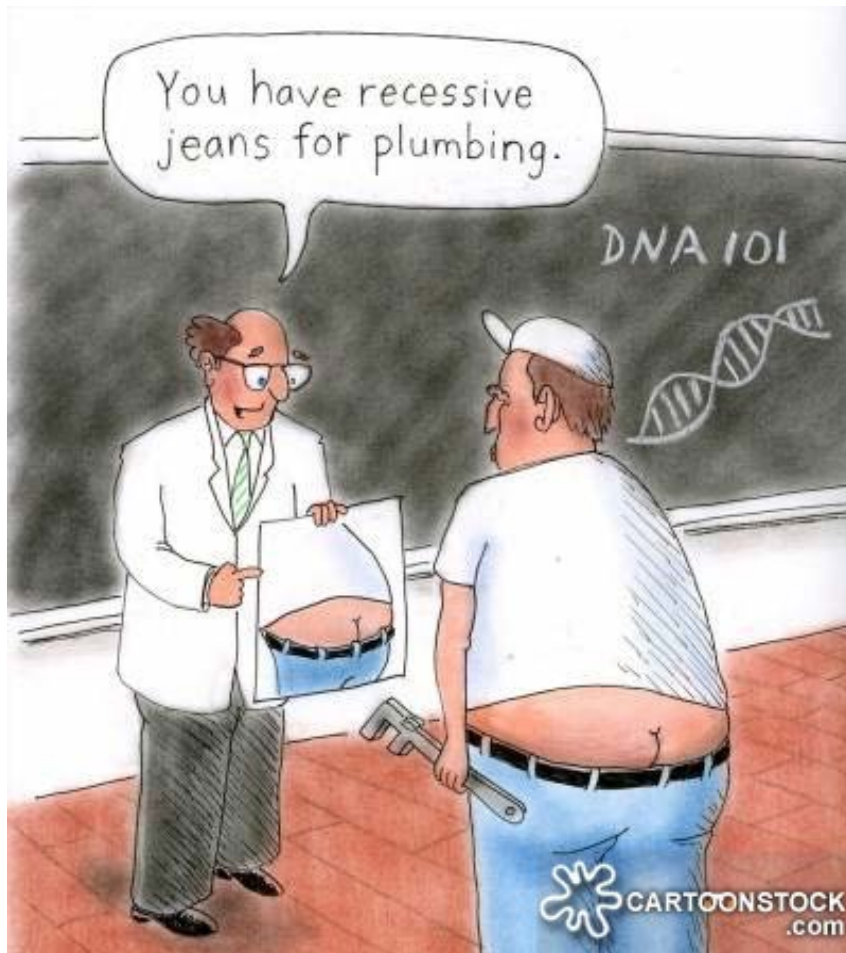


WHY IS SAH IMPORTANT?

Low prevalence but high risk of death & disability

Frequently missed diagnosis with high risk of serious adverse outcome

BOTTOM LINE

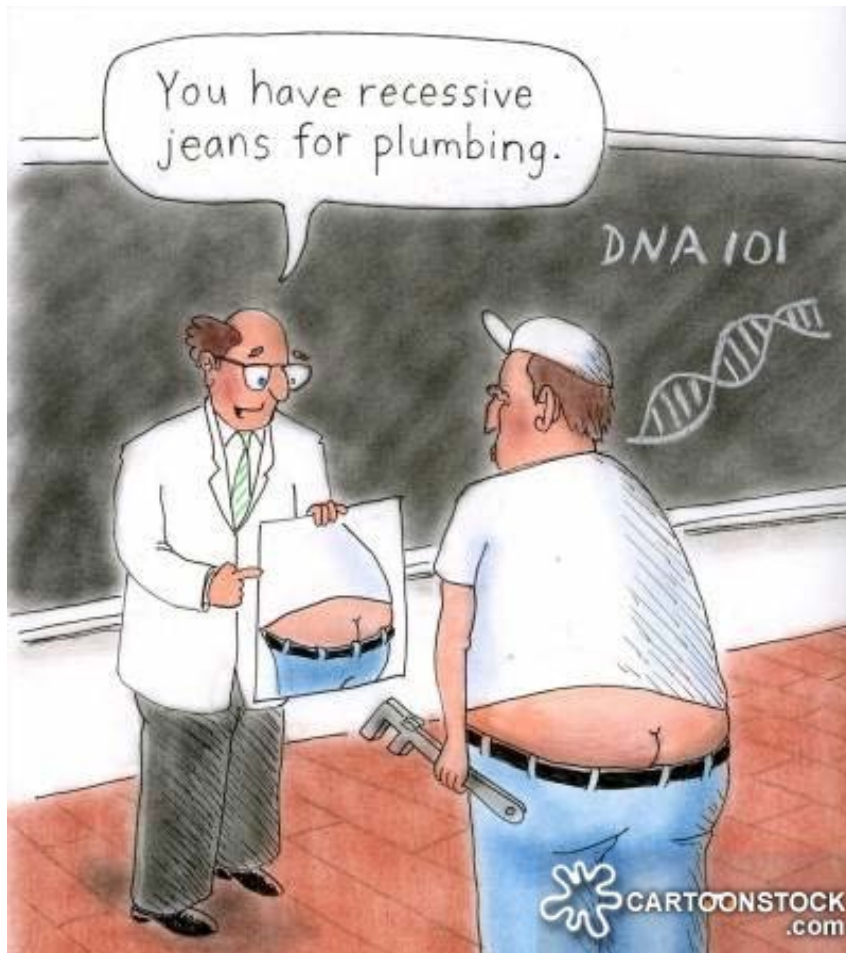


DIFFERENTIAL DIAGNOSIS:

Think of the 10 serious causes of headache

Use memory aids like POUND, SSNOOP and SUM to identify worrisome patterns of headaches and red flags

BOTTOM LINE



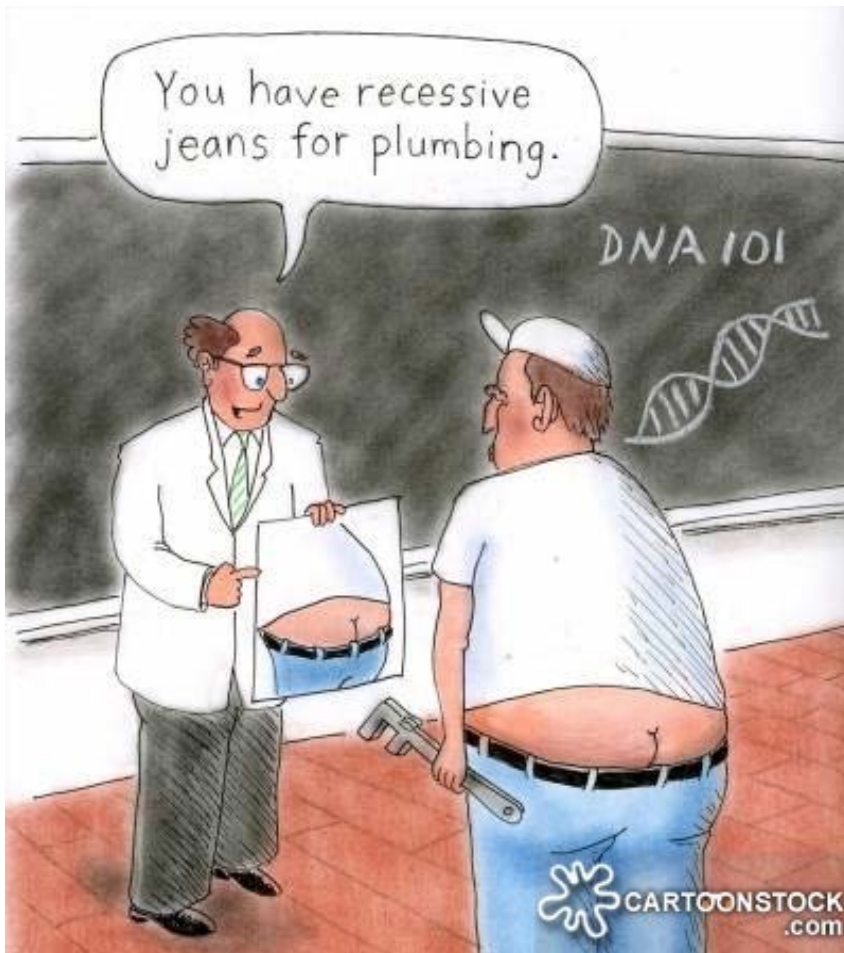
DIAGNOSIS OF SAH:

Use the Ottawa SAH rule to identify high risk headaches

Order Unenhanced CT +/- LP, then DSA if either positive

Use a Shared Decision model to decide if LP necessary to R/O SAH

BOTTOM LINE



TREATMENT OF SAH:

Early diagnosis and transfer

Nimodipine

Monitor BP, volume, sugar and temp

Seizure prophylaxis

Use clinical scales

THANKS:

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The Podcasters:

- Anton Helman (EMC)
- Ken Milne (SGEM)
- Oli Flowers (LITFL)
- **KEENER QUESTION:**
Name the music artists featured in this podcast!

