SMALLgroups

Approach to Acute Headache: A Flipped Classroom Module for Emergency Medicine Trainees

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ABSTRACT:

Audience: This module is designed for emergency medicine trainees. Though it focuses on those early in their career (medical students and junior residents), it is applicable to all emergency medicine learners.

Introduction: In the United States, headache is the fifth most-common primary complaint of patients presenting to the emergency department and can be the primary symptomatic manifestation of many life-threatening illnesses. The emergency physician plays a unique role in diagnosing and managing these patients. The emergency physician's two major responsibilities are to relieve headache pain and to ensure that life-threatening causes are diagnosed and treated.

Objectives: At the end of this module, the learner will be able to: 1) list the diagnoses critical to the emergency physician that may present with headache; 2) identify key historical and examination findings that help differentiate primary (benign) from secondary (serious) causes of headache; 3) discuss the indications for diagnostic imaging, lumbar puncture and laboratory testing in patients with headache; 4) recognize life-threatening diagnoses on CT imaging and CSF examination; 5) describe treatment strategies to relieve headache symptoms.

Methods: This module includes a complete flipped classroom module. Learners are responsible for viewing a 20-minute video prior to the 30-minute small-group, case-based didactic discussion portion. The learners are assessed with multiple-choice question assessments, for low stakes retrieval practice or spaced practice. This could alternatively be run as a team-based learning session, with the pre- and post-tests used as an

individual or group readiness assessment test, and the small group exercises converted to a group application exercise.

Topics: Headache, subarachnoid hemorrhage, migraine, occult trauma, meningitis, temporal arteritis, carbon monoxide toxicity, acute glaucoma, cervical artery dissection, space occupying lesion, idiopathic intracranial hypertension.

USER GUIDE

List of Resources:

Learner Audience:
Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:
Learner responsible content (LRC): 20 minute video
Pre-test: 15 minutes *(can be done asynchronously)*
Didactic portion (Small group discussion): 30 minutes
Post-test: 15 minutes *(can be done asynchronously)*

Recommended Number of Learners per Instructor:
An unlimited number of learners can watch the video. Based on existing literature, we recommend small groups of 5-8 for the in-class case discussion.[1]

Topics:
Headache, subarachnoid hemorrhage, migraine, occult trauma, meningitis, temporal arteritis, carbon monoxide toxicity, acute glaucoma, cervical artery dissection, space occupying lesion, idiopathic intracranial hypertension.

Objectives:
At the end of this module, the learner will be able to:

1. List the diagnoses critical to the emergency physician that may present with headache.
2. Identify key historical and examination findings that help differentiate primary (benign) from secondary (serious) causes of headache.
3. Discuss the indications for diagnostic imaging, lumbar puncture and laboratory testing in patients with headache.
4. Recognize life-threatening diagnoses on CT imaging and CSF examination.
5. Describe treatment strategies to relieve headache symptoms.

Linked objectives and methods:
Current didactic schedules built upon hour-long, lecture-based presentations have significant limitations.[2-7] The flipped classroom model provides an alternative in which students absorb a short lecture asynchronously, then use class time to focus on application, simulation, case-based, or problem-solving exercises.[5-7] This module is ideally implemented as part of the ACGME required weekly didactic requirement. It provides an approach to a commonly encountered emergency department (ED) chief complaint that is a part of the standard-setting ABEM Model of the Clinical Practice of Emergency Medicine: acute headache.[8]

Learners are introduced to each of the 5 objectives during the asynchronous video. The leaners then apply what they know to specific cases. During the case-based small group discussion, learners are asked to list their differential diagnosis for headache (Objective 1). They discuss the key features of the history and physical to differentiate between each cause of headache (Objective 2). Discussion leaders then ask what testing the learners would order and why (Objective 3). Learners then interpret test results, recognizing life-threatening diagnoses (Objective 4). Finally, learners propose treatment strategies (Objective 5). This process is repeated with a second case.

Recommended pre-reading for instructor:

- The in-class discussion leaders only need to read the "Instructor Handout," which will guide them through the cases to be discussed. No further preparation is needed for emergency medicine faculty members.

Learner responsible content (LRC):

- Instruct learners to watch the following 20-minute video prior to the didactic session. We recommend sending the link one week in advance, with an email reminder two days before the didactic session.
- The video is available for viewing on the JETem YouTube channel https://youtu.be/RNWPWmBUgil

Technology necessary:

- Learners will need access to YouTube to watch the video asynchronously. No technology is required for the didactic portion of the module.

Results and tips for successful implementation:
The in-class portion of the module can occur in the same room as previously scheduled didactics, though if desired, separate rooms for each small-group may be optimal. We recommend groups of five to eight learners; though local faculty availability will likely guide the size of each group. The session could

alternatively be run as a team-based learning session, with the pre- and post-tests as individual and/or group readiness assessment tests and the small group discussion questions as a group application exercise (followed by a whole class discussion of pre-/post-test and group application exercise answers).

Learners will access the asynchronous video through the JETem YouTube channel (https://youtu.be/RNWPWmBUgil). An instructor should send an email to the participants with a link to the video approximately five days before the planned didactic conference; we recommend that the instructor send another reminder email two days prior to the didactic session.

The assessments can be used in several ways:

- The pre-test can be given before releasing the video link or at the start of the didactic session (as an individualized readiness assessment, iRAT and/or group readiness assessment test, gRAT).
- The post-test can be given after watching the video module, as a gRAT, or several days later as a tool for spaced retrieval practice.

Based on our experience, spending 15 minutes for each assessment consumed valuable "in-class" time and decreased excitement for the module.

If this is the learners' first experience with the flipped classroom, it is important to clearly explain the importance of the pre-class preparation, in order to avoid confusion or decreased participation during the didactic session.

Associated content:

1. Learner Responsible Content, video link: https://youtu.be/RNWPWmBUgil
2. Headache Pre-test
3. Headache Post-test
4. Headache Learner Handout
5. Headache Pre-test Key
6. Headache Post-test Key
7. Headache Instructor Handout

References/Suggestions for Further Reading:

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3. Tan E, Brainard A, Larkin GL. Acceptability of the flipped classroom approach for in-house teaching in emergency medicine. *Emerg Med Australas.* 2015;27(5):453-459. doi: 10.1111/1742-6723.12454
4. Deiorio NM, Fitch MT, Jung J, Promes SB, Thibodeau LG, Woolley WL, et al. Evaluating educational interventions in emergency medicine. *Acad Emerg Med.* 2012;19(12):1442-1453. doi: 10.1111/acem.12022
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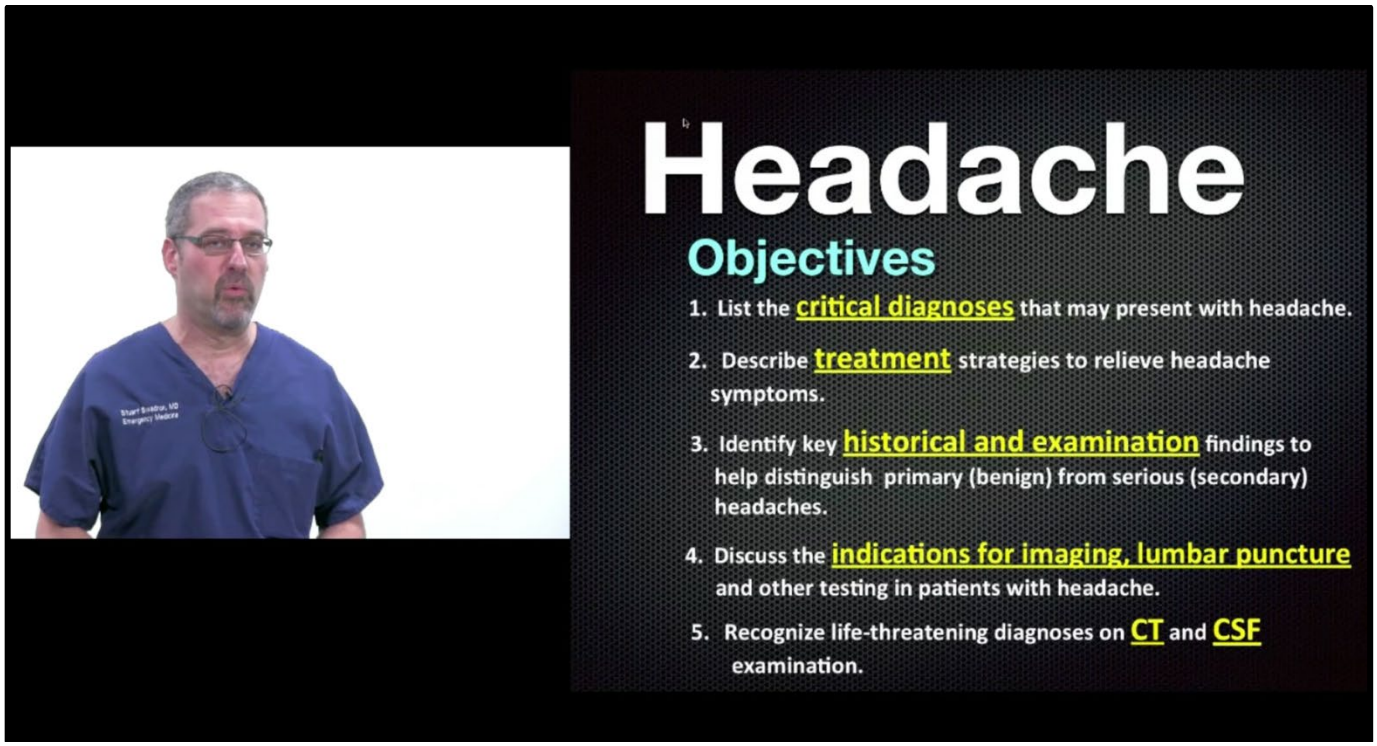
6. Prober CG, Khan S. Medical education reimagined: a call to action. *Acad Med.* 2013;88(10):1407-1410.
7. Mehta NB, Hull AL, Young JB, Stoller JK. Just imagine: new paradigms for medical education. *Acad Med.* 2013;88(10):1418-1423. doi: 10.1097/ACM.0b013e3182a36a07

LEARNER MATERIALS

Learner Responsible Content (LRC)

Instruct learners to watch the following 20-minute video prior to the didactic session. We recommend sending the link one week in advance, with an email reminder two days before the didactic session.

Video Link: https://youtu.be/RNWPWmBUgil



LEARNER MATERIALS

Headache Pre-Test

Name: _____

1. A 45-year-old female with a past medical history of migraine headaches presents to the emergency department with a severe frontal headache. The patient reports that she was exercising this morning, approximately 8 hours ago, when she felt a sudden onset severe headache associated with nausea and vomiting. She notes that typically her migraines are occipital, gradual in onset, and fairly mild. Physical exam reveals an uncomfortable appearing female with no focal neurologic deficits. Computed tomography (CT) scan of the brain is unremarkable. Which of the following studies is the next **best** step in establishing the diagnosis?
    a. CT angiogram
    b. Lumbar puncture
    c. Magnetic resonance (MR) angiogram
    d. Magnetic resonance imaging (MRI) brain

2. A 45-year-old female with no past medical history presents to the emergency department with daily headaches over the past month. The patient states the headaches are most severe in the morning and then gradually subside throughout the day. She denies fevers, chills, nausea or vomiting, or any recent trauma. She has no history of migraines or headaches in the past, and states no one at home is sick. She became concerned because she reports that the intensity of the headaches has gradually increased over the past week and her ibuprofen is losing its efficacy. Vital signs are unremarkable, and physical exam, including a neurologic exam, is unremarkable. Urine dipstick and pregnancy tests are negative. Which of the following is the most appropriate next step in management?
    a. Administer high flow oxygen by face mask
    b. Discharge home with opioid for breakthrough pain
    c. Order non-contrast CT head
    d. Perform lumbar puncture

Headache Pre-Test

3. A 35-year-old female presents to the emergency department with one day of severe headache associated with nausea but no vomiting. The headache started in the morning and gradually progressed throughout the day. The patient reports seeing bright lights in the periphery of her vision prior to headache onset, which has occurred in several past similar headaches. The patient denies fevers or recent infectious symptoms. Complete physical exam including neurologic exam is unremarkable. Which of the following is the most appropriate next step in management?
    a. CT head
    b. Lumbar puncture
    c. Metoclopramide
    d. Morphine

4. A 25-year-old male is brought in by ambulance after being struck on the right side of the head with a baseball bat. At triage, the patient endorses a severe headache and significant nausea and vomiting. The patient's mental status rapidly deteriorates and he is rushed back to the resuscitation area. Physical exam is significant for a large right parietal hematoma, as well as a right fixed and dilated pupil. Which of the following is most likely to be injured in this patient?
    a. Cerebral artery branch
    b. Cerebral bridging vein
    c. Meningeal artery branch
    d. Temporal artery

Headache Pre-Test

5. A 24-year-old human immunodeficiency virus (HIV) positive male non-compliant with his medications presents to the emergency department with headache and fever for 4 days. Vital signs: Blood pressure (BP) 138/79, heart rate (HR) 116, respiratory rate (RR) 20, temperature (T) 102.2°F (39.0°C). Physical exam reveals a cachectic male who is alert and oriented but has significant nuchal rigidity on exam. He has no neurologic deficits and the remainder of the physical exam unremarkable. Which of the following is the most appropriate next step in management?
    a. Antibiotic initiation followed by CT head and lumbar puncture
    b. Antibiotic initiation followed by lumbar puncture
    c. CT head followed by lumbar puncture and then antibiotic initiation
    d. Lumbar puncture followed by antibiotic initiation

6. A 75-year-old female presents to the emergency department with severe right-sided headache over the past week. The headache was gradual in onset but has continued to worsen over the past several days. The patient reports that her headache is particularly painful when chewing and she is unable to eat due to the pain. She denies fever, nausea or vomiting. Physical exam is negative for any focal neurologic deficits, but reveals tenderness to palpation on the lateral aspect of the forehead. Failure to treat this disease appropriately may lead to which of the following feared complications?
    a. Blindness
    b. Cerebral venous sinus thrombosis
    c. Ischemic stroke
    d. Intracerebral hemorrhage

Headache Pre-Test

7. A 23-year-old male is brought in to the emergency department by his family for severe headaches, vomiting, fever, and bizarre behavior over the previous 24 hours. Initial vital signs: BP 137/84, HR 115, RR 22, T 102.2°F (39.0°C). Physical exam is remarkable for an altered male who is unable to fully cooperate with a neurologic exam. However, he appears to move all four extremities without deficit. The patient demonstrates significant pain with range of motion of his neck. A CT head is performed and is unremarkable. Cerebral spinal fluid (CSF) analysis from your lumbar puncture reveals the following: glucose 60 mg/dL, protein 150 mg/dL, 250 WBC/uL with 85% lymphocytes, 4,050 RBC/uL. Gram stain is negative, and the CSF is also sent for culture. Which of the following is the most appropriate next step in management of this patient?
    a. Administer acyclovir, ceftriaxone and vancomycin intravenously (IV)
    b. Administer ceftriaxone and dexamethasone IV
    c. CT angiography and neurosurgery consultation
    d. No antibiotic coverage and observation for results of CSF culture

8. A 43-year-old female with a history of diabetes presents to the emergency department with six days of gradually progressive severe headache. She describes the headache as a throbbing pain involving her entire forehead associated with nausea. She denies any fever, recent infectious symptoms, or trauma. Physical exam reveals an uncomfortable, obese female with an otherwise unremarkable exam, except fundoscopic exam with loss of spontaneous venous pulsations bilaterally. The patient has no neurologic or visual deficits. Which of the following is the next best step in management of this patient?
    a. CT angiography head
    b. CT non-contrast head
    c. MR brain with diffusion weighted imaging
    d. MR brain with venography

Headache Pre-Test

9. A 44-year-old female presents to the emergency department with a bitemporofrontal headache that started four days ago. The pain is constant, but nonexertional. She also endorses the sensation of a vice-like squeezing of her head. She denies fevers, chills, nausea, vomiting, or recent trauma. She states having had several of these episodes over the past few years. Vital signs: BP 141/86, HR 93, RR 18, T 98.7°F (37.0°C). On physical exam, cranial nerves are intact, and the patient has normal sensation and strength in all four extremities. Reflexes are 2+ bilaterally to all extremities. Visual acuity is normal, and her intra-ocular pressure is 18 mmHg in both eyes. Fundoscopic exam is unremarkable. Which of the following is the next best step in management of this patient?
    a. CT head
    b. Discharge with nonsteroidal anti-inflammatory drugs (NSAIDs)
    c. Erythrocyte sedimentation rate
    d. High-flow oxygen

10. A 65-year-old male with no past medical history presents to the emergency department with sudden onset of severe headache that started this afternoon while on his afternoon walk just as he entered a dark store. He describes the headache as the worst of his life. The headache is right frontal involving his forehead. He also reports right-sided blurry vision. Physical exam reveals an uncomfortable appearing male. Neurologic exam is unremarkable other than a right-sided mid-range pupil that is minimally reactive to light. Which of the following tests is most likely to confirm the diagnosis in this patient?
    a. CT angiogram
    b. Erythrocyte sedimentation rate
    c. Fluorescein staining
    d. Ocular tonometry

Headache Post-Test

Name: _____

1. A 51-year-old female presents to the emergency department with a sudden onset severe headache for 2 hours, associated with nausea and vomiting. Physical exam reveals an uncomfortable appearing female. However, there are no focal neurologic deficits and the remainder of the physical exam is unremarkable. Vital signs: BP 156/78, HR 110, RR 18, T 98.7°F (37.0°C). Computed tomography (CT) scan of the head shows diffuse subarachnoid hemorrhage. Which of the following agents is most likely to improve outcome in this patient?
    a. Labetolol
    b. Nimodipine
    c. Nitroglycerin
    d. Nitroprusside

2. A 77-year-old male with a history of diabetes, hypertension, hyperlipidemia, and seasonal allergies presents to the emergency department with a chief complaint of sudden onset of left frontal headache, nausea, and blurry vision. Neurologic exam reveals no deficits other than a left mid-range pupil, which is minimally reactive to light. The remainder of the physical exam is unremarkable. Intra-ocular pressure is 50 mmHg on the left, 18 mmHg on the right. Which of the following of the patient's medications likely contributed to this presentation?
    a. Diphenhydramine
    b. Labetolol
    c. Metformin
    d. Simvastatin

Headache Post-Test

3. A 68-year-old female presents to the emergency department with progressive left-sided headache over the past two weeks. The pain was gradual in onset but has progressed significantly and is now severe. It is particularly painful when the patient chews her food. Physical exam reveals an uncomfortable appearing female, however her physical exam, including a complete neurologic exam, is unremarkable other than tenderness to palpation over the lateral aspect of her forehead. Laboratory analysis, including a complete blood count and metabolic panel, is unremarkable other than an elevated erythrocyte sedimentation rate. Which of the following comorbidities is most likely to be found in this patient?
    a. Lupus erythematosus
    b. Polymyalgia rheumatica
    c. Polymyositis
    d. Raynaud's phenomenon

4. A 42-year-old male presents to the emergency department with a severe headache. He reports that over the ten days each evening he has had a sudden onset severe headache lasting about 30 minutes and then resolving. The headaches are on the right side of the head only over the temporal area. Physical exam reveals an anxious appearing male with right-sided ptosis and conjunctival injection. The remainder of the physical exam, including a complete neurologic exam, is unremarkable. Visual acuity is intact. Which of the following is the most appropriate next step in management of this patient's condition?
    a. CT head followed by lumbar puncture
    b. High flow oxygen
    c. Metoclopramide
    d. Pilocarpine

Headache Post-Test

5. A 19-year-old male student with no past medical history presents to the emergency department with 24 hours of headache, nausea and vomiting, and fever. He denies trauma, numbness or weakness, or travel. Physical exam reveals an anxious and uncomfortable male who is alert and oriented but has photophobia and nuchal rigidity. He has no neurologic deficits. Fundoscopic exam, although difficult, reveals clear disc margins bilaterally. The remainder of the physical exam is remarkable only for tachycardia and fever. The nurses note that, while they secured peripheral IV access, the patient has become more agitated. Which of the following is the most appropriate next step in management?
    a. Antibiotics
    b. CT head
    c. Lumbar puncture
    d. MRI brain

6. A 35-year-old male is brought in by ambulance after a bicycle accident. He was riding without his helmet when he was struck on the side by another bicyclist. Per paramediics, the patient was initially communicative. However, his neurologic status declined on transport to the hospital. On presentation, the patient has a Glascow coma scale (GCS) of 5. Physical exam is significant for a large right parietal hematoma as well as a right fixed and dilated pupil. Which of the following findings on non-contrast CT head is most consistent with this patient's presentation?
    a. Diffuse petechial hyperdense lesions along gray-white junction
    b. Extra-axial hyperdense collection that does not extend beyond suture lines
    c. Extra-axial hyperdensity collection that is crescent-shaped
    d. Hyperdense collection outlining the cerebral sulci

Headache Post-Test

7. A 55-year-old female with a history of hypertension and breast cancer, status post resection and in remission for several years, presents to the emergency department with a daily headache for the past week. She has no other medical problems and denies a history of significant headaches in the past. She states the pain is worst in the morning and then gradually improves throughout the day. She denies fever, infectious symptoms, or trauma. Triage vital signs: BP 188/99, HR 87, RR 14, oxygen saturation (O_2Sat) 100%, T 98.7°F (37.0°C). Strength, sensation, reflex, cranial nerve, and cerebellar testing are unremarkable. The oral opioid pain medication administered at triage has not improved her pain. Which of the following is the most appropriate next step in management?
    a. CT head
    b. Labetalol IV
    c. Mannitol IV
    d. Serum CA-125 level

8. A 22-year-old pregnant female at 24 weeks gestation presents to the emergency department with a severe headache that developed gradually over 24 hours. She denies fever, other infectious symptoms, or trauma. Vital signs: BP 165/91, HR 85, RR 18, T 98.7°F (37.0°C). During the physical exam, the patient has a 30 second generalized tonic-clonic seizure that resolves without medication. In addition to consulting obstetrics, which of the following is the most appropriate next step in management?
    a. Emergent CT head
    b. Lorazepam IV
    c. Labetalol IV
    d. Magnesium sulfate IV

Headache Post-Test

9. A 35-year-old HIV positive male with a last known CD4 count of 80 cells/uL presents to the emergency department with three days of gradually progressive headache, nausea and vomiting, and fever. Computed tomography (CT) head is negative for mass, shift, or bleed, so a lumbar puncture is performed. Cerebal spinal fluid analysis reveals an opening pressure 70 cm H2O, glucose 40 mg/dL, protein 100 mg/dL, and WBC count 40 cells/uL with a mononuclear predominance. Which of the following is the most likely cause of this patient's presentation?
    a. Cryptococcus neoformans
    b. Mycobacterium tuberculosis
    c. Neisseria meningitidis
    d. Streptococcus pneumonia

10. A 43-year-old female with a history of diabetes presents to the emergency department with six days of gradually progressive severe headache. She describes the headache as a throbbing pain involving her entire forehead associated with nausea. She denies any fever, recent infectious symptoms, or trauma. Physical exam reveals an uncomfortable, obese female with an otherwise unremarkable exam, except fundoscopic exam with loss of spontaneous venous pulsations bilaterally. The patient has no neurologic or visual deficits. MRI brain is read unremarkable. Lumbar puncture reveals opening pressure of 43 cm H2O. CSF analysis is unremarkable. Which of the following is the next best step in management of this patient?
    a. Acetazolamide
    b. Optic nerve sheath fenestration
    c. Prednisone
    d. Serial lumbar punctures

LEARNER MATERIALS

Small Group Handout

Headache: Case # 1

Ms. Jones is a 32-year-old woman with a history of migraines, who presents with left sided head and neck pain. She states that the headache developed over the course of a few seconds after her yoga class. She describes it as aching in quality. She states that the headache is similar to previous migraines.
Past medical history (PMH): unremarkable; Past surgical history (PSH): status post tonsillectomy at age 5; Social history (SH): occasional alcohol; Medications (meds): occasionally takes Excedrin migraine

Physical exam (PE): T 36.8°C, BP 130/85, HR 84, RR 18, O_2sat 98% on RA.
General (GEN): She is in no acute distress
Cardiovascular (CV): Regular rate and rhythm, no murmurs, rubs or gallops
CHEST: Lungs clear to auscultation bilaterally
Neurological (NEURO): Left pupil is 2mm smaller than the right and there is slight ptosis of the left eyelid. Remaining neurologic exam normal

ED Course: She feels much better after receiving prochlorperazine 10mg IV

What is your differential diagnosis?

What is the significance of the asymmetric pupil and ptosis?

Does a response to therapy have diagnostic value?

How should this patient be evaluated?

LEARNER MATERIALS

Would your differential diagnosis and evaluation plan change if she were 8 months pregnant?

What would be the most likely etiology if she had ptosis and a dilated pupil?

What neurologic exam finding frequently accompanies Idiopathic Intracranial Hypertension?

LEARNER MATERIALS

Headache: Case #2

Ms. Smith is a 31-year-old female who presents with "bad headaches" on and off for 1 month. She denies nausea and vomiting. She complains of photophobia and left eye blurriness. She denies fevers and chills. The nursing notes state that she gets them every night when she goes to bed. There is no history of trauma. She has been taking aspirin as needed for pain.

PMH: unremarkable. PSH: cholecystectomy and a cesarean section. SH is positive for tobacco. Meds: acetaminophen and aspirin, as needed

PE: T 36.4, BP 137/94, HR 61, RR 22, 02 saturation of 99% on RA
GEN: She is an obese woman in NAD
HEENT: Pupils equally round and reactive
CHEST: Clear to auscultation bilaterally
CV: Regular rate and rhythm
Abdominal (ABD): Soft non-tender, non-distended
NEURO: Alert and oriented X3.

ED Course: She receives 10 mg prochlorperazine, 25 mg diphenhydramine and 4 mg of morphine (all IV). She felt better and was discharged home on acetaminophen-hydrocodone as needed.

What other historical features and PE findings would you like to know?

What tests would you order?

What is your differential diagnosis?

What is the significance of her improvement with narcotics and dopamine antagonists?

LEARNER MATERIALS

Headache: Case #2 Continued

She presents to the same ED 8 days later complaining of feeling worse. She states her pain is more severe when she is in bed. She denies nausea and vomiting. She has no fever, chills, cough, chest pain, dysuria, joint pain, focal weakness or rash.

PE: BP 129/88, Pulse 74, Temp 36.3 °C (97.3 °F) (Oral), Resp 21
Height (Ht) 5' 3" (1.6 m), Weight (Wt) 104.327 kg (230 lb) Body mass index (BMI) 40.75 kg/m2, SpO2 99%
GEN: She is in no distress, judgment/insight appropriate
Head, eyes, ears, nose and throat (HEENT): Normal conjunctiva, normal oropharynx and oral mucosa
CHEST: Normal respiratory effort
CV: regular rate and rhythm, no murmurs, rubs or gallops
ABD: Soft non-tender, non-distended
NEURO: She follows commands appropriately and has a normal gait, PERRL, EOMI, no CN deficits, normal motor and sensory exam, no nuchal rigidity.

How should she be further evaluated?

What is your differential diagnosis?

How would the differential diagnosis change if she were elderly?

INSTRUCTOR MATERIALS

Headache Pre-Test Key

*Correct answers **bolded** and <u>underlined</u>*

1. A 45-year-old female with a past medical history of migraine headaches presents to the emergency department with a severe frontal headache. The patient reports that she was exercising this morning, approximately 8 hours ago, when she felt a sudden onset severe headache associated with nausea and vomiting. She notes that typically her migraines are occipital, gradual in onset, and fairly mild. Physical exam reveals an uncomfortable appearing female with no focal neurologic deficits. Computed tomography scan of the brain is unremarkable. Which of the following studies is the next best step in establishing the diagnosis?
    a. Angiogram
        i. This patient's history is concerning for subarachnoid hemorrhage. While a CT angiogram may be necessary to evaluate for aneurysms in the setting of a positive lumbar puncture (LP), the LP is necessary to evaluate for bleeding and to help distinguish between bleeding aneurysms and incidental findings of aneurysms.
    b. <u>Lumbar puncture</u>
        i. The correct answer is lumbar puncture. This patient's sudden onset headache brought on by activity is concerning for subarachnoid hemorrhage. CT head alone is positive in 92% of cases when performed within 24 hours and there is some literature suggesting that this number is actually even higher. Given new data about the high sensitivity of CT head for subarachnoid hemorrhage (SAH) within 6 hours, LP may not be necessary in that time window. However, as of now, and especially after 6 hours, current recommendations are that in all patients in whom one is concerned about subarachnoid hemorrhage, a lumbar puncture should be performed looking for RBCs/xanthochromia in the setting of a negative head CT.
    c. MR angiogram
        i. This patient's history is concerning for subarachnoid hemorrhage. While a MR angiogram may be necessary to evaluate for aneurysms in the setting of a positive LP, the LP is necessary to evaluate for bleeding and to help distinguish between bleeding aneurysms and incidental findings of aneurysms.
    d. MRI brain

i. This patient's history is concerning for subarachnoid hemorrhage. While MRI brain may detect hemorrhage, angiography is the more appropriate imaging modality to evaluate for the presence of aneurysms.

2. A 45-year-old female with no past medical history presents to the emergency department with daily headaches over the past month. The patient states the headaches are most severe in the morning and then gradually subside throughout the day. She denies fevers, chills, nausea or vomiting, or any recent trauma. She has no history of migraines or headaches in the past, and states no one at home is sick. She became concerned because she reports that the intensity of the headaches has gradually increased over the past week and her ibuprofen is losing its efficacy. Vital signs are unremarkable, and physical exam, including a neurologic exam, is unremarkable. Urine dipstick and pregnancy tests are negative. Which of the following is the most appropriate next step in management?
    a. Administer high flow oxygen by face mask
        i. This patient's history of progressive intensity headaches worst in the morning, as well as her lack of history of prior headaches, is concerning for a mass lesion. High flow O_2 is the initial treatment of choice for cluster headaches.
    b. Discharge home with opioid for breakthrough pain
        i. This patient's history of progressive intensity headaches worst in the morning, as well as her lack of history of prior headaches, is concerning for a mass lesion. Hydrocodone and other narcotics may be used to help
    c. <u>Order non-contrast CT head</u>
        i. The correct answer is CT head. This patient's history of progressive intensity headaches worst in the morning, as well as her lack of history of prior headaches, is concerning for a mass lesion. The initial study of choice is CT scan, although MRI may be more sensitive.
    d. Perform lumbar puncture
        i. This patient's history of progressive intensity headaches worst in the morning, as well as her lack of history of prior headaches, is concerning for a mass lesion. CT head should first be obtained. Lumbar puncture at this time, is not indicated.

3. A 35-year-old female presents to the emergency department with one day of severe headache associated with nausea but no vomiting. The headache started in the morning and gradually progressed throughout the day. The patient reports seeing bright lights in the periphery of her vision prior to headache onset, which has occurred in several past similar headaches. The patient denies fevers or recent infectious symptoms. Complete physical exam including neurologic exam is unremarkable. Which of the following is the most appropriate next step in management?
    a. CT head
        i. This patient's history of headaches as well as her gradual onset of headache without fever or infectious symptoms and visual aura is suggestive of classic migraine headaches. CT is unnecessary.
    b. Lumbar puncture
        i. This patient's history of headaches as well as her gradual onset of headache without fever or infectious symptoms and visual aura is suggestive of classic migraine headaches. Lumbar puncture is unnecessary.
    c. <u>Metoclopramide</u>
        i. The correct answer is metoclopramide. This patient's history of headaches as well as her gradual onset of headache without fever or infectious symptoms and visual aura is suggestive of classic migraine headaches. Treatment in the emergency department typically involves IV metoclopramide or prochloperazine or subcutaneous sumatriptan. Dihydroergotamine is also an alternative. Morphine is typically less effective for migraine headaches.
    d. Morphine
        i. This patient's history of headaches as well as her gradual onset of headache without fever or infectious symptoms and visual aura is suggestive of classic migraine headaches. Morphine is less effective than metoclopramide in the treatment of migraine headaches.

4. A 25-year-old male is brought in by ambulance after being struck on the right side of the head with a baseball bat. At triage, the patient endorses a severe headache and significant nausea and vomiting. The patient's mental status rapidly deteriorates and he is rushed back to the resuscitation area. Physical exam is significant for a large right parietal hematoma, as well as a right fixed and dilated pupil. Which of the following is most likely to be injured in this patient?

a. Cerebral artery branch
    i. This patient's presentation of trauma followed by a lucid interval and rapid decline, as well as his neurologic exam is classic for an epidural hematoma. Epidurals most commonly occur due to rupture of the middle meningeal artery from direct trauma.
b. Cerebral bridging vein
    i. This patient's presentation of trauma followed by a lucid interval and rapid decline, as well as his neurologic exam is classic for an epidural hematoma. Epidurals most commonly occur due to rupture of the middle meningeal artery from direct trauma. Bridging vein injury is the cause of subdural hematomas, and more classically in elderly or alcoholics.
c. <u>Meningeal artery branch</u>
    i. The correct answer is middle meningeal artery. This patient's presentation of trauma followed by a lucid interval and rapid decline, as well as his neurologic exam is classic for an epidural hematoma. Epidurals most commonly occur due to rupture of the middle meningeal artery from direct trauma.
d. Temporal artery
    i. While the temporal artery is the appropriate location, it arises from the external carotid artery and is extracranial.

5. A 24-year-old HIV positive male non-compliant with his medications presents to the emergency department with headache and fever for four days. Vital signs: BP 138/79, HR 116, RR 20, T 102.2°F (39.0°C). Physical exam reveals a cachectic male who is alert and oriented but has significant nuchal rigidity on exam. He has no neurologic deficits and the remainder of the physical exam unremarkable. Which of the following is the most appropriate next step in management?
    a. <u>Antibiotic initiation followed by CT head and lumbar puncture</u>
        i. The correct answer is immediate antibiotic initiation followed by CT head and lumbar puncture. This patient is immunocompromised, so despite his nonfocal neurologic exam, he requires a CT scan prior to performing a lumbar puncture. In cases where there is no delay to lumbar puncture (such as a neurologically intact healthy person who does not require a CT scan), antibiotics can be started after LP is performed. However, the recommendation is that whenever any delay is anticipated, including the

need to obtain a CT scan, antibiotic coverage should be initiated immediately.

b. Antibiotic initiation followed by lumbar puncture
    i. This patient's history of HIV and thus immunosuppression necessitates that a CT be obtained prior to a lumbar puncture. As a result, in this case antibiotics should not be delayed and should be started immediately, followed by CT head.
c. CT head followed by lumbar puncture and then antibiotic initiation
    i. This patient's history of HIV and thus immunosuppression necessitates that a CT be obtained prior to a lumbar puncture. Additionally, antibiotics should not be delayed and should be started immediately.
d. Lumbar puncture followed by antibiotic initiation
    i. This patient's history of HIV and thus immunosuppression necessitates that a CT be obtained prior to a lumbar puncture. Additionally, antibiotics should not be delayed and should be started immediately.

6. A 75-year-old female presents to the emergency department with severe right-sided headache over the past week. The headache was gradual in onset but has continued to worsen over the past several days. The patient reports that her headache is particularly painful when chewing and she is unable to eat due to the pain. She denies fever, nausea or vomiting. Physical exam is negative for any focal neurologic deficits, but reveals tenderness to palpation on the lateral aspect of the forehead. Failure to treat this disease appropriately may lead to which of the following feared complications?
    a. <u>Blindness</u>
        i. This patient's presentation is concerning for temporal arteritis, which is a chronic vasculitis. The feared complication of this disease is blindness. Diagnosis is suspected based on clinical features as well as an elevated ESR, and is confirmed by biopsy. Glucocorticoids are the initial treatment of choice.
    b. Cerebral venous sinus thrombosis
        i. This patient's presentation is concerning for temporal arteritis, which is a chronic vasculitis. Cerebral venous thrombosis is caused by thrombosis of cerebral veins or sinuses. Risk factors include oral contraceptives, pregnancy, malignancy, and other prothrombotic conditions
    c. Ischemic stroke

i. This patient's presentation is concerning for temporal arteritis, which is a chronic vasculitis. The most feared complication is blindness. Ischemic stroke is a possible complication although it is very rare.

d. Intracerebral hemorrhage
   i. This patient's presentation is concerning for temporal arteritis, which is a chronic vasculitis. The most feared complication is blindness. Ischemic stroke is a possible complication although it is very rare. Intracerebral hemorrhage is unlikely.

7. A 23-year-old male is brought in to the emergency department by his family for severe headaches, vomiting, fever, and bizarre behavior over the previous 24 hours. Initial vital signs: BP 137/84, HR 115, RR 22, T 102.2°F (39.0°C). Physical exam is remarkable for an altered male who is unable to fully cooperate with a neurologic exam. However, he appears to move all four extremities without deficit. The patient demonstrates significant pain with range of motion of his neck. A CT head is performed and is unremarkable. CSF analysis from your lumbar puncture reveals the following: glucose 60 mg/dL, protein 150 mg/dL, 250 WBC/uL with 85% lymphocytes, 4,050 RBC/uL. Gram stain is negative, and the CSF is also sent for culture. Which of the following is the most appropriate next step in management of this patient?
   a. <u>Administer acyclovir, ceftriaxone and vancomycin IV</u>
      i. The correct answer is empiric coverage including acyclovir. This patient's exam as well as his lumbar puncture results (elevated protein, elevated RBCs, normal glucose, lymphocyte predominant elevated WBCs) is suggestive of herpes encephalitis. Treatment is early initiation of IV acyclovir. Given that this patient is significantly ill-appearing, empiric coverage with broad spectrum antibiotics is also reasonable pending the results of the CSF culture. CSF should also be sent for HSV-PCR.
   b. Administer ceftriaxone and dexamethasone IV
      i. This patient's history and exam is concerning for herpes encephalitis. Bacterial meningitis is less likely and he should be covered with acyclovir.
   c. CT angiography and neurosurgery consultation
      i. This patient is presenting with herpes encephalitis. Although the CSF demonstrates a large quantity of red blood cells, infection is higher on the differential than ruptured aneurysm or arteriovenous malformation.
   d. No antibiotic coverage and observation for results of CSF culture

i. This patient's history and exam is concerning for herpes encephalitis. This is not a simple, uncomplicated viral meningitis. He should be covered with acyclovir.

8. A 43-year-old female with a history of diabetes presents to the emergency department with 6 days of gradually progressive severe headache. She describes the headache as a throbbing pain involving her entire forehead associated with nausea. She denies any fever, recent infectious symptoms, or trauma. Physical exam reveals an uncomfortable, obese female with an otherwise unremarkable exam, except fundoscopic exam with loss of spontaneous venous pulsations bilaterally. The patient has no neurologic or visual deficits. Which of the following is the next best step in management of this patient?
    a. CT angiography head
        i. This patient's age as well as her obesity, in conjunction with her gradually progressive headache and early papilledema is suggestive of idiopathic intracranial hypertension. Neuroimaging is required to exclude secondary causes of intracranial hypertension. The preferred test is MRI with MR venography.
    b. CT non-contrast head
        i. This patient's age as well as her obesity, in conjunction with her gradually progressive headache and early papilledema is suggestive of idiopathic intracranial hypertension. Neuroimaging is required to exclude secondary causes of intracranial hypertension. The preferred test is MRI with MR venography. CT is the alternative when MR is contraindicated, although CT has lower sensitivity and specificity.
    c. MR brain with diffusion weighted imaging
        i. This patient's age as well as her obesity, in conjunction with her gradually progressive headache and early papilledema is suggestive of idiopathic intracranial hypertension. Neuroimaging is required to exclude secondary causes of intracranial hypertension. The preferred test is MRI with MR venography. Diffusion weighted imaging is most commonly used for detecting ischemia/infarct.
    d. <u>MR brain with venography</u>
        i. This patient's age as well as her obesity, in conjunction with her gradually progressive headache and early papilledema is suggestive of idiopathic intracranial hypertension. Neuroimaging is required to exclude secondary

causes of intracranial hypertension. The preferred test is MRI with MR venography.

9. A 44-year-old female presents to the emergency department with a bitemporofrontal headache that started 4 days ago. The pain is constant, but nonexertional. She also endorses the sensation of a vice-like squeezing of her head. She denies fevers, chills, nausea, vomiting, or recent trauma. She states having had several of these episodes over the past few years. Vital signs: BP 141/86, HR 93, RR 18, T 98.7°F (37.0°C). On physical exam, cranial nerves are intact, and the patient has normal sensation and strength in all 4 extremities. Reflexes are 2+ bilaterally to all extremities. Visual acuity is normal, and her intra-ocular pressure is 18 mmHg in both eyes. Fundoscopic exam is unremarkable. Which of the following is the next best step in management of this patient?
    a. CT head
        i. This patient is presenting with tension-type headache. Given the unremarkable exam and classic and stable history, there is no indication for emergent neuroimaging at this time.
    b. <u>Discharge with NSAIDs</u>
        i. This patient is presenting with tension-type headache: bilateral location, pressing/tightening quality, nonexertional without nausea/vomiting and no more than one of photophobia/phonophobia, with each episode lasting between 30minutes to days. The acute treatment consists of simple analgesia (NSAIDs, acetaminophen, aspirin, caffeine).
    c. Erythrocyte sedimentation rate
        i. This patient is presenting with tension-type headache. Erythrocyte sedimentation rate is useful as a screening test for temporal arteritis. Given the unremarkable exam, there is no indication for ESR screening at this time.
    d. High-flow oxygen
        i. This patient's history of squeezing type pain as well as her unremarkable exam is suggestive of tension headache. Cluster headaches are classically one-sided and involve unilateral symptoms such as tearing of the eyes and rhinorrhea.

10. A 65-year-old male with no past medical history presents to the emergency department with sudden onset of severe headache that started this afternoon while on his afternoon walk just as he entered a dark store. He describes the headache as the worst of his life. The headache is right frontal involving his forehead. He also reports right-sided blurry vision. Physical exam reveals an uncomfortable appearing male. Neurologic exam is unremarkable other than a right-sided mid-range pupil that is minimally reactive to light. Which of the following tests is most likely to confirm the diagnosis in this patient?
    a. CT angiogram
        i. This patient's history is most consistent with acute glaucoma. CT angiogram would be helpful in the settting of suspected subarachnoid hemorrhage
    b. Erythrocyte sedimentation rate
        i. Erythrocyte sedimentation rate is a blood test used to screen for temporal arteritis. This patient is presenting with acute glaucoma.
    c. Fluorescein staining
        i. Fluoroscein is used to detect corneal abrasion or lacerations. While corneal injuries are certainly on the differential diagnosis, the question stem is describing a patient with classic acute glaucoma, in which fluoroscein staining has no significant role.
    d. <u>Ocular tonometry</u>
        i. The correct answer is ocular tonometry. This patient's history of sudden onset pain which started while entering a dark room, as well as his fixed and mid-range pupil is concerning for acute glaucoma. Measuring of intraocular pressure using ocular tonometry will confirm the diagnosis. Treatment is with pressure-lowering drops (timolol, pilocarpine, etc) as well as systemic treatments such as acetazolamide.

Headache Post-Test Key

*Correct answers **bolded** and <u>underlined</u>*

1. A 51-year-old female presents to the emergency department with a sudden onset severe headache for 2 hours, associated with nausea and vomiting. Physical exam reveals an uncomfortable appearing female. However, there are no focal neurologic deficits and the remainder of the physical exam is unremarkable. Vital signs: BP 156/78, HR 110, RR 18, T 98.7°F (37.0°C). CT scan of the head shows diffuse subarachnoid hemorrhage. Which of the following agents is most likely to improve outcome in this patient?
    a. Labetolol
        i. Blood pressure control in subarachnoid hemorrhage is somewhat controversial. No specific target has been identified, and the 2012 American Stroke Association guidelines suggest that a decrease in systolic BP to less than 160 “is reasonable.” Specific agents for blood pressure control (rather than vasospasm prevention) are largely at the physicians discretion, but recommendations are to avoid vasodilators such as nitroglycerin and nitroprusside.
    b. <u>Nimodipine</u>
        i. The correct answer is nimodipine. Nimodipine is recommended in patients with subarachnoid hemorrhage because it is thought to reduce the incidence of subsequent vasospasm.
    c. Nitroglycerin
        i. Blood pressure control in subarachnoid hemorrhage is somewhat controversial. No specific target has been identified, and the 2012 American Stroke Association guidelines suggest that a decrease in systolic BP to less than 160 “is reasonable.” Specific agents for blood pressure control (rather than vasospasm prevention) are largely at the physicians discretion, but recommendations are to avoid vasodilators such as nitroglycerin and nitroprusside.
    d. Nitroprusside
        i. Blood pressure control in subarachnoid hemorrhage is somewhat controversial. No specific target has been identified, and the 2012 American Stroke Association guidelines suggest that a decrease in systolic BP to less than 160 “is reasonable.” Specific agents for blood pressure control (rather than vasospasm prevention) are largely at the physicians

discretion, but recommendations are to avoid vasodilators such as nitroglycerin and nitroprusside.

2. A 77-year-old male with a history of diabetes, hypertension, hyperlipidemia, and seasonal allergies presents to the emergency department with a chief complaint of sudden onset of left frontal headache, nausea, and blurry vision. Neurologic exam reveals no deficits other than a left mid-range pupil, which is minimally reactive to light. The remainder of the physical exam is unremarkable. Intra-ocular pressure is 50 mmHg on the left, 18 mmHg on the right. Which of the following of the patient's medications likely contributed to this presentation?
    a. **Diphenhydramine**
        i. The correct answer is diphenhydramine. This patient's presentation is concerning for acute angle glaucoma. Medications that can precipitate acute glaucoma include anticholinergics (such as diphenhydramine), glucocorticoids, SSRI's, TCA's, MAOI's, antiparkinsonian drugs, antipsychotics, and H1/H2 blockers.
    b. Labetolol
        i. This patient's presentation is concerning for acute glaucoma. Labetolol is unlikely to precipitate this condition.
    c. Metformin
        i. This patient's presentation is concerning for acute glaucoma. Metformin is unlikely to precipitate this condition.
    d. Simvastatin
        i. This patient's presentation is concerning for acute glaucoma. Simvastatin is unlikely to precipitate this condition.

3. A 68-year-old female presents to the emergency department with progressive left-sided headache over the past two weeks. The pain was gradual in onset but has progressed significantly and is now severe. It is particularly painful when the patient chews her food. Physical exam reveals an uncomfortable appearing female, however her physical exam, including a complete neurologic exam, is unremarkable other than tenderness to palpation over the lateral aspect of her forehead. Laboratory analysis, including a complete blood count and metabolic panel, is unremarkable other than an elevated erythrocyte sedimentation rate. Which of the following comorbidities is most likely to be found in this patient?
    a. Lupus erythematosus

i. This patient's presentation is concerning for temporal arteritis/giant cell arteritis. PMR occurs in about 50 percent of patients with GCA. Lupus is not associated with temporal arteritis.

b. <u>Polymyalgia rheumatica</u>

i. The correct answer is polymyalgia rheumatic. This patient's presentation is concerning for temporal arteritis/giant cell arteritis. PMR occurs in about 50 percent of patients with GCA. The cause is unknown, however both PMR and GCA are associated with HLA-DR4. PMR is characterized by stiffness, joint pain, muscle tenderness, as well as systemic findings such as weakness, depression, and low-grade fever. Initial treatment of choice for both diseases is systemic glucocorticoids.

c. Polymyositis

i. This patient's presentation is concerning for temporal arteritis/giant cell arteritis. PMR occurs in about 50 percent of patients with GCA. Polymyositis is not associated with temporal arteritis.

d. Raynaud's phenomenon

i. This patient's presentation is concerning for temporal arteritis/giant cell arteritis. PMR occurs in about 50 percent of patients with GCA. While there are case reports of Raynaud's phenomenon to temporal arteritis, it is relatively uncommon.

4. A 42-year-old male presents to the emergency department with a severe headache. He reports that over the 10 days each evening he has had a sudden onset severe headache lasting about 30 minutes and then resolving. The headaches are on the right side of the head only over the temporal area. Physical exam reveals an anxious appearing male with right-sided ptosis and conjunctival injection. The remainder of the physical exam, including a complete neurologic exam, is unremarkable. Visual acuity is intact. Which of the following is the most appropriate next step in management of this patient's condition?

a. CT head followed by lumbar puncture

i. This patient's history is suggestive of cluster headache. CT scan is not unreasonable as some patients with these symptoms can have structural abnormalities, but the daily quality of the headache makes subarachnoid unlikely and lumbar puncture is not necessary.

b. <u>High flow oxygen</u>

i. The correct answer is high flow oxygen. This patient's history and exam is classic for cluster headaches. Cluster headaches are characterized by attacks of unilateral pain and are relatively short-lived. Physical exam can demonstrate ptosis, miosis, lacrimation, conjunctival injection, rhinorrhea, or nasal congestion. This should occur only during headache and be ipsilateral to the pain. Initial treatment is with high flow oxygen, which can abort the headache.

c. Metoclopramide
   i. This patient's history is suggestive of cluster headache. Metoclopramide is more effective in the treatment of migraine headaches.

d. Pilocarpine
   i. This patient's history is suggestive of cluster headache. While acute glaucoma is part of the differential diagnosis, the intermittent, short duration of symptoms with spontaneous resolution, makes glaucoma less likely.

5. A 19-year-old male student with no past medical history presents to the emergency department with 24 hours of headache, nausea and vomiting, and fever. He denies trauma, numbness or weakness, or travel. Physical exam reveals an anxious and uncomfortable male who is alert and oriented but has photophobia and nuchal rigidity. He has no neurologic deficits. Fundoscopic exam, although difficult, reveals clear disc margins bilaterally. The remainder of the physical exam is remarkable only for tachycardia and fever. The nurses note that, while they secured peripheral IV access, the patient has become more agitated. Which of the following is the most appropriate next step in management?

a. <u>Antibiotics</u>
   i. This patient's history is concerning for meningitis. Ideally, antibiotic therapy should be initiated immediately after lumbar puncture, if there is not a significant delay. However, in cases where lumbar puncture may be delayed, such as in this case of an increasingly agitated patient, antibiotics should be started prior to obtaining CSF.

b. CT head
   i. The suspicion for meningitis is high in this patient. Routine CT before lumbar puncture is not always required, although CT indicated in cases of: immunosuppression, history of CNS disease, history of seizure <7days, focal neurologic deficit, age >60yr, papilledema, and/or altered level of

consciousness. CT would probably be indicated in this patient secondary to his increasing agitation, but antibiotics should not be delayed for CT.

c. Lumbar puncture
    i. This patient's history is concerning for meningitis. Ideally, antibiotic therapy should be initiated immediately after lumbar puncture, if there is not a significant delay. However, in cases where lumbar puncture may be delayed, such as in this case of an increasingly agitated patient, antibiotics should be started prior to obtaining CSF.
d. MRI brain
    i. While MR imaging may confirm this patient's suspected meningitis, this patient is not stable, with his increasing agitation.

6. A 35-year-old male is brought in by ambulance after a bicycle accident. He was riding without his helmet when he was struck on the side by another bicyclist. Per paramediics, the patient was initially communicative. However, his neurologic status declined on transport to the hospital. On presentation, the patient has a GCS of 5. Physical exam is significant for a large right parietal hematoma as well as a right fixed and dilated pupil. Which of the following findings on non-contrast CT head is most consistent with this patient's presentation?
    a. Diffuse petechial hyperdense lesions along gray-white junction
        i. Diffuse axonal injury on CT head may appear as petechial hemorrhages along the gray-white junction, most prominently at the corpus callosum and/or brainstem.
    b. <u>Extra-axial hyperdense collection that does not extend beyond suture lines</u>
        i. Epidural hematoma on CT head is a biconvex or lenticular shaped extra-axial hyperdensity.
    c. Extra-axial hyperdensity collection that is crescent-shaped
        i. Subdural hematoma on CT head is a crescent shaped extra-axial hyperdensity.
    d. Hyperdense collection outlining the cerebral sulci
        i. Subarachnoid hemorrhage on CT head may appear as pooling of blood in the interpeduncular fossa or occipital horns of the lateral ventricles, or in the subarachnoid space (outlining the sulci).

7. A 55-year-old female with a history of hypertension and breast cancer, s/p resection and in remission for several years, presents to the emergency department with a daily

headache for the past week. She has no other medical problems and denies a history of significant headaches in the past. She states the pain is worst in the morning and then gradually improves throughout the day. She denies fever, infectious symptoms, or trauma. Triage vital signs: BP 188/99, HR 87, RR 14, O2Sat 100%, T 98.7°F (37.0°C). Strength, sensation, reflex, cranial nerve, and cerebellar testing are unremarkable. The oral opioid pain medication administered at triage has not improved her pain. Which of the following is the most appropriate next step in management?

a. <u>CT head</u>
   i. The correct answer is CT head. This patient's cancer history, as well as her report of progressive intensity headaches worst in the morning, as well as her lack of history of prior headaches, is concerning for a mass lesion. The initial study of choice is CT scan, although MRI may be more sensitive.

b. Labetalol IV
   i. Although this patient's blood pressure is initially high, there is no indication of end-organ damage that would suggest hypertensive emergency (e.g. encephalopathy or neurologic deficit). Emergent lowering of blood pressure is not indicated at this time.

c. Mannitol IV
   i. Increased intracranial pressure is certainly part of the differential diagnosis in a patient with suspected intracranial mass, headache, and hypertension. Classically, Cushing's triad consists of: hypertension, bradycardia, irregular respirations. However, this question does not describe a patient with impending herniation, of which mannitol/hypertonic saline may be indicated.

d. Serum CA-125 level
   i. Serum tests for cancer biomarkers are rarely indicated in the emergent setting. Additionally, CA-125 is most commonly used for ovarian/adnexal tumors.

8. A 22-year-old pregnant female at 24 weeks gestation presents to the emergency department with a severe headache that developed gradually over 24 hours. She denies fever, other infectious symptoms, or trauma. Vital signs: BP 165/91, HR 85, RR 18, T 98.7°F (37.0°C). During the physical exam, the patient has a 30 second generalized tonic-clonic seizure that resolves without medication. In addition to consulting obstetrics, which of the following is the most appropriate next step in management?
   a. Emergent CT head

i. This patient's presentation is concerning for eclampsia and magnesium should be given to prevent recurrent seizures. A CT head would be reasonable; however this patient is not stable for transport at this time.

b. Lorazepam IV
   i. This patient's presentation is concerning for eclampsia. Lorazepam can be given for a prolonged seizure, but magnesium is the mainstay of treatment and will prevent future seizures.

c. Labetalol IV
   i. This patient's presentation is concerning for ecclampsia. While persistently uncontrolled hypertension increase the risk of stroke, this patient should receive magnesium sulfate first to prevent recurrent seizures (which in turn may increase the blood pressure further).

d. <u>Magnesium sulfate IV</u>
   i. The correct answer is magnesium sulfate. This patient's presentation is concerning for eclampsia. Magnesium sulfate is the mainstay of treatment because it will help to prevent future seizures. The recommendation is to give 4-6 g IV over 15-20 min. An alternative is to give 5 g IM into each buttock. After initial magnesium administration, a drip can be started at 2g/hr.

9. A 35-year-old HIV positive male with a last known CD4 count of 80 cells/uL presents to the emergency department with three days of gradually progressive headache, nausea and vomiting, and fever. CT head is negative for mass, shift, or bleed, so a lumbar puncture is performed. CSF analysis reveals an opening pressure 70 cm H2O, glucose 40 mg/dL, protein 100 mg/dL, and WBC count 40 cells/uL with a mononuclear predominance. Which of the following is the most likely cause of this patient's presentation?

a. <u>Cryptococcus neoformans</u>
   i. This patient is at high risk for cryptococcal infection due to his low CD4 count. The elevated opening pressure as well as the mononuclear predominant CSF is suggestive of Cryptococcus infection. Treatment is induction with amphotericin and flucytosine for two weeks, followed by continued therapy with fluconazole.

b. Mycobacterium tuberculosis

i. Although AIDS patients may have atypical presentations with various bacterial etiologies, this question is describing a classic cryptococcal meningitis patient.

c. Neisseria meningitidis
   i. Although AIDS patients may have atypical presentations with various bacterial etiologies, this question is describing a classic cryptococcal meningitis patient.
d. Streptococcus pneumonia
   i. Although AIDS patients may have atypical presentations with various bacterial etiologies, this question is describing a classic cryptococcal meningitis patient.

10. A 43-year-old female with a history of diabetes presents to the emergency department with six days of gradually progressive severe headache. She describes the headache as a throbbing pain involving her entire forehead associated with nausea. She denies any fever, recent infectious symptoms, or trauma. Physical exam reveals an uncomfortable, obese female with an otherwise unremarkable exam, except fundoscopic exam with loss of spontaneous venous pulsations bilaterally. The patient has no neurologic or visual deficits. MRI brain is read unremarkable. Lumbar puncture reveals opening pressure of 43 cm H2O. CSF analysis is unremarkable. Which of the following is the next best step in management of this patient?

a. <u>Acetazolamide</u>
   i. The correct answer is acetazolamide. This patient's history and presence of early papilledema on fundoscopic exam is suggestive of idiopathic intracranial hypertension. Treatment is initially with acetazolamide as well as weight loss. Surgery is indicated for deteriorating visual function and includes optic nerve sheath fenestration, CSF diversion/shunting, or intracranial venous sinus stenting.
b. Optic nerve sheath fenestration
   i. This patient's history is suggestive of IIH (Idiopathic Intracranial Hypertension). The initial treatment of choice is acetazolamide and weight loss. Surgical interventions, such as optic nerve sheath fenestration, is reserved for cases failing maximal medical therapy.
c. Prednisone

i. This patient's history is suggestive of IIH (Idiopathic Intracranial Hypertension). The initial treatment of choice is acetazolamide and weight loss. Glucocorticoids, although recommended in the past, have significant adverse effects, which should be weighed carefully against the potential benefits (thus is not a first-line therapy).

d. Serial lumbar punctures
   i. This patient's history is suggestive of IIH (Idiopathic Intracranial Hypertension). Serial lumbar punctures is no longer recommended as a treatment for this disease.

INSTRUCTOR MATERIALS

Small Group Instructor Handout

Headache: Case #1

Ms. Smith is a 31-year-old female who presents with "bad headaches" on and off for 1 month. She denies nausea and vomiting. She complains of photophobia and left eye blurriness. She denies fevers and chills. The nursing notes state that she gets them every night when she goes to bed. There is no history of trauma. She has been taking aspirin as needed for pain.

PMH: unremarkable. PSH: cholecystectomy and a c-section. SHx is positive for tobacco. Medications: acetaminophen and aspirin as needed

PE: T 36.4, BP 137/94, HR 61, RR 22 and 02 saturation of 99%.
GEN: She is an obese woman in no acute distress
HEENT: Pupils equally round and reactive
CHEST: Clear to auscultation bilaterally
CV: Regular rate and rhythm
ABD: Soft non-tender and non-distended
NEURO: Alert and oriented X3.

ED Course: She receives 10 mg prochlorperazine, 25 mg diphenhydramine and 4 mg of morphine (all IV). She felt better and was discharged home on norco as needed.

What is your differential diagnosis?

Recurrent migraine, SAH, cervical artery dissection (carotid and vertebral)

What is the significance of the asymmetric pupil and ptosis?

Horner's syndrome: 1) due to hemispheric lesions like thalamus bleed, 2) brainstem lesions (vascular, MS, pontine gliomas, encephalitits) but usually associated with pain and temperature loss on contralateral side of body and anhidrosis 3) cervical cord lesions (usually cause loss of sensation in arms, loss of arm reflexes, and bilateral horner's which of course is very hard to detect) 4) root lesions at T1 (pancoast tumor causing pain in the shoulder and axilla, wasting of small hand muscles and a Horner's syndrome) and lastly 5) injury to the sympathetic chain (post surgery, tumor, carotid dissection, can be seen in migraines and especially cluster. Anhidrosis is rarely a feature.

INSTRUCTOR MATERIALS

Does a response to therapy have diagnostic value?

No

How should this patient be evaluated?

CT head non-contrast to r/o SAH, if negative would consider LP (traditional teaching). Several recent studies have evaluated the need for LP after negative CT head performed within 6 hours of onset of headache. Perry et al found 100% sensitivity and specificity for SAH in 953 patients that had CT head within 6 hours of onset of headache, with zero deaths or negative outcomes at 3 months. Backes et al found 98.5% sensitivity for CT head within 6 hours, while Blok found a negative non-contrast head CT within 6 hours of symptoms had a 99.9% NPV for SAH.[9-11]

If work-up was negative, or the suspicion for cervical artery dissection was high, would proceed with CTA head and neck or MRA head and neck. The reported sensitivity and specificity of MRA and CTA for diagnosis of craniocervical arterial dissection are relatively similar, ranging from 50-100% sensitive.[12]

Would your differential diagnosis and evaluation plan change if she were 8 months pregnant?

Consider:

1. Preeclampsia
2. Pituitary apoplexy (Sheehan's syndrome) would present like a SAH with vision loss.
3. Cerebral vein thrombosis is more common during pregnancy and after delivery, due to hypercoaguable state.

What would be the most likely etiology if she had ptosis and a dilated pupil?

Mass expanding lesion causing a 3rd nerve palsy: posterior communicating artery aneurysm

What neurologic exam finding frequently accompanies Idiopathic Intracranial Hypertension?

Papilledema

6th nerve palsy (false localizing sign, but a surrogate marker for intracranial hypertension, found in 10-20% of patients.[13]

INSTRUCTOR MATERIALS

IIH is a disorder that predominantly affects young, obese women characterized by raised intracranial pressure. The incidence of IIH is expected to increase as obesity rates increase. Presentation is variable, but symptoms include:

- headaches
- visual loss
- pulsatile tinnitus
- back and neck pain

Acetazolamide may have benefits in patients with mild visual loss. Weight loss is also an effective disease-modifying treatment.[16]

Patient Results: ***Instructors: Provide these results to learners after the aforementioned discussion.***
CT head: negative
LP: normal
US carotids: "abnormal flow"
MRA neck: carotid artery dissection
CTA neck: carotid artery dissection

Diagnosis: Carotid Dissection
Incidence

- 2% of ischemic strokes, but 10-25% of cases in the young and middle-aged
- Affects all age groups, but peak in 5th decade.

Clinical Features:

- Minor precipitating event is frequently elicited (yoga, painting ceiling, coughing, sneezing). Chiropractic manipulation of the neck causes stroke in 1 in 20,000 cases
- Triad: All three present in less than one-third of patients, 2/3 "strongly" suggests the diagnosis.
- Pain (one side of face, head, neck)
- Partial Horner's syndrome (Ptosis, miosis without anhidrosis. Sweat glands are innervated by the sympathetic plexus surrounding the external carotid artery and are less commonly involved)
- Pain is usually the initial symptom, followed ~4 days later (median) by stroke/Horner's syndrome
- 1/4 of patients with history of migraine consider this HA to be similar to their migraines

- May also present with cranial nerve abnormalities (12% of patients). 3, 5, 7, 12 are most common.
- Pulsatile tinnitus is reported in ¼ of patients. Bruit may be present
- Ischemic symptoms in 50-95% of patients. TIA may precede, but 1/5 have CVA without warning signs.

Diagnostic Tests

- Angiography has traditionally been gold standard, but is being replaced by CT and MRI
- U/S may show an abnormal pattern of flow (90%), but the site of dissection is generally not seen
- Helical CTA is comparable to MRI/A

Prognosis

- 90% of stenoses resolve and 2/3 of occlusions recanalize within first 2-3 months.

Treatment

- Antithrombotic treatment to prevent thromboembolic complications because 90% of infarcts due to dissection are thromboembolic
- AHA guidelines: Antithrombotic treatment with either an anticoagulant (heparin, low molecular weight heparin or warfarin) or a platelet inhibitor (aspirin, clopidogrel or the combination of extended-release dipyridamole plus aspirin) for at least 3 to 6 months is reasonable for patients with extracranial carotid or vertebral arterial dissection associated with ischemic stroke or TIA. Level of Evidence B.[14]
- Anticoagulation strategy should be discussed with local vascular surgeon
- Theory that this treatment (or TPA) may extend the dissection appears to be unfounded

Why is this case subtle?

- This is a tough diagnosis to make even when symptoms are classic. Headache may mimic a patient's typical symptoms and Horner's syndrome can be overlooked without a thorough exam.

INSTRUCTOR MATERIALS

Headache: Case #2

Ms. Smith is a 31-year-old female who presents with "bad headaches" on and off for 1 month. She denies nausea and vomiting. She complains of photophobia and left eye blurriness. She denies fevers and chills. The nursing notes state that she gets them every night when she goes to bed. There is no history of trauma. She has been taking aspirin as needed for pain.

PMH: unremarkable. PSH: cholecystectomy and a cesarean section. SHx is positive for tobacco.
Medications: acetaminophen and aspirin as needed

PE: T 36.4, BP 137/94, HR 61, RR 22 and 02 saturation of 99%.
GEN: She is an obese woman in NAD
HEENT: Pupils equally round and reactive
CHEST: Clear to auscultation bilaterally
CV: Regular rate and rhythm
ABD: Soft non-tender, non-distended
NEURO: Alert and oriented X3.

ED Course: She receives 10 mg prochlorperazine, 25 mg diphenhydramine and 4 mg of morphine (all IV). She felt better and was discharged home on acetaminophen-hydrocodone as needed.

What other historical features and PE findings would you like to know?

Previous hx of headaches, associated diplopia, dizziness (vertigo), dysarthria, dysphagia, weakness. Others in family ill with HA (CO exposure in the evenings)
Head, ear, throat and neck exam, Visual acuity, exam of CN 3-8, fundoscopic exam, may perform a slit lamp exam and check pressures if eye red, injected or cornea appeared cloudy, motor exam, coordination, sensation

What tests would you order?

She had a cbc and chem 10 performed, although many would order nothing beyond a visual acuity and maybe a pregnancy test

Instructors: *Provide results to learner for the tests they decided to order*
***Na* of 139, K 4.1, Cl of 109 and CO2 of 21. Glucose was 98, Bun 13 and Cr 0.6.**

Wbc: 11.1; Hb: 13.4; Plt: 357.

***Instructors: Reveal that she is on norplant only if asked directly about contraception**

What is your differential diagnosis?

At this point it was assumed to be her typical migraine
Acute angle closure glaucoma, intracranial HTN from IIH (pseudotumor cerebri), cerebral vein thrombosis, SAH, mass.

What is the significance of her improvement with narcotics and dopamine antagonists?

Response to treatment does not rule out serious disease

Headache: Case #2 Continued

She presents to the same ED eight days later complaining of feeling worse. She states her pain is more severe when she is in bed. She denies nausea and vomiting. She has no fever, chills, cough, chest pain, dysuria, joint pain, focal weakness or rash.

PE: BP 129/88 | Pulse 74 | Temp 36.3 °C (97.3 °F) (Oral) | Resp 21 | Ht 5' 3" (1.6 m) | Wt 104.327 kg (230 lb) BMI 40.75 kg/m2 | SpO2 99% |
GEN: She is in no distress, judgment/insight appropriate
HEENT: Normal conjunctiva, normal oropharynx and oral mucosa
CHEST: Normal respiratory effort
CV: regular rate and rhythm, no murmurs, rubs or gallops
ABD: Soft non-tender and non-distended
NEURO: She follows commands appropriately and has a normal gait, pupils equally round and reactive to light, extraocular movements intact, no cranial nerve deficits, normal motor and sensory exam, no nuchal rigidity.

How should she be further evaluated?

Repeat visits for the same chief complaint should warrant extra scrutiny and diligence

Differential diagnosis?

Migraine
Intracranial HTN from IIH (pseudotumor cerebri)
Cerebral vein thrombosis
Atypical meningitis (possibly coccidiomycosis if from San Joaquin valley)

CNS mass
Tension headache
Temporomandibular joint disease

How would the differential diagnosis change if she were elderly?

Would consider temporal arteritis, or intracranial HTN from a tumor, or chronic subdural

Instructors: *Provide results to learners for the tests they decided to order*
CT head: normal
LP: 1wbc, 0rbc, gram stain normal, glucose 75 and protein of 33
Opening pressure: 29 *(give only if asked)* and if LP performed with patient supine
MRI/MRV: transverse sinus thrombosis

Cerebral venous thrombosis is a rare disease that involves thrombosis of the veins and sinuses of the brain, most commonly the superior sagittal sinus. The incidence is 5 per 1 million persons, and is the cause of 0.5% of strokes. Risk factors include genetic or acquired thrombophilia, pregnancy, use of oral contraceptives, and hyperhomocysteinemia. It can be triggered by infection, brain tumor, inflammatory conditions, genetic thrombophilias, head trauma, or certain medications. Diagnosis is typically made through neuroimaging.

Standard medical treatment consists of low-molecular-weight heparin and endovascular thrombolysis. Small case reports have found that the newer oral anticoagulants can be used for CVT treatment; however, they are associated with increased risk of bleeding and other adverse effects.[15]

She was admitted and placed on anticoagulation. Ob/GYN surgically removed her norplant.

INSTRUCTOR MATERIALS

Learning Objectives Key

Following the small group cases, you can review the didactic session objectives below. You may verbally ask the learners the following objective questions, or may have them write the answers individually.

1. **List the critical diagnoses that may present as headache.**
   Subarachnoid hemorrhage, bacterial meningitis, temporal arteritis, carbon monoxide toxicity, acute angle closure glaucoma, cerebellar infarct, cervical artery dissection, cerebral venous thrombosis, Idiopathic Intracranial Hypertension, pituitary apoplexy, brain tumor with increased intracranial pressure, pre-eclampsia.

2. **Describe treatment strategies to relieve headache symptoms**
   Treat the patient's pain while evaluating the cause. Most patients will improve with dopamine antagonists, no matter what the cause is. There is no diagnostic value to treatment response. Faster is better.

3. **Identify key historical and examination findings to help distinguish primary (benign) from secondary (serious) headaches.**
   Primary headaches:
   - Tension, migraine, cluster, etc. (It is not important to distinguish the exact type).
   - Typically recurrent and improve during ED stay.

   Secondary headaches:
   - Sudden onset, maximal at onset, different from patient's previous headaches
   - Consider occult trauma in vulnerable populations, which could cause a subdural
   - Assume serious etiology if there is a neurologic finding
   - Carbon monoxide poisoning – flu like symptoms, whole family sick, dog sick
   - Acute angle closure glaucoma – red eye, steamy cornea, non-reactive mid-dilated pupil
   - Temporal arteritis – jaw claudication, temporal tenderness or nodularity, visual loss, associated with polymyalgia rheumatic, as PMR occurs in about 50 percent of patients with giant cell arteritis. "Rule of 50s" can help remember useful points - "temporal arteritis affects patients at least 50 years of age, with a serum ESR greater than 50 mm/hr and is treated with 50mg of prednisone daily"
   - Cervical artery dissection – sudden onset head and neck pain, h/o minor trauma, stroke symptoms

- Cerebral venous thrombosis – increased risk if hyper-coaguable state such as pregnancy, sepsis
- Pre-eclampsia – remember even if patient is postpartum

4. **Discuss the indications for imaging, lumbar puncture and other testing in patients with headache**
   - Don't delay steroids and antibiotics if working a patient up for bacterial meningitis
   - CT/LP if sudden onset headache, if those are negative consider MRI/A (or CTA) if patient at risk for cervical artery dissection, or MRV if patient at risk for sinus thrombosis.
   - Image if headache with AMS and or focal neuro finding
   - Image if new onset headache in an older person
   - Consider ESR in patients over 50 year-old and intermediate concern for temporal arteritis. Patients with high likelihood of TA should be started on steroids empirically and then can get biopsy.

5. **Recognize life-threatening diagnoses on CT and CSF examination.**

CSF – if blood consider subarachnoid, if WBCs consider meningitis, if blood and pus consider herpes encephalitis
IIH – increased opening pressure on LP and pain improves with removal of CSF