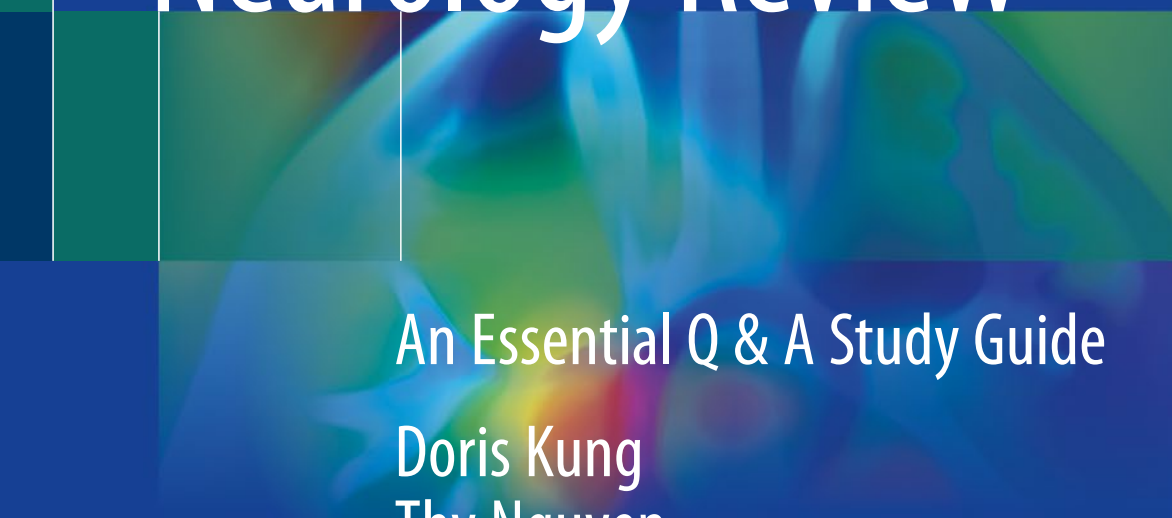
Absolute Case-Based Neurology Review



An Essential Q & A Study Guide

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Springer

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ISBN 978-3-030-11131-1 ISBN 978-3-030-11132-8 (eBook)
https://doi.org/10.1007/978-3-030-11132-8

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

In our daily lives, we all wear many hats. One of our shared hats is a passion for neurology patients. We developed this passion together during our neurology residency training at Baylor College of Medicine. Several years later, with many of our own children running around, we brainstormed about how we could help share our love for neurology patients with others.

We find that neurology is a daunting field for many learners. Collectively, we have encountered learners from many levels: observers, medical students, residents, and fellows. It is always striking how much learners develop such a deep foundation of knowledge from their patient encounters. It can take rereading a paragraph from a textbook several times for it to "stick." However, the story of that one unique patient may be one a learner recalls and shares lifelong.

Our goal is to provide interesting patient stories and frame them in "cases" so that students can recall neurologic knowledge. We use up-to-date and evidence-based questions to help our learners. We encourage them to use this book as a primary study tool, along with references to help them in their neurology rotations, tests, and daily practice. Questions are grouped into important topics in neurology so that learners who need to focus their studying in a particular area can do so. Answers and references are provided at the end of each section.

We hope that our enthusiasm for neurology patients, like a bad virus, is contagious.

We would like to thank Dr. Joseph Kass for his guidance. We thank our students, particularly Chloe Nunnely, Austin Jones, and Ethan Edmondson, for reviewing and helping us refine the questions. We thank our families who have always encouraged us and we love you immensely!

Houston, TX, USA — Doris Kung
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Acknowledgments

From Dr. Kung:
Thank you to my friends, family, my wonderful children, and my loving husband. Thank you God for blessing my work and family life.

From Dr. Nguyen:
I want to thank the neuromuscular team and my colleagues at UT for guidance, mentorship, and helping me to take the best care of my patients. I want to thank the medical students, residents, and fellows at UT for inspiring me every day to teach and learn. Thank you to the most supportive husband, Jim, for supporting me to pursue any of my goals even if it means more babysitting for him. Thank you to the best kids in the world: Jett, Kaia, and Leia. Thank you to my parents, John and Lan, who have sacrificed so much to give me opportunities. Most of all, thank you to my patients who let me share in their journeys.

From Dr. Das:
I would like to acknowledge the love of my family, their faith, and unending positivity. I am grateful for each patient along this path who has enriched my understanding and perspective. I am as well immensely grateful, even for the brief time I have had to know the beautiful spirit of Paradise, California.

Contents

Neuroanatomy

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Questions

1. You are asked to consult on a woman with altered mental status and weakness. In the ER, she is found to have hyponatremia to 112. Over the next 24 hours, her sodium level becomes 140. On examination, she has normal vital signs. She is moaning and incoherent. Eye movements seem full. She has significant quadriparesis and does not move any extremity to painful stimuli. Her reflexes are increased. Which of the following diagnostic studies would be most helpful in ascertaining the etiology of change in her motor examination?

   A. Repeat BMP as her motor symptoms may be related to her sodium level dropping again to 112
   B. CT head without contrast stat to evaluate for new onset bilateral lobar hemorrhage
   C. MRI brain without contrast with attention to the brainstem to evaluate for demyelination in the corticospinal tract
   D. Electrodiagnostic studies (electromyography (EMG) and nerve conduction studies) to assess for critical illness polyneuropathy/myopathy

2. A 33 year-old woman presents to your office with difficulty walking. She reports that 10 years ago, she underwent a gastric bypass procedure (Roux en Y) and lost 150 pounds since that time. She has not been compliant with post-operative visits with her bariatric surgeons. She reports that she is not currently taking any medications. Her vital signs are stable. Her neurologic examination shows normal strength except for mild weakness in distal bilateral lower extremities: dorsiflexion, plantar flexion, toe flexion and toe extension. Reflexes are brisk in the upper extremities with crossed adductors in the patella and absent at the ankles. Sensory examination shows reduced vibration and proprioception up to the knees bilaterally. Her gait reveals reduced hip flexion

D. Kung et al., *Absolute Case-Based Neurology Review*,
https://doi.org/10.1007/978-3-030-11132-8_1

and knee flexion movements with some steppage. Which of the following findings might be seen on a pathologic level to explain her symptoms?

A. Loss of myelin in the corticospinal and dorsal column tracts in the spinal cord
B. Abnormality in the corticospinal tract and degeneration of the anterior horn cells
C. Multifocal demyelinating plaques located throughout the brain and spinal cord affecting multiple different long tracts
D. Degeneration of the spinocerebellar tracts and dorsal column tracts in the spinal cord

3. A 70 year-old man presents to your clinic with imbalance. This has been slowly progressive over at least 5–6 years, but he cannot really tell a date of onset. His social history reveals that he drinks about "a fifth" of liquor per day since his 30s. He has been cutting down. On examination, he has normal cranial nerves without nystagmus. Strength and reflexes are normal. Sensation shows some reduced pinprick and temperature distal to the ankles. His finger to nose, rapid alternating movements and heel to shin are normal. He has significant difficulty with tandem gait and can only perform 2 or 3 steps before lurching. Which of the following alcohol related findings may explain his primary complaint of imbalance?

A. Alcohol is directly toxic to the small nerve fibers
B. Alcohol can lead to vitamin deficiencies that cause a sensory-motor polyneuropathy
C. Alcohol can lead to degeneration in the cerebellum, particularly the cerebellar lobes
D. Alcohol can lead to degeneration in the cerebellum, particularly the cerebellar vermis

4. A 30 year-old woman presents for evaluation of headache for 3–4 months. She reports constant progressive headache that have not responded to over the counter ibuprofen or acetaminophen. She also reports visual loss that occurs in her "peripheral vision". She denies improvement with rest and sometimes awakens in the middle of the night with her headache. Her neurologic examination shows normal strength, reflexes, coordination and sensation. On visual field testing, you notice that she has difficulty making out fingers in her bitemporal fields. Which of the following etiologies could explain her symptoms?

A. Intractable status migrainosus with scotoma
B. Pituitary adenoma compressing on the optic chiasm
C. Idiopathic intracranial hypertension (pseudotumor)
D. Bilateral occipital lobe hemorrhage

5. An 80 year-old woman with known cerebral amyloid angiopathy presents for a follow up visit. She reports new onset of visual changes. Her neurologic examination shows normal strength, sensation, reflexes and coordination. However, visual field confrontational testing shows reduced detection of finger movements in the patient's left superior quadrant of both eyes (left homonymous superior quandrantanopia). The examining physician orders an MRI and calls the radiologist to discuss her concerns. She tells the radiologist to look for an abnormality (bleed) in which of the following areas?

   A. Right temporal lobe
   B. Right optic nerve
   C. Optic chiasm
   D. Right parietal lobe

6. You receive a consult for a 45 year-old woman who was involved in a motor vehicle accident leading to whiplash and left vertebral artery dissection. Brain imaging (MRI) has already been performed and shows a classic, left, lateral medullary infarct secondary to her vascular injury. Which of the following findings, if present on your examination, would NOT be explained by her Wallenberg's syndrome?

   A. Left ptosis, miosis, anhidrosis
   B. Reduced sensation in the left face to pinprick and temperature
   C. Vertigo
   D. Left tongue weakness leading to deviation of tongue to the left

7. A 48 year-old man is admitted for acute myocardial infarction and undergoes cardiac catheterization (through right femoral artery) and stenting. The following day, he reports acute onset of severe weakness, numbness and pain in his right lower extremity. Examination shows weakness in right hip flexion, knee extension and adduction with reduced sensation in the right medial thigh and medial calf. His reflexes are normal except for absent right patella reflex. Which of the following would be the next diagnostic step?

   A. Electromyography and nerve conduction studies
   B. Magnetic Resonance Imaging (MRI) of the lumbar spine with and without contrast
   C. Computed Tomography (CT) abdomen and pelvis without contrast
   D. Lumbar puncture

8. A 56 year-old diabetic man presents with recent good diabetic control. He reports recent unintentional weight loss of 30 pounds in the last few months. However, he also reports severe pain, weakness and numbness in his left lower extremity. He denies back pain or any recent trauma. His examination shows weakness and atrophy of his left quadriceps with significant weakness in hip

flexion, knee extension, and milder weakness in dorsiflexion and gastrocnemius. His examination shows a stocking-glove distribution sensory loss but with loss of sensation in the anterior medial thigh on the left as well. Ankle jerks are absent bilaterally, present in the right patella and absent in the left patella. Which of the following is the likely localization of his new symptoms?

A. Diabetic, symmetric, sensorimotor, polyneuropathy
B. Left lumbosacral root lesion, acutely at S1
C. Motor neuron disease, such as ALS
D. Left lumbosacral radiculoplexus neuropathy

9. A 38 year-old woman presents to the emergency room with acute onset of double vision and left facial weakness. Her initial blood pressure is 176/115 and pulse is 80. She has limited abduction of the left eye on left lateral gaze and weakness in eye closure and facial droop on the left. You also notice that her right arm and leg drift down after 8 seconds of antigravity movement. Which of the following is the most likely neuroanatomic site for her symptoms?

A. Left lateral medulla
B. Left ventral pons
C. Left medial midbrain
D. This is likely a functional disorder as her symptoms cannot be explained by a single neuroanatomic site.

10. A 14 year-old ice skater, fell on her buttocks during a practice free skate. She presents to your clinic with right face, arm and leg weakness, numbness and pain. Her examination shows reduced sensation on the right face in V1, V2 and V3 regions which stops and becomes normal at the nasal ridge line. For her right arm and leg numbness, the sensation becomes normal at the umbilicus line. On her examination, she does not lift up her right leg at all and when you place your hand under her left ankle, she does not exert much pressure when trying to lift up the right leg. Despite manual strength testing, you encourage her to walk. She is able to stand by herself and lurches to both the right and left without falling. She will occasionally buckle one leg or the other. Her reflexes are normal. Which of the following is the next best step for this patient?

A. MRI brain with and without contrast
B. Electromyography and nerve conduction studies
C. MRI lumbosacral spine without contrast
D. Referral to psychology for therapy

11. A 25 year-old woman with relapsing remitting multiple sclerosis presents to the ER with 10 days of diplopia. On your examination, you note normal and equally reactive to pupils. Fundoscopic examination is normal. On left lateral gaze, you note that the patient's left eye reveals nystagmus and the right eye does not completely adduct. Upward gaze, right lateral gaze and downward gaze are

normal. Which of the following would be the most likely concerning site for a new MS relapse in this patient?

A. Left occipital cortex
B. Left medial longitudinal fasciculus
C. Right medial longitudinal fasciculus
D. Left cranial nerve V1 nucleus

12. A 57 year-old man with 20 pack year tobacco use, hyperlipidemia, hypertension and prior right middle cerebral artery stroke presents with new onset seizures. His wife reports that seizures start with gaze to the left, followed by version of the neck and body to the left, loss of awareness and generalized tonic-clonic activity. These have occurred on at least 3 occasions since his stroke 1 year ago. All events are similar. Which of the following areas is the most likely site of onset of the clinical seizures?

A. Right occipital lobe
B. Right lateral geniculate nucleus
C. Right frontal eye field
D. Right supplementary motor area

13. A 40 year-old woman with Ehler's Danlos syndrome presents with a severe, acute headache on the left. On your examination, you notice that the patient's right pupil is 3 mm and reactive and left pupil is 1 mm and pinpoint. She also has ptosis on the left eyelid. Her sweating on both sides of the face seem normal. Otherwise, her cranial nerve examination, sensory examination, reflexes, cerebellar examination and strength are normal. Which of the following would be the next best diagnostic step for this patient?

A. MRI of the brain with special attention to the cavernous sinus
B. CT angiogram of the neck
C. CT of the chest
D. Cocaine test in the eyes

14. A 22 year-old man was in his usual state of health until this morning. He noticed upon awakening that he had difficulty closing his right eyelid and moving his right mouth. He also noticed that his breakfast did not taste right. He went to school, but his teacher advised that he go to the emergency room when he saw him. On examination, he had weakness of orbicularis oris and orbicularis oculi with reduced taste sensation. You do not note any other cranial nerve, sensory, strength or reflex abnormalities. What is the next best step?

A. Oral valacyclovir 14 day course
B. Oral steroids, high dose course
C. MRI brain with and without contrast
D. Electromyography and nerve conduction study of the right facial nerve

15. A 40 year-old woman with rheumatoid arthritis presents with 6 months of neck pain radiating to her right middle finger. Symptoms began after she sustained whiplash following a motor vehicle accident. Her examination shows weakness in right triceps, pronation, and finger extensors. Her right triceps reflex is absent and she has reduced sensation in the right middle finger compared to the left mildly. Which of the following neuroanatomical sites is most likely leading to her symptoms?

    A. Right C5 nerve root
    B. Right C6 nerve root
    C. Right C7 nerve root
    D. Right radial nerve

16. A 32 year-old previously healthy man presents to your clinic with difficulty walking, progressive for several years. His examination shows normal sensation (no sensory level) and weakness of both lower extremities (proximally and distally). His upper extremity strength and reflexes are normal. He has hyperreflexia in his patella and ankles. His toes are upgoing on plantar response. His tone is increased. He denies any urinary or bowel symptoms. He had a recent MRI of the cervical, thoracic and lumbosacral spine with and without contrast which were normal. Which of the following is the next best diagnostic step?

    A. Electromyography and nerve conduction studies
    B. MRI of the bilateral lumbosacral plexus
    C. CT of the brain without contrast
    D. Lumbar puncture

17. A 49 year-old man presents with severe back pain after lifting a refrigerator while moving. He reports tingling and pain that radiates down the right posterior thigh, posterolateral calf, and lateral foot. Examination shows normal strength except for mild right plantar flexion and toe flexion weakness. Reflexes are normal except for absent right ankle jerk. Sensory examination is normal to all modalities despite subjective sensory symptoms. Which of the following neuroanatomical locations is likely causing the patient's symptoms?

    A. Right S1 nerve root
    B. Right L5 nerve root
    C. Right L4 nerve root
    D. Right Lumbar plexopathy

18. A 31 year-old previously healthy woman presents with 3 days of painful loss of vision in one eye. Her fundoscopic examination is normal bilaterally. On light examination of her pupils, her left eye reacts normally to light. Upon swinging the penlight to the right eye, her pupil dilates. On repeat examination, these findings are reproducible. Otherwise, her cranial nerve, sensory, motor, reflexes

and cerebellar examination are normal. Which of the following is the most likely cause of her symptoms?

A. Demyelinating plaque in her left occipital lobe
B. Demyelinating plaque in her right occipital lobe
C. Demyelinating plaque in her left optic nerve
D. Demyelinating plaque in her right optic nerve

19. A young, thin 20 year-old female presents with weakness, numbness and pain in her right hand for at least 1 year. Examination shows wasting and weakness in her right abductor digiti minimi, first dorsal interosseous and abductor pollicis brevis. Sensory examination shows reduced sensation in the fifth digit and half the fourth digit, as well as the medial forearm. Which of the following is the most likely neuroanatomic location of the patient's symptoms?

A. Ulnar nerve at the elbow
B. Ulnar nerve at the wrist
C. Posterior cord of the brachial plexus
D. Lower trunk of the brachial plexus

20. A 38 year-old man presented with a right carotid artery dissection following a few days of neck-popping. He presented with right MCA stroke on admission, including left hemiparesis and sensory loss. He is on anticoagulation. On the second hospital day, he is noted to have a neurologic change with a dilated right pupil on examination. Which of the following is the likely etiology of his symptoms?

A. Increased ICP due his large right MCA stroke leading to papilledema on his right optic nerve.
B. Embolic infarct leading to right ophthalmic artery occlusion and his new exam findings.
C. Increased edema of his right MCA ischemic stroke leading to uncal herniation and pressure on his ipsilateral right CN III.
D. He may have had widespread dissections which were missed on admission leading to his new neurologic findings.

Answers

1. The correct answer is C. Based on the patient's history her sodium was corrected fairly rapidly. Most literature supports correction of hyponatremia of less than or equal to 8–12 mEq/L in a 24 hour period. The primary concern of rapid overcorrection is a complication called central pontine myelinolysis, where the sodium shifts lead to loss of myelin in the corticospinal tract fibers particularly in the basis pontis. A is not the best choice as electrolyte fluctuations would not

explain her profound weakness. CT head without contrast would not detect brain stem demyelinating and there is no reason to believe from the clinical stem that she has developed hemorrhage. D is not the best choice as the patient's examination localizes to an upper motor neuron process. EMG and nerve conduction studies are MOST helpful in assessing lower motor neuron processes. Given the hyperreflexia, her examination is more consistent with an upper motor neuron process (Sterns et al. 2007).

2. The correct answer is A. Following Roux-en-Y procedures, there is loss of the major site of absorption of vitamin B12 and other vitamins. As the patient has been non-compliant and on no medications, she likely had a deficiency in this vitamin. Vitamin B12 deficiency leads to loss of myelin in the corticospinal and dorsal column tracts as well as a peripheral neuropathy. The patient's clinical examination is most consistent with a myeloneuropathy. Choice B might occur in a patient with Lou Gherig's disease. Choice C describes pathology that would be consistent with a process such as multiple sclerosis. Choice D may occur in a patient with Friedrich's ataxia (Goodman 2015).

3. The correct answer is D. Alcohol can lead to degeneration in the cerebellum, particularly the cerebellar vermis. This has been seen in MRI and pathologic studies of patients exposed to significant alcohol. Choice A, although true, is not the best answer to explain the etiology of the patient's imbalance. The patient does seem to exhibit a small fiber neuropathy on examination (loss of sensation to pinprick and temperature in a length-dependent pattern). However, this would not explain his significant abnormalities on tandem gait. Choice B, although true, does not apply to this patient's examination. This patient does not exhibit signs of a large fiber neuropathy on his examination. Choice C, degeneration in the cerebellum (particularly cerebellar lobes) would be more indicative of an appendicular ataxia with abnormal findings on heel to shin, rapid alternating movements and finger to nose, which the patient did not display (Shanmugarajah et al. 2016; Boronat et al. 2017).

4. The correct answer is B. A bitemporal hemianopia would be concerning for a lesion compressing the optic chiasm. Therefore, choice B is the best answer. The remaining answer choices (A, C and D) would not typically cause a bitemporal hemianopsia (Foroozan 2016).

5. The correct answer is A. This patient's left superior homonymous quadrantanopia is concerning for a hemorrhage in the right temporal lobe. This is due to the optic radiations in the temporal or Meyer's loop. Choice D is not correct as a right parietal lobe hemorrhage would classically cause a homonymous inferior quadrantanopia. Choice C is not correct as optic chiasm would classically cause a bitemporal hemianopia. Choice B is not correct as optic nerve lesions would lead to loss of vision in the ipsilateral eye (Glisson 2014; Zhang et al. 2006).

6. The correct answer is D. Lateral medullary or Wallenberg's syndrome is a classic board review or test question. The most common etiology is vascular. Answer choice A describes Horner's syndrome which is present in a Wallenberg syndrome due to the descending sympathetic tract. Choice B is also present in Wallenberg's syndrome due to a spinal trigeminal nucleus and tract (ipsilateral facial loss to pinprick and temperature). Choice C is also present in Wallenberg due to involvement of the vestibular nucleus. Choice D is generally not true as the hypoglossal nucleus and nerve are in the medial medulla. Other features of Wallenberg syndrome that were not discussed include contralateral loss of pain and temperature due to spinothalamic tract in the arm and leg, ipsilateral ataxia due to involvement of the inferior cerebellar peduncle and dysphagia/dysarthria due to involvement of the nucleus ambiguus (IX and X) (Lui and Bhimji 2018).

7. The correct answer is C. This patient most likely has right lumbar plexopathy. The right femoral artery catheterization may have developed bleeding into the right retroperitoneal space. The next best step would be CT of the abdomen/pelvis to evaluate for retroperitoneal bleeding, choice C. For EMG/NCS, this would be too early for Wallerian degeneration of sensory and motor fibers, which occur up to 14 days after a nerve insult. An MRI of the lumbar spine may be useful if there was an acute root lesion. However, with the recent femoral artery catheterization, a retroperitoneal bleed and lumbar plexus involvement would be the first concern. Regarding choice d, there would not be an indication for a lumbar puncture at this time (van Alfen and Malessy 2013).

8. The correct answer is D, left lumbosacral radiculoplexus neuropathy, also known as diabetic amyotrophy. This entity is a subacute diabetic complication that can occur in the setting of unintentional weight loss. The current theory is both a diabetic vasculitis leading to infarcts in the nerves/plexus and a possible immune-mediate component. Although the patient does likely have a, diabetic symmetric, sensorimotor, polyneuropathy, it does not seem to explain his new symptoms of left lower extremity pain, weakness and numbness. Although he has loss of ankle jerks and mild weakness in left gastrocnemius, the other affected muscles hip flexion (iliopsoas L2 & L3), knee extension (quadriceps L3 & L4), dorsiflexion (tibialis anterior L4 & L5) cannot be explained by an S1 radiculopathy. The loss of ankle jerks bilaterally is likely due to a long standing neuropathy. The lack of upper motor neuron signs and prominent pain/sensory symptoms are unlikely in choice C, motor neuron disease (Laughlin and Dyck 2014).

9. The correct answer is B. Crossed signs are considered a diagnostic clue to brainstem lesions. This patient presents with ipsilateral left VI and VII nerve palsies along with contralateral arm/leg weakness. These findings can be seen in a left ventral pons syndrome. The left lateral medulla syndromes cause contralateral loss of pain/temperature and ipsilateral facial sensory loss, ipsilateral dysarthria/dysphagia, ipsilateral Horner's syndrome and ipsilateral cerebellar ataxia. The left medial midbrain syndrome classically causes ipsilateral 3rd nerve palsy with contralateral hemiplegia (Selvadurai et al. 2016).

10. The best answer is D. This patient displays many neurologic signs on examination concerning for conversion disorder. She has numbness that splits midline. She has a positive Hoover's maneuver (described as not exerting effort into the examiner's hand placed under the left ankle when trying to lift the right ankle) and inconsistent examination (no strength on manual testing, but able to sustain herself against gravity with gait). Therefore, a referral to psychology may be useful for the patient (McWhirter et al. 2011; Blumenfeld 2002a).

11. The correct answer is C. This patient's left lateral gaze findings are consistent with an internuclear ophthlamoplegia. These findings are due to a problem with the pathway for horizontal yoked gaze. The right cranial nerve III nucleus (adduction) is yoked to the left cranial nerve VI nucleus and parapontine reticular formation by a pathway called the medial longitudinal fasciculus. The MLF is named according to its connection to the ipsilateral cranial nerve III nucleus. Therefore, difficulty with left lateral gaze would be due to right MLF (right adduction-right cranial nerve III and left abduction-left cranial nerve VI), answer choice C (Feroze and Wang 2018; Fix 2004).

12. The best answer is C, right frontal eye field. Seizures in this area will make the patient look away from the focus of the seizure, in this man's case the left. The right lateral geniculate nucleus is a subcortical structure, and not commonly thought to lead to seizures. The supplementary motor area may lead to seizures that involve the patient axially and then both sides of the body, such as the "fencing posture". Occipital lobe seizures more commonly cause elementary visual hallucinations. These seizures may sometimes cause eye deviations as well. However, in this patient, he had a prior right MCA territory stroke and this vascular supply would affect the right frontal eye field, not the right occipital lobe. Prior strokes are the most common cause of new onset seizures in older adults (Beleza and Pinho 2011; Flaherty and Flynn 2011; Blumenfeld 2002b).

13. The correct answer is B. The next best step in this patient with a known connective tissue disorder and findings of Horner's syndrome would be to perform CT angiogram of the neck to evaluate for carotid artery dissection. Although cavernous sinus lesions can lead to Horner's syndrome, there is not involvement of other cranial nerves in the cavernous sinus (2, 3, 4, V1, V2 and 6) to suggest this should be the next diagnostic step. Pancoast tumors (apex of the lung) can also involve the sympathetic chain as it courses to the superior cervical ganglion. However, these usually will involve sweating (anhidrosis) as well as ptosis and miosis. A cocaine test in the eye can be performed to confirm a Horner's syndrome. However, in this case, it would be more useful to evaluate for the vascular lesion, carotid artery dissection (Flaherty and Flynn 2011; Blumenfeld 2002c).

14. The correct answer is B. This patient has a Bell's palsy. He has presented within 24 hours of symptom onset. He should be prescribed high dose oral steroids, which has been shown to improve outcomes if prescribed within 72 hours of

symptom onset. Some practitioners do prescribe oral antivirals, but this is not as well-accepted as oral steroids. An MRI brain with and without contrast should be reserved for atypical features or recurrent cases. It would be too early to perform an EMG on this patient and this is not necessary in all cases of Bell's palsy (Holland and Bernstein 2014).

15. The correct answer is C. The most likely site of involvement leading to her symptoms is C, right C7 nerve root. The right C7 nerve root feeds the right triceps reflexes and plays a role in the actions of right triceps (C6-7-8, elbow extension), pronation (median nerve, C6 & C7) and finger extensors (extensor digitorum communis, radial nerve, C7 & C8). The right middle finger is also a dermatome fed by the C7 root (Rainville et al. 2017; Blumenfeld 2002d, i).

16. The next best step would be C, CT of the brain without contrast. Rarely, a parasagittal mass or lesion could lead to paraparesis and spasticity without sensory changes or bowel or bladder changes. Answers A and B would be reasonable choices if there were not florid upper motor neuron signs as in this patient. A lumbar puncture would not be useful in this case (Mazlan & Fauzi, 2011; Blumenfeld 2002e).

17. The correct answer is A. This patient most likely has a right S1 nerve root irritation based on his lower back pain with radiating tingling and examination which shows weakness of S1 innervated muscles (toe flexion, gastrocnemius) and loss of the ankle jerk (Mondelli et al. 2013; Blumenfeld 2002f).

18. The correct answer choice is D, demyelinating plaque in her right optic nerve. This patient presents with classic symptoms of optic neuritis: painful subacute visual loss. The swinging flashlight test described above is consistent with a relevant afferent pupillary defect in the right eye or Marcus-Gunn pupil. This is due to a lesion in the optic nerve. The fundoscopic examination is often normal in 2/3 of optic neuritis patients due to retrobulbar optic neuritis. Lesions in the occipital lobes are uncommon, but would be more likely to present with a visual field cut than pupillary abnormalities (Bermel and Balcer 2013; Fix 2004).

19. The correct answer is D, lower trunk of the brachial plexus. The medial forearm sensory innervation is out of the dermatome of the ulnar nerve. Additionally, the abductor pollicis brevis weakness is a median-innervated muscle (Ferrante and Ferrante 2017; Blumenfeld 2002g).

20. The best answer in this scenario, taking into account the timing of his right MCA stroke and new neurologic findings would be answer choice C (Velasquez et al. 2015; Blumenfeld 2002h). Brain edema typically can begin 3 days after a large stroke and risk declines by the 7th day post-stroke. This patient's symptoms indicate that there is swelling and a false localizing sign is seen with the right pupil dilation due to pressure on cranial nerve III. This is caused by compression of the crus cerebri at the midbrain level (Kernohan's notch phenomenon).

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Headache

2

Questions

1. A 35 year old woman with a history of headaches since she was 17 comes to you complaining of recurrent headaches for many years. Her headaches occur once a week in the frontal area, are very intense and throbbing in characteristic lasting 2 hours without taking any medicine. The headaches are associated with nausea but no vomiting, no photophobia or phonophobia. What characteristic makes this headache less likely a migraine?

   A. Frontal location
   B. Frequency
   C. Duration
   D. Associated symptoms
   E. Unilateral location

2. A 25 year old woman with history of focal seizures and migraines presents with headaches occurring twice a week. She is on birth control pills. Her migraines are associated with auras occasionally. What is not an appropriate option for preventative treatment of her migraines?

   A. Valproic acid
   B. Topiramate
   C. Propranolol
   D. Verapamil
   E. Venlafaxine

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https://doi.org/10.1007/978-3-030-11132-8_2

3. Your 58 year old patient presents to emergency room (ER) with 4 days of continued migraines. Your patient has a history of migraines since 20 years old, controlled hypertension, history of a TIA without residual deficits, and hyperlipidemia on cholesterol medications. The patient is taking Lisinopril, topiramate, aspirin, and atorvastatin. The patient has had migraines about once a month for the last year. The ER physician asks you which medicines are appropriate for treatment. What medicine would you avoid?

   A. Sumatriptan
   B. Intravenous fluids
   C. Intravenous sodium valproate
   D. Dexamethasone
   E. Metoclopramide

4. A 20 year old woman presents with recurrent headaches. She admits to gaining some significant weight over the last 3 years in college with a Body Mass Index >30. Occasionally she notes some blurry vision with her headaches. What feature listed is not typical of idiopathic intracranial hypertension?

   A. Transient visual obscuration
   B. Elevated opening pressures on lumbar puncture >20 cm of water
   C. Pulsatile tinnitus
   D. Unilateral papilledema
   E. Empty sella

5. A patient with idiopathic intracranial hypertension has been on treatment for her condition. She continues to have frequent headaches and her vision has been declining slightly. She is on acetazolamide. She has lost 5 pounds in the last 3 months. She is asking what is the next best step?

   A. Weight loss alone
   B. Weight loss and higher dosage of acetazolamide
   C. Optic nerve sheath fenestration
   D. Venous sinus stenting
   E. Ventriculoperitoneal shunt placement

6. A 48 year old man presents to the emergency room with a severe headache. He has never had headaches before. On exam he is lethargic and has right sided weakness. You suspect that he may have suffered a subarachnoid hemorrhage. Which characteristic below would be more likely to increase his risk for an aneurysmal rupture causing his symptoms?

   A. Aneurysm of 4 mm
   B. White Caucasian race
   C. Low blood pressure on admission

D. Connective-tissue disease
E. History of cigarette smoking 5 years ago

7. A 60 year old woman presents with pain on the right side of her face. Any time she chews or wind blows on that side of her face, she has sharp shooting pain on the right cheek down into the front of her chin. Her neurological exam is normal except for the pain on palpation to the right side of the face. She has been treated with an anti-epileptic medication. What is a likely cause of her condition?

A. Neurovascular compression
B. Demyelinating Disease
C. Mass
D. Aneurysm
E. Congenital Malformation

8. A 55 year old woman presents to your office with new onset headaches. Her headaches started after she fell in the bathroom 2 weeks ago. She did lose consciousness after this fall but awoke less than a minute later with no neurological complaints except for headaches. Her exam shows no focal deficits. She still has some mild to moderate headaches and mild lightheadedness. What is the next best step?

A. MRI brain with and without contrast
B. CT head without contrast
C. CT head with and without contrast
D. MRI brain without contrast
E. CT angiogram with and without contrast

9. A 65 year old presents with 1 day of headaches, neck stiffness, and fever. He has altered mental status upon presentation and is noted to have left sided shaking lasting less than 3 minutes that resolves with lorazepam given intravenously. His exam is significant for a positive Brudzinki's sign. What is the most concerning symptom that should preclude a lumbar puncture?

A. Seizure
B. Fever
C. Neck stiffness
D. Headaches
E. Age

10. 38 year old with migraines is taking a new medication. She complains of weight loss since starting this medicine. What is the next best step?

A. Taper off propranolol
B. Taper off valproic acid

C. Taper off amitriptyline
D. Taper off topiramate
E. Taper off gabapentin

11. 20 year old man with no significant past medical history presents with episodic headaches for the past 4 years. He has no family history of headaches. He describes his headaches as very intense, occurring daily in the last 6 months, with a typical duration of at least 5 hours. Headaches are unilateral and are associated with nausea. He has no tearing or runny nose. His exam is unremarkable for focal deficits. What is the acute treatment of choice?

A. Oxygen
B. Amitriptyline
C. Verapamil
D. Sumatriptan
E. Hydrocodone

12. 34 year old woman with history of migraines presents with worsening headaches for the past 5 months. She complains of worse headaches in the morning, bilateral temporal in location, pressure-like in sensation with moderate intensity. There is no photophobia or phonophobia. There is no nausea. Her exam is normal with no evidence of papilledema. She takes ibuprofen and has used this on a daily basis but has increased her intake in the last 4 months because the headaches are getting worse. Ibuprofen helps but the headache usually returns by nighttime or the next morning. What is your next best step?

A. MRI brain
B. Lumbar Puncture
C. Discontinue Ibuprofen
D. Change the ibuprofen to naproxen
E. Add Sumatriptan

13. 42 year old woman with history of depression and hypertension. She is on escitalopram and Lisinopril. Her hypertension is under control and she presents with headaches. She describes having headaches once a month, that are severe. She has to lie down in a quiet dark room during a headache and when she awakens several hours later the headache usually has resolved. Her physician prescribed sumatriptan. She takes the medicine and develops symptoms of flushing, racing heart beats, altered mentation, and mydriasis. What is the most accurate statement?

A. She is having symptoms due to an adverse reaction to sumatriptan
B. She is having symptoms due to an interaction between escitalopram and sumatriptan
C. She is having a severe migraine attack

D. She is having an anxiety attack
E. She should see her doctor in the next week.

14. A 34 year old woman presents with a severe headache. She started with left sided weakness for about 10 minutes followed by numbness for another 10 minutes prior to the headache. The headache is associated with nausea, vomiting, and is right sided with pulsating characteristic. She has had a headache like this one in the past. She has a family history of similar headaches and symptoms. What would be an appropriate first-line treatment choice for an acute headache?

A. Sumatriptan
B. Ibuprofen
C. Lamotrigine
D. Rizatriptan
E. Dihydroergotamine

15. A 65 year old man with a history of hypertension, hyperlipidemia, and migraines presents with a sharp headache over his left temple that has occurred daily for the last month. His headaches are different from his typical migraines and have not responded to over-the-counter analgesics. He has no tearing, nausea, photophobia, or phonophobia. He endorses mild jaw pain, which worsens with eating, as well as intermittent fevers and myalgias. On physical exam, his vital signs are stable and he has no focal findings aside from moderate tenderness over the left side of his face and scalp. Initial laboratory results reveal an elevated C reactive protein (CRP). What is the next step?

A. Erythrocyte Sedimentation Rate (ESR)
B. CT Angiogram (CTA) of the head
C. Start Prednisone
D. Biopsy
E. Admission to the hospital

Answers

1. The correct answer is C. The diagnostic criteria for migraines are outlined by the International Headache Society in the International Classification of Headache Disorders, 3rd Edition. It states that A. patients must have at least 5 attacks fulfilling criteria B-D. B. Headaches last 4–72 hours untreated. C. Headaches have at least 2 of the following 4 characteristics: 1. Unilateral location, 2. Pulsating quality, 3. Moderate or severe pain intensity, 4. Aggravation by or causing avoidance of routine physical activity. And D. Headache is accompanied by 1 of the following: 1. Nausea and or vomiting, or 2. Photophobia and phonophobia. In this case the patient fulfills criteria A, C, D, and E but not B (her headache lasts only 2 hours untreated) (Headache Classification Committee of the International Headache Society (IHS) 2018).

2. The correct answer is E. Venlafaxine is relatively contraindicated in patients with epilepsy because it can lower the seizure threshold. The higher the dosage the higher the risk. Choices A and B are appropriate choices for patients with seizures and migraines but one has to consider the patient's desires for pregnancy. In this case, the patient is not interested in pregnancy and is on birth control. It is important to keep in mind that topiramate can lower the effectiveness of some birth control pills. Thus, valproic acid would be the better choice if choosing between A and B. Finally propranolol and verapamil are both appropriate choices as well for headache prevention. These medications would not be affected by her birth control pills or her seizures. Her history of having migraines with aura should not influence your choice regarding which preventative medicines to choose (Silberstein 2015; Hill et al. 2015).

3. The correct answer is A. This patient is suffering from status migrainosus (migraine lasting greater than 72 hours. Intravenous (IV) fluids, metoclopramide, IV sodium valproate are all approved therapies for acute migraine treatment. Metoclopramide has both antiemetic effects and anti-inflammatory effects for headache relief. Valproate has shown evidence for status migrainosus relief as well. Dexamethasone is also an appropriate choice though recent data shows that the benefit is likely to be seen 72 hours after discharge. Finally, sumatriptan is contraindicated in patients with a history of cerebrovascular or cardiovascular disease. With this patient's history of a TIA, this patient should not receive any medicines that can cause vasoconstriction (Rozen 2015; Woldeamanuel et al. 2015).

4. The correct answer is D. This patient possibly has idiopathic intracranial hypertension (IIH). Bilateral papilledema is typical of IIH. Other common symptoms of patients with this condition are headaches, obesity or recent significant weight gain, transient visual obscuration, pulsatile tinnitus, diplopia, and back pain. Patients can have abnormal imaging with an empty sella noted on brain imaging and even bilateral transverse sinus stenosis but there should not be deformity or displacement of the ventricular system. The modified Dandy Criteria for IIH requires that patients have a CSF pressure that is >20 cm of water and often a stricter criteria of >25 cm of water is used unless they have other features that are more suggestive of IIH (Wall 2017; Piper et al. 2015).

5. The correct answer is B. The patient should be advised to continue weight loss and can increase the dosage of acetazolamide. In the idiopathic intracranial hypertension treatment trial, the patients' maximally tolerated dosage was 4 grams/day. Patient also taking acetazolamide had a higher reduction in their weight (−7.5 kg vs. placebo −3.45 kg). Optic nerve sheath fenestration, venous sinus stenting, and ventriculoperitoneal shunts are invasive options for treatment of IIH but the patient should first attempt to get to the highest tolerated dosage of acetazolamide before considering surgical options. Based on a recent Cochrane review there is still a lack of randomized controlled trials for treatment of IIH (NORDIC Idiopathic Intracranial Hypertension Study Group Writing Committee 2014).

6. The correct answer is D. Connective tissue disorders may predispose patients to aneurysm formation and subsequent rupture. Aneurysms of 7 millimeters (mm) or larger are at a higher risk for rupture so a 4 mm aneurysm has a much lower risk. Black race and Hispanic ethnicity also has been shown to increase risk of aneurysm rupture so B is not correct. High blood pressure rather than low blood pressure is a risk for aneurysmal rupture. Current smoking is also a risk but not necessarily a history of smoking (Lawton and Vates 2017).

7. The correct answer is A. This patient has trigeminal neuralgia. Neurovascular compression is the cause of the majority of cases of trigeminal neuralgia. Most often a vascular loop is indenting the trigeminal nerve root and causes the classic unilateral neuralgic pain of trigeminal neuralgia. Multiple sclerosis patients are at a 20 times higher risk of trigeminal neuralgia compared to the general population but this is not the most common cause of trigeminal neuralgia. Posterior fossa mass, aneurysm, or Chiari malformation should all be considered and 15% of cases of trigeminal neuralgia are found to have a structural cause but again are not the most common cause (Cheshire 2015).

8. The correct answer is B – CT head without contrast. This patient may be suffering from a subdural hematoma. Headaches from subdural hematomas can appear gradually. Focal neurological symptoms and mental status changes can occur and should also indicate necessity for scanning the brain. CT head without contrast is the fastest and best study to obtain to look for hemorrhage. The other options can also be done but option B is just as sensitive for showing hemorrhage. CT angiogram would not be helpful in identifying the subdural hematoma (Chou 2018).

9. The correct answer is A. Seizure. The patient has symptoms concerning for acute bacterial meningitis. In a paper by Joffe, the contraindications for lumbar puncture in a patient with acute bacterial meningitis include rapidly deteriorating mental status and low Glasgow coma score of <13, dilated or fixed pupils, fixed deviation of the eyes or lack of a doll's eye reflex, posturing, seizures, papilledema, respiratory abnormalities, or hypertension with bradycardia. It is important to recognize any abnormal features that may increase the risk of brain herniation (Joffe 2007).

10. The correct answer is D. Taper off topiramate. Common side effects of topiramate include paresthesias, weight loss, altered taste, decreased cognition, kidney stones, acute angle-closure glaucoma, and birth defects including low birth weight and cleft lip/palate. Valproic acid's side effects include liver toxicity, pancreatitis, neural tube defects, hyperammonemia with encephalopathy, tremor, thrombocytopenia, alopecia, weight gain and GI symptoms. Gabapentin's side effects include sedation and swelling of the lower extremities. Propranolol is a nonspecific beta-blocker and common side effects include weight gain, fatigue, and decreased blood pressures. Amitriptyline is a tricyclic

antidepressant that has much anti-cholinergic effects and thus commonly causes weight gain, dry mouth, constipation, and sedation (Bagnato and Good 2016; Couch 2009).

11. The correct answer is D. Sumatriptan. The key to this question is figuring out the criteria for migraine and then finding the correct abortive treatment choice. The International Headache Society states that the patient needs to have at least 5 typical headaches, lasting 4–72 hours (untreated), with 2 out of the 4: unilateral, throbbing, worse with exertion, and/or moderate to severe in intensity, AND 1 out of the 2: nausea and/or vomiting, or photophobia and phonophobia. Finally, it cannot be attributed to another disorder. Another headache type that may come to mind, are cluster headaches which fall under the category of Trigeminal Autonomic Cephalalgias. The patient needs to have at least 5 typical headaches as well. Cluster headaches last 15–180 minutes (untreated), severe or very severe unilateral orbital, supraorbital, and/or temporal pain, with 1 of the following: ipsilateral conjunctival injection and/or tearing, ipsilateral nasal congestion and/or rhinorrhea, ipsilateral eyelid edema, ipsilateral forehead and facial sweating, ipsilateral miosis and/or ptosis, or a sense of restlessness or agitation. The attacks occur once a day or up to 8 times per day. The treatment for migraines acutely, can include the triptan medications, the first in its class, Sumatriptan. Hydrocodone is not a preferred treatment choice for migraines. Amitriptyline is a good preventative medication for migraines but not for abortive treatment. Oxygen is a good acute treatment for cluster headaches. Verapamil is a good preventative treatment for cluster headaches (Becker 2015).

12. The correct answer is C. Discontinue ibuprofen. This patient is most likely experiencing medication overuse headaches. These headaches are present more than 15 days out of the month in a patient with a pre-existing headache disorder, a history of regular use for more than 3 months of one or more drugs: including ergots, triptans, opioids, or combination analgesics on at least 10 or more days in a month, simple analgesics for more than 15 days in a month, or combination of these medicines for at least 10 or more days in a month. The best and first treatment is to discontinue the offending agent. There is no consensus on the best treatment option for persistent headache if discontinuation does not help or if patient does not comply (Silberstein et al. 2005; Tepper 2012).

13. The correct answer is B. She is having symptoms due to Serotonin Syndrome. In 2006 the FDA put out a warning about triptans interacting with selective serotonin reuptake inhibitor or serotonin norepinephrine reuptake inhibitor causing Serotonin Syndrome. The actual data for how common this interaction occurs has not been determined despite the FDA warnings. The symptoms of Serotonin syndrome are restlessness, agitation, anxiety, flushing, tachycardia, altered mentation, and hyperreflexia. These are not symptoms of a migraine and not typical of an anxiety attack. This is a life-threatening emergency and she

should be sent to the ER, not to her physician a week from now. Side effects of sumatriptan include fatigue, chest pain, neck pain, jaw pain, dizziness, and flushing. It is important not to prescribe triptan medicines to patients with history of stroke, myocardial infarction, or uncontrolled hypertension (Sclar et al. 2012).

14. The correct answer is B. ibuprofen. This patient meets International Headache Society criteria for familial hemiplegic migraines. The acute treatments for these headaches include analgesics such as acetaminophen and ibuprofen. There is controversy whether triptan medicines are safe for patients with this type of headache and the FDA warns against use of triptans and ergotamines for patient with hemiplegic or basilar-type migraines though many experts feel that it is still safe to administer. Lamotrigine is a good preventative medicine for treatment of hemiplegic migraines but is not used in acute treatments (Pelzer et al. 2013).

15. The correct answer is C. Start Prednisone. This man is suffering from symptoms typical of giant cell arteritis (GCA). The symptoms of GCA include older age, headache (usually unilateral), temporal tenderness, jaw claudication, occasional fever and myalgias, and elevated inflammatory markers such as thrombocytosis and C-reactive Protein (CRP). ESR is less specific for GCA according to the study from El-Dairi and colleagues. According to their recommended algorithm, if there is a suspicion for GCA, steroids should be started even prior to temporal artery biopsy. Admission is not likely necessary unless patient is having ischemic symptoms. CTA is not reliable in identifying GCA (El-Dairi et al. 2015).

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Demyelinating Diseases

3

Questions

1. A 24 year old woman presents with numbness of the left arm. On exam, she has no cranial nerve or motor deficits. Her only abnormal finding is decreased sensation in the left arm along the lateral arm to the thumb. She notes that when she bends her head forward there is a sharp shooting pain down her spine. She has not had symptoms like this in the past. What is the next best step?

   A. MRI cervical spine
   B. MRI brain
   C. EMG/NCS
   D. Upper extremity evoked potentials
   E. Start interferon treatment

2. A 28 year old man presents with left sided weakness. He has an MRI brain with gadolinium showing 1 non-enhancing left periventricular T2 hyperintense lesion. What data does this man need in order to be diagnosed with Multiple Sclerosis?

   A. Dissemination in space at least ten T2 hyperintense lesions on MRI
   B. Dissemination in space and time
   C. T1 black-hole lesions on MRI
   D. Lesion involving the optic nerve
   E. Elevated protein in the spinal fluid analysis

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https://doi.org/10.1007/978-3-030-11132-8_3

3. A 10 year old child presents with symptoms of right sided weakness. Mother reports that the patient had the flu 3 weeks ago. MRI brain shows scattered bilateral T2 hyperintense lesions with some surrounding edema involving the gray and white matter. There is no family history of similar symptoms. What symptom would support a diagnosis of Acute Disseminated Encephalomyelitis (ADEM)?

   A. Meningitic signs
   B. Seizures
   C. Fever
   D. Encephalopathy
   E. Hyperreflexia

4. A 30 year old woman presents with left eye pain that is worse with movement and has decreased vision. She has never had any neurological symptoms prior. Her neurological exam shows a left relative afferent pupillary defect. She has had no prior history of neurological deficits. Her brain MRI shows 2 periventricular lesions without enhancement and 1 juxtacortical lesion in the left frontal region that is nonenhancing. Her MRI of the orbits shows enhancement and swelling of the left optic nerve. Her spine MRI shows no spinal cord lesions. Her lumbar puncture shows elevated protein with oligoclonal banding. Her visual evoked potentials show abnormal conduction in the left eye. What is the best treatment option for this patient?

   A. Oral steroids
   B. IV steroids
   C. IV immunoglobulins
   D. Plasma Exchange
   E. IV cyclophosphamide

5. A 43 year old woman with history of Relapsing-Remitting Multiple Sclerosis presents with right leg numbness and weakness. Her brain MRI shows three periventricular lesions in the bilateral frontal regions and one infratentorial lesion that are nonenhancing. She has no other focal neurological deficits on exam and has normal vision on exam with no afferent pupillary defect. What would you need to do prior to starting treatment?

   A. Evaluate for pseudoexacerbation
   B. Obtain an MRI thoracic spine with and without contrast
   C. Obtain an MRI orbits with contrast
   D. Obtain a lumbar puncture for oligoclonal bands
   E. Check her eyes for papilledema

6. A 43 year old woman with history of right leg numbness and weakness that recovered 1 year ago presents with pain in her neck when bending forward. Her

brain MRI shows three periventricular lesions in the bilateral frontal regions and one infratentorial lesion that are nonenhancing. Her cervical spine MRI shows an enhancing spinal cord lesion at C5. She has no other focal neurological deficits on exam and has normal vision on exam with no afferent pupillary defect. She has normal labs, urinalysis, and chest x-ray. How would you treat this patient in the acute period?

A. Intravenous cyclophosphamide
B. Intravenous immunoglobulin
C. Plasma exchange
D. Intravenous steroids
E. Subcutaneous Interferon beta

7. A 40 year old man with Relapsing-Remitting Multiple Sclerosis presents to your clinic for treatment of his disease. He has had successful treatment with Glatiramer acetate. What is a side effect of Glatiramer acetate?

A. Flu-like symptoms
B. Progressive multifocal leukoencephalopathy (PML)
C. Elevated Liver Function Tests (LFTs)
D. Bradycardia
E. Lipoatrophy

8. A 27 year old woman presents with history of migraines, neck pain, and generalized fatigue. Her PCP performed an MRI showing abnormal white matter lesions. Which region of the neuraxis listed is not commonly affected in Multiple Sclerosis?

A. Infratentorial
B. Subcortical
C. Periventricular
D. Spinal cord
E. Juxtacortical

9. A 43 year old woman with optic neuritis recovers from her symptoms 2 weeks later. Six months later she develops an episode of diplopia. On exam she has difficulty adducting her left eye and nystagmus of the right eye with right lateral gaze. Localize her lesion.

A. Left Medial Longitudinal Fasciculus
B. Left Medial Lemniscus
C. Right Medial Longitudinal Fasciculus
D. Right Medial Lemniscus
E. Left Paramedian Pontine Reticular Formation
F. Right Paramedian Pontine Reticular Formation

10. A 6 year old boy presents with weakness and imbalance. His mother reports that he was sick with the flu a few weeks ago. He presents now with fever, lethargy, and left sided weakness. He has never had symptoms like this before. His brain MRI shows several large patchy non-enhancing periventricular T2 hyperintense lesions bilaterally and two lesions in the juxtacortical region in the right frontal and right parietal region. His lumbar puncture shows no evidence of infection and he has some mild increase in protein in the spinal fluid analysis. He is diagnosed with Acute Disseminated Encephalomyelitis. What would you recommend for treatment?

    A. Interferon-beta
    B. IV methylprednisolone
    C. Glatiramer Acetate
    D. IV cyclophosphamide
    E. Plasma exchange

11. A 43 year old woman with history of right leg numbness and weakness that recovered 1 year ago presents with pain in her neck when bending forward. Her brain MRI shows 3 periventricular lesions in the bilateral frontal regions and 1 infratentorial lesion that are nonenhancing. Her cervical spine MRI shows an enhancing spinal cord lesion at C5. She has no other focal neurological deficits on exam and has normal vision on exam with no afferent pupillary defect. What is her diagnosis?

    A. Progressive-Relapsing Multiple Sclerosis
    B. Secondary-relapsing Multiple Sclerosis
    C. Neuromyelitis Optica
    D. Primary Progressive Multiple Sclerosis
    E. Relapsing-Remitting Multiple Sclerosis

12. A 30 year old woman presents with left eye pain that is worse with movement and has decreased vision. Her neurological exam shows a left relative afferent pupillary defect. She has had no prior history of neurological deficits. Her brain MRI shows 2 periventricular lesions without enhancement and 1 juxtacortical lesion in the left frontal region that is nonenhancing. Her MRI of the orbits shows enhancement and swelling of the left optic nerve. Her spine MRI shows no spinal cord lesions. Her lumbar puncture shows elevated protein with oligoclonal banding. Her visual evoked potentials show abnormal conduction in the left eye. What in her history increases her probability of developing clinically definite Multiple Sclerosis?

    A. Her age
    B. Her MRI brain
    C. Her abnormal visual evoked potential

D. Oligoclonal banding in the cerebrospinal fluid (CSF)
E. Presenting symptom at onset of optic neuritis

13. A 25 year old woman presents for evaluation of right facial pain. When she chews or brushes she gets sharp shooting electricity-like pain in the right face. Wind blowing on her face can trigger the pain easily. She has an abnormal MRI brain showing 2 oval shaped T2 hyperintense lesions in the periventricular region and 1 in the brainstem. One of the periventricular lesions is enhancing. What would be the best next step?

A. Wait for another clinical attack before treating
B. Start disease modifying treatment
C. Repeat MRI in 1 month
D. Start carbamazepine alone
E. Get an MRI of the cervical spine

14. A 45 year old Asian man presents with pain in his neck. Pain is worse upon flexing his neck. The pain does not radiate down in to the extremities. He denies weakness and numbness in the extremities. He has noted mild urinary urgency. His exam is notable for some brisk reflexes in the upper and lower extremities, positive Hoffman's bilaterally, and upgoing toes. His history includes a 2 week episode of left eye pain with vision loss that improved spontaneously occurring 6 months ago. His MRI of the brain shows no T2 or enhancing lesions. His MRI cervical spine shows an extensive hyperintense lesion on T2 imaging in the cervical spine starting from C3 to the T1 spinal level with mild swelling of the cord. What is his most likely diagnosis?

A. Acute Disseminated Encephalomyelitis
B. Multiple Sclerosis
C. Neuromyelitis Optica
D. Spinal cord tumor
E. Transverse Myelitis

15. A 35 year old man with history of RRMS presents for follow up. He complains of fatigue, urinary urgency and weakness in his legs. His exam shows hyperreflexia and 4/5 weakness in the legs. He is on interferon-beta and cannot tolerate the side effects. What are not the typical side effects?

A. Depression
B. Flu-like symptoms
C. Liver toxicity
D. Leukopenia
E. Aseptic Meningitis

Answers

1. The correct answer is A. The patient has aLhermitte's sign. Lhermitte's is a phenomenon that occurs when a person bends the neck forward and a shocking sensation is felt traveling down the spine, often due to demyelination of the spinal cord or hyperexcitability MRI of the cervical spine would be the best next step to look for possible spinal cord lesions that could be contributing to her symptoms. The patient most likely is have a clinical isolated syndrome. An MRI brain would be helpful in addition to the MRI of the neck but would not identify the lesion that contributes to her current symptoms. EMG/NCS would be helpful if suspecting a peripheral nerve lesion. Upper extremity evoked potential would be helpful to show any prolongation of response from the nerves to the spinal cord but an MRI cervical spine is more specific. Interferon treatment would be started if there was a suspicion for Multiple Sclerosis (Khare and Seth 2015).

2. The correct answer is B. The patient would meet 2017 McDonald's criteria for the diagnosis of MS if he had evidence of dissemination in space and time. This person is presenting with his first clinical attack, named a Clinically Isolated Syndrome. In order to fulfil the dissemination in space criteria the person must have another clinical attack in a different area of the body or one or more T2 hyperintense lesions in at least 2 of 4 areas – periventricular, cortical, juxtacortical, infratentorial, and/or spinal cord. To fulfil Dissemination in time criteria, the patient needs a second clinical attack in a different distribution or the MRI must show gadolinium enhancing and non-enhancing lesions or a new T2 hyperintense lesion on a follow up MRI. The MRI does not need to show T1 black hole lesions nor does the patient need an optic nerve lesion to meet crtieria for MS. Though spinal fluid testing can be an additional laboratory test used in fulfilling the criteria, currently the criteria require oligoclonal banding and not necessarily protein elevation (Thompson et al. 2018).

3. The correct answer is D. Encephalopathy is atypical for other demyelinating disorders and is necessary as part of the diagnosis of Acute Disseminated Encephalomyelitis (ADEM). Fever and meningitic signs should prompt work up for infection and meningitis as a top differential. Seizures and hyperreflexia would not be necessary for the diagnosis of ADEM (Neuteboom et al. 2017).

4. The correct answer is B. This patient has acute optic neuritis. Based on the Optic Neuritis Treatment Trial (ONTT) results showed that visual recovery was fastest with IV methylprednisolone and delayed onset to clinically definite Multiple Sclerosis for unknown reasons. The authors of one article recommended to use IV methylprednisolone 1 g × 3 days or 500 mg × 5 days without an oral taper for typical optic neuritis. Oral steroids did increase recurrence of optic neuritis so this is not recommended. IV immunoglobulins has shown only weak evidence of benefit. Plasma Exchange can be considered in steroid-

unresponsive patients but is not currently a first line treatment recommendation. IV cyclophosphamide is not used in acute optic neuritis treatment (Toosy et al. 2014).

5. The correct answer is A. Multiple Sclerosis (MS) patients can have focal symptoms that mimic exacerbations of their MS in the setting of infection, fever, or even in extreme heat. This is called a pseudoexacerbation. Patients will not have any new lesions on MRI during a pseudoexacerbation. It is important to evaluate for and treat the underlying condition such as fever or infection so as not to incorrectly treat for an exacerbation with medications that can worsen the underlying problem. B and C are not correct because these may not reveal any lesions but a MRI cervical spine could be a better choice to identify an active lesion. D is not correct because the patient does not need oligoclonal banding testing in this situation since the diagnosis is already confirmed, although a lumbar puncture may be necessary if meningitis or encephalitis is suspected. E is also not correct since she has no ophthalmological complaints (Berkovic and Krieger 2016).

6. The correct answer is D. High dose corticosteroids are the recommended first-line treatment for acute exacerbations of Multiple Sclerosis. Treatment can be with either intravenous or oral corticosteroids for 3–5 days. An oral steroid taper may be done following the high dose corticosteroid treatment but is not necessary. Patients who have been unresponsive to treatment with high dose corticosteroids in the past or currently may be treated with intravenous immunoglobulin or plasma exchange. Those not responding to the latter may consider treatment with intravenous cyclophosphamide (Frohman et al. 2016).

7. The correct answer is E. Glatiramer acetate does not require monitoring. An idiosyncratic adverse reaction may be lipoatrophy, which can cause dimpling of the skin from loss of fat tissue in the subcutaneous layers of skin. Flu-like symptoms and elevated LFTs are side effects of Interferon-beta treatment. PML is a risk with Natalizumab and also has been reported with dimethyl fumarate and fingolimod. Bradycardia is an adverse reaction with fingolimod especially with the first dose (Frohman et al. 2016).

8. The correct answer is C. This patient presents with nonspecific symptoms that are not typical of clinically isolated syndrome or Multiple Sclerosis. Symptoms of Multiple Sclerosis are typically distinct focal deficits that may correspond to a CNS lesion. Multiple sclerosis lesions on MRI are also very distinct and are typically greater than 3 mm in size, well-circumscribed, and oval appearing in the periventricular white matter, juxtacortical, infratentorial, or spinal cord regions. Lesions that are not typical of MS are nonspecific white matter lesions that may appear punctate, non-ovoid appearing, and scattered in the subcortical white matter (Okuda and Krieger 2016).

9. The correct answer is A. Left Medial Longitudinal Fasciculus. This patient has a left Internuclear Ophthalmoplegia (INO). The lesion corresponds to the left eye that cannot adduct (3rd nerve function) which is ipsilateral to the side of the lesion (Feroze and Wang 2018; Fix 2014).

10. The correct answer is B. IV methylprednisolone. Acute Disseminated Encephalomyelitis (ADEM) is an immune-mediated disorder that affects the CNS and generally thought of as a monophasic disease. Its classic presentation is one of a young child with prior history of viral infection presenting with rapidly progressive symptoms of fever, altered mentation, and focal neurological symptoms. The most widely used first line treatment for someone diagnosed with ADEM is IV methylprednisolone. Plasma exchange and IVIG have been reported to be used with some success in patients that were refractory to IV steroids but are not used first-line. Interferon-beta, Glatiramer acetate, and IV cyclophosphamide are not thought to be useful in this monophasic disease (Tenembaum et al. 2007).

11. The correct answer is E. Relapsing-Remitting Multiple Sclerosis (RRMS). The patient has had a second clinical attack at this time consistent with the diagnosis of Relapsing-Remitting Multiple Sclerosis. Most patients with MS start with this form of the disease and later progress to having secondary-progressive MS. Progressive-Relapsing MS is a less common form where patients develop accumulating lesions and disability with partial or no recovery after each clinical attack. Primary Progressive MS patients have clinical disability and progression from the onset of the disease. Finally Neuromyelitis Optica is an immune-mediated disorder that affects the spinal cord and the optic nerve primarily with antibodies to Aquaporin-4 (NMO IgG) (Krieger 2016).

12. The correct answer is B. Her abnormal MRI brain. The Optic Neuritis Treatment Trial ended in 2006 after following patients for 15 years. The cumulative probability of developing MS was 50%. Patients who had one or more lesions on MRI after their first attack of optic neuritis had a 72% risk of developing MS versus a 25% risk if there were no lesions on MRI. The highest risk of developing MS was in the first 5 years. Her age is not a high risk factor for Multiple Sclerosis. Though oligoclonal banding is seen in patients with Multiple Sclerosis this was not found to be a positive predictive risk factor for MS, nor was an abnormal visual evoked potential. Optic neuritis by itself is not a risk for developing MS (Optic Neuritis Study Group 2008).

13. The correct answer is B. Start disease modifying treatment. This patient has had her first Clinically Isolated Syndrome with presentation of Trigeminal Neuralgia. Her MRI shows several lesions both in the periventricular and brainstem (infratentorial) region which fulfills criteria for Dissemination in Space. Her MRI also shows that one of the lesions is enhancing and separate

from the Trigeminal neuralgia and thus her MRI displays Dissemination in Time (Polman et al. 2011).

14. The correct answer is C. Rituximab. Neuromyeltis optica or now better known as Neuromyeltis optica spectrum disorder (NMOSD) is an autoimmune disorder affecting primarily the spinal cord (usually a longitudinally extensive lesion of more than 3 vertebral levels), optic nerve (often bilateral optic neuritis), and some brain regions. Antibodies to Aquaporin-4 (also called NMO IgG) are commonly found in patients affected by this disease and makes this disease distinct from Multiple Sclerosis. Treatment is thus distinct from multiple sclerosis. Though this patient does have Transverse myelitis this would not be the most appropriate diagnosis. He does not have MRI brain lesions to suggest a diagnosis of Multiple Sclerosis and typical spinal lesions in MS involve shorter segments and typically cause partial cord involvement. This patient has a history of optic neuritis and thus a spinal cord tumor diagnosis would not explain this well (Katz Sand 2016).

15. The correct answer is E. Aseptic Meningitis. The common side effects of Interferon-beta medications are injection site reaction and flu-like symptoms. Depression, liver toxicity, and leukopenia are also adverse effects to warn the patient of and monitor. Baseline and periodic monitoring of their cell counts and liver functions are important. Aseptic meningitis is not a common side effect of the medication (Ontaneda and Fox 2013).

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Epilepsy

4

Questions

1. A 56 year old man with history of diabetes, stroke, and hypertension presents to the Emergency Room with a laceration to his forehead after a fall. Patient says he woke up in the morning and walked to the bathroom to get ready as usual for work. His spouse, who was with him during the episode, stated that the patient said he felt lightheaded, and hit the edge of the bed as he fell to the floor. There was some shaking of both arms and legs with unresponsiveness for about 5 seconds and the patient awoke quickly. Upon awakening, the patient complained of pain where he hit his head. He was able to answer questions and seemed back to his baseline. On arrival to the emergency room, he is awake and his neurological exam is intact. He denies any headache except for tenderness in the forehead. His brain scan shows only a scalp hematoma with no intracranial hemorrhage and an old infarct in the right basal ganglia. His labs and electrocardioagram are all within normal limits except an elevated blood sugar of 180 milligrams/deciliter (mg/dL) (normal <140 mg/dL). What is the most likely cause of his transient loss of consciousness?

   A. Seizure due to old stroke
   B. Hyperglycemia
   C. Stroke
   D. Cardiac arrhythmia
   E. Orthostatic hypotension

2. A 24 year old woman with history of migraines, anxiety, depression, and structural epilepsy presents with a typical seizure episode. Her home medications consist of leviteracetam 1000 mg twice daily, propranolol 20 mg twice daily, amitriptyline 25 mg nightly, bupropion 300 mg daily, and escitalopram 20 mg daily. She has not added any new medications in the last month but she did

D. Kung et al., *Absolute Case-Based Neurology Review*,
https://doi.org/10.1007/978-3-030-11132-8_4

adjust the doses of all medications in the last 6 months. Which medication is likely to lower her seizure threshold?

A. Leviteracetam
B. Propranolol
C. Bupropion
D. Escitalopram
E. Amitriptyline

3. A patient with a history of epilepsy comes in with seizures. Her mother says seizures have lasted 2–3 minutes each. Patient has three seizures in a row with no return to baseline. What is the next best step in immediate management?

A. Patient's seizures have self-resolved. Monitor patient in the Emergency Room and discharge when patient awakens.
B. Patient should be given a barbiturate.
C. Patient should be given benzodiazepine.
D. Patient should be treated with phenytoin.
E. Patient should be treated with fosphenytoin.

4. A patient is evaluated for status epilepticus. What is an effective management choice after 0.1 mg/kg intravenous lorazepam has been administered if the patient continues to seize?

A. Rectal diazepam
B. Intramuscular phenytoin
C. Intravenous midazolam
D. Intravenous valproic acid
E. Intravenous propofol

5. A 26 year old patient with history of obesity, depression, and focal epilepsy presents to the clinic. Patient is concerned about her weight and would like to change her seizure medication to an agent that will not affect her weight. Which medication would you prescribe to help?

A. Leviteracetam
B. Gabapentin
C. Carbamazepine
D. Lacosamide
E. Topiramate

6. A 6 month old baby presents with recent onset of episodes of jerking. The child wakes up in the morning with contraction of his body and then tonic posturing of the trunk and all limbs lasting a few seconds. This happens a few times in clusters. When the jerking stops the baby cries and is slightly lethargic appearing. What do you expect to see on EEG?

A. 3 Hz generalized spike and wave activity
B. 1–2 Hz generalized spike and slow-wave activity
C. Fast spike activity
D. Hypsarrhythmia
E. Focal epileptiform discharges

7. A 37 year old man is in the Epilepsy Monitoring Unit and has a history of bizarre behavior at night. The patient is recorded in the unit and has a typical event. The patient is described as having some head deviation to the left followed by stiffening of his entire body. The entire episode lasts about 45 seconds. The patient is unresponsive during this time. Afterwards the patient snores loudly and falls back to sleep. In the morning he awakens feeling very tired. What kind of seizure is he having?

A. Simple partial seizure
B. Complex partial seizure
C. Generalized tonic-clonic seizure
D. Psychogenic nonepileptic seizure
E. Secondarily generalized seizure

8. A patient comes in after having a seizure. She has left mesial temporal sclerosis. She was well controlled on lamotrigine. Her last seizure was 1 year ago. She is on no other medications. What is not a common reason for this breakthrough seizure?

A. Missed dose of medication
B. A change in the metabolism of lamotrigine
C. Lack of sleep
D. Stress
E. A change in the dosage of lamotrigine

9. Your 20 year old patient with history of complex partial seizures presents with a seizure lasting 20 minutes and is still seizing upon arrival to the ER. His mother says he has lost his normal antiepileptic medicines and thus has not been taking them for the last 1–2 days. He is afebrile with a blood pressure of 142/73 and heart rate of 110. He has received 2 mg of intravenous (IV) lorazepam in the ambulance with continued seizures. He is on phenytoin at home and his level is 4 mg/dL. He weighs 82 kg. What is the best first-line therapy?

A. IV lorazepam
B. IV phenytoin
C. IV valproic acid
D. IV propofol
E. IV midazolam

10. A 2 year old girl is brought in by EMS. She was at home when parents noted she was shaking in all extremities, eyes were rolled back, and she was unresponsive. This lasted 2 minutes and the girl was very lethargic afterwards. The toddler was noted to be sick with high fevers that day. On exam she has a fever of 104, mild neck stiffness, and is still sleepy. She has no history of medical problems and has no history of prior seizures. Her immunizations are up to date. Her brother also had a seizure with a fever when he was her age. What on her exam would suggest an indication for lumbar puncture?

    A. High Fever
    B. Seizure
    C. Sedation
    D. Neck Stiffness
    E. No prior history of seizures

11. A 6 year old boy is brought in by parents for decline in performance at school. Teachers say he was doing fine last year in school. Parents have noted recently he seems to have episodes of staring but this lasts only a few seconds and he returns to his conversation without interruption. EEG shows 3 Hz spike and wave activity during one of these staring episodes. What is the best treatment you would choose?

    A. Valproic acid
    B. Phenytoin
    C. Vigabatrin
    D. Carbamazepine
    E. Tiagabine

12. A 20 year old woman has seizures described as starting with left sided twitching and eye deviation to the left with unresponsiveness. These seizures last 2–3 minutes and afterwards patient is lethargic. Recently since starting her new anti-epileptic medication she has become more irritable. What is the anti-epileptic medicine she is taking?

    A. Valproic acid
    B. Gabapentin
    C. Lamotrigine
    D. Leviteracetam
    E. Phenytoin

13. A 61 year old man has a seizure and is treated by EMS. His exam is notable for left upper and lower limb shaking with eyes rolled back and is unresponsive per witnesses. The seizure lasts 2 minutes and patient is post-ictal following the seizure. His seizures have stopped upon arrival in the ER. He has no prior history of seizures. He has no significant medical problems and drinks one beer a

week. His UDS is negative and alcohol level is 0. His MRI scan shows a previous old stroke in the right MCA distribution and a meningioma adjacent to the right parietal cortex without mass effect. How would you approach this patient?

A. Tell him that his seizure is due to alcohol use.
B. Tell him that his seizure will require treatment with long-term anti-epileptic medications
C. Tell him that his seizure is due to the meningioma
D. Tell him that he needs to get a SPECT study of the brain
E. Tell him that he needs to get an EEG before starting anti-epileptic medicines

14. A 40 year old man is diagnosed with left mesial temporal sclerosis. He has tried phenytoin but continues to have seizures. He is currently on Leviteracetam 1500 mg BID and still has seizures at least once a week. His EEG confirms seizures originating from the left medial temporal region. What is his next best choice of treatment?

A. Trial of a higher dose of leviteracetam.
B. Surgical resection of the left temporal region
C. Trial of carbamazepine.
D. No surgery since this would cause aphasia and memory loss
E. Trial of new generation anti-epileptic, lacosamide

15. A 63 year old man presents with a history of episodic events of altered awareness. He says prior to the moment of altered behavior and awareness he notes that he has a sense of fear and anxiety. His wife notes he then stares blankly and stiffens up in the right upper extremity. He is unresponsive for about 1–2 minutes. When this passes he is very tired and amnestic about the event. Where does his seizure originate?

A. Frontal
B. Temporal
C. Parietal
D. Occipital
E. Subcortical

Answers

1. The correct answer is E. The patient likely had an episode of orthostatic hypotension with convulsive syncope. Given the prodrome symptoms of lightheadedness and history of diabetes he may have a propensity for secondary autonomic nervous system dysfunction. Primary causes of autonomic nervous system dysfunction can be seen in conditions such as Multiple Systems

Atrophy. Answer A is incorrect because the patient also did not display any prolonged postictal phase, which is typical in patients after a generalized seizure. It is also not likely that a subcortical stroke would be the origin of a seizure. B is incorrect because it is unlikely that a slightly elevated blood glucose would cause a syncopal event. Answer C is incorrect because the patient presented with no focal findings to suggest a stroke and is lower on the differential of causes of transient loss of consciousness. Answer D is incorrect because the patient had a normal electrocardiogram making cardiac arrhythmia lower on the differential (Saal and van Dijk 2014).

2. The correct answer is C. Bupropion has known potential for increasing seizure risk and thus careful consideration should be taken before prescribing this medication to patients with epilepsy. Answer A is incorrect because this is a good anti-epileptic medication for structural epilepsy but can affect mood. Answer B is incorrect because propranolol is a beta-blocker and has no effect on seizure potential. Answer D is also incorrect and can be safely given to patients with epilepsy. Answer E is incorrect because the dose of the tricyclic antidepressant is not high and though tricyclic antidepressants can increase risk of seizures it is usually at doses of 200 mg or more per day (Sirven 2016).

3. The correct answer is C. The patient is prone to status epilepticus. By definition, status epilepticus is defined as a seizure or recurrent seizures without return to baseline lasting 30 minutes using the Epilepsy Foundation definition. However, in most cases this definition should not prevent treatment of seizures lasting more than 5 minutes or lack of return to baseline from repeated seizures lasting more than 5 minutes. Most seizures resolve within 5 minutes and often in less time. Thus if seizures have been ongoing for 5 minutes or more, it is recommended to begin treatment with a benzodiazepine. Answer A and B are not correct for the above reasons. Answer D and E are good second line medications if the benzodiazepine has not stopped the seizure. Fosphenytoin has the advantage of being given faster through an intravenous line than phenytoin and thus may often be used in the acute setting (Betjemann and Lowenstein 2015).

4. The correct answer is D. Intravenous antiepileptic medications are the next step in the management of continued seizures after full doses of benzodiazepines have been administered. Intravenous valproic acid, fosphenytoin, phenytoin, or leviteracetam are all acceptable choices for management. Answer A is incorrect because rectal diazepam is a good first line choice for status epilepticus but once the full dose (0.1 mg/kg) of benzodiazepines have been given there is likely no benefit from additional benzodiazepines. Answer B and E are incorrect because these are medications often administered for refractory status epilepticus after the second line medications, (i.e. phenytoin, fosphenytoin, valproic acid, or leviteracetam) have failed to control the seizures. Intravenous fosphenytoin is preferred over intravenous phenytoin because it can be admin-

istered faster and usually given at 20 mg/kg. Answer C is incorrect because phenytoin is not administered intramuscularly (Betjemann and Lowenstein 2015).

5. The correct answer is E. Topiramate has a known side effect of weight loss. It also has side effects of paresthesias often in the fingers and toes, kidney stones, cognitive slowing, glaucoma, and taste changes. The other answer choices do not have much effect on weight loss and specifically gabapentin is associated with weight gain. Side effects of leviteracetam include irritability or even psychosis in young children. Side effects of gabapentin include swelling in the legs, weight gain, and somnolence. Side effects of carbamazepine include hyponatremia, liver toxicity, Stevens-Johnson rash, and osteoporosis. Side effects of lacosamide include PR prolongation, suicidality, and somnolence.

6. The correct answer is D. This patient has seizure characteristics of infantile spasms. Infantile spasms often begin at around 4–7 months of age. Hypsarrhythmia is the description of the EEG pattern that is chaotic and disorganized with very high amplitude slow wave discharges. Answer A is a typical EEG pattern of Absence epilepsy. Answer B and C is an EEG pattern seen in Lennox-Gastaut syndrome. Focal epileptiform discharges are seen in patients with simple or complex partial seizures (Pavone et al. 2014).

7. The correct answer is E. The patient is having a focal frontal lobe seizure (likely originating from the right side supplemental motor region) which then secondarily generalizes to the rest of the brain causing the "stiffening of his entire body". Simple partial seizures typically are not associated with unresponsiveness. Complex partial seizures are associated with unresponsiveness but the seizures stays on one side of the body. A generalized tonic-clonic seizure typically starts with tonic and then clonic generally symmetric movements of the entire body. Many frontal lobe seizures can be mistaken for psychogenic non-epileptic events and thus Epilepsy Monitoring Units can help distinguish true epileptic events from non-epileptic events.

8. The correct answer is B. The other answer choices are often causes of breakthrough seizures. Answer B is not a common cause but it can be a cause in the setting of pregnancy. During pregnancy, metabolism of lamotrigine can increase, subsequently causing lowered plasma levels of lamotrigine in the body and increasing seizure potential. A few weeks after delivery, metabolism of lamotrigine can drop to baseline levels. It is important to determine pregnancy plans with epilepsy patients (Bonnett et al. 2017; Gerard and Meador 2016).

9. The correct answer is A. IV lorazepam 2 mg loading dose is the preferred first-line treatment for status epilepticus. You should aim to give 0.1 mg/kg total, 2 mg/min. Midazolam IM would be another good choice. IV phenytoin or

valproic acid are good choices as the next choice if patients are not responding to benzodiazepines. If patient is going to receive anesthetic agents like IV propofol, then most likely their seizures are refractory to all other prior AED choices. Patients should be intubated prior to giving these medicines and with continuous EEG monitoring to ensure they are in burst suppression. The anesthetic can be weaned off after 24 hours if patient is no longer seizing (Brophy et al. 2012).

10. The correct answer is D. Neck Stiffness. Simple febrile seizures can occur between the ages of 1 month to 8 years old characterized by a generalized tonic-clonic seizure after a fever >100.4 degrees Farenheit, lasting less than 15 minutes with return to normal consciousness. The American Academy of Pediatrics recommends a lumbar puncture if a patient presents with meningeal signs or symptoms by history or exam, if a patient 6–12 months of age is not up to date with Haemophilis influenza type b or Streptococcus pneumoniae immunizations, or if the child has been on antibiotic treatment since this can mask signs of meningitis (Oluwabusi and Sood 2012).

11. The correct answer is A. Valproic acid. This patient displays symptoms classic for childhood absence epilepsy. Symptoms usually begin at around ages 4–10 years. Girls are more commonly affected than boys. Often absence seizures are triggered by hyperventilation. In randomized controlled trials, ethosuximide and valproic acid were found to be have the best success rate but valproic acid caused more attention problems. Thus, ethosuximide has been advocated as the first-line medication; and valproic acid as second-line. Lamotrigine can also be used with slightly less success rate than the above two. Phenytoin, vigabatrin, carbamazepine, and tiagabine have been found to possibly exacerbate absence seizures (Tenney and Jain 2014).

12. The correct answer is D. Leviteracetam. Leviteracetam acts by binding the synaptic vesicle protein SV2A and acts to decrease neuronal hyperactivation. Its main side effects are sedation, dizziness and psychiatric disturbances, namely irritability and depression especially notable in children. Valproic acid blocks sodium channels and T-type calcium channels, with an added GABA potentiation as its mechanisms of action. Valproic acid's important side effects include liver toxicity, pancreatitis, and teratogenicity as well as weight gain, sedation, alopecia, parkinsonism, tremor, encephalopathy, and hyperammonemia. Lamotrigine is a sodium channel blocker and its main side effects include dizziness, blurred vision, rash, and rarely Stevens-Johnson syndrome. Phenytoin is also a sodium channel blocker and its side effects can be dangerous at high doses causing hypotension, arrhythmias, ataxia, nystagmus, and even increased seizures. Other important side effects of phenytoin include liver toxicity, hirsutism, cerebellar atrophy, gingival hyperplasia, osteopenia, neuropathy, rash, and rare Stevens-Johnson syndrome (Abou-Khalil 2016).

13. The correct answer is B. Tell him that his seizure will require treatment with long-term anti-epileptic medications. This patient has his first unprovoked seizure. His imaging suggests that the most likely source of his seizures is the old cortical stroke affecting the right MCA and less likely the meningioma since there is no mass effect. Based on the guidelines from the American Academy of Neurology, he is at an increased risk for seizure recurrence due to the presence of a brain lesion corresponding to the seizure semiology (characteristic). It is unlikely that this seizure was due to alcohol use or withdrawal of alcohol when he drinks only one beer a week. A SPECT study is not going to change your management on this patient and thus not useful. An EEG is also not absolutely necessary. The study by Krumholz et al. stated that starting AED therapy would reduce the risk of a second seizure though it did not change the remission rate over the long term (Krumholz et al. 2015).

14. The correct answer is B. Surgical resection of the left temporal region. This patient is a perfect candidate for epilepsy surgery. His current dose of leviteracetam is already at a good dose and higher doses of the medication (greater than 3000 mg daily) is unlikely to change the seizure frequency much. Carbamazepine may be a good choice for partial onset seizures but studies have shown that patients that have failed the first anti-epileptic medication, have a low likelihood of responding to a second or third anti-epileptic medicine, (14% per the study from Dr. Kwan and Brodie). Surgery is possible for this patient with temporal lobe epilepsy, either dominant or nondominant lobes. The resection is slightly smaller on the dominant side for obvious reasons. In a study by Wiebe, et al. patients who received temporal lobe resections, 58% had seizure freedom at 1 year compared to only 8% in the medically treated group (Kwan and Brodie 2000; Wiebe et al. 2001).

15. The correct answer is B. Temporal. This is a classic description of temporal lobe seizures. Patients often complain of an aura with feelings of anxiety or epigastric rising sensation. This is followed by the seizure sometimes with repetitive motor phenomenon, called automatisms. Posturing can occur in the contralateral limb and ipsilateral "nose wiping" has also been reported (Skidmore 2016).

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Dementia

5

Questions

1. A 67 year old woman presents with her family for memory loss. Daughter says patient seems more forgetful and repetitive during conversations. She has forgotten to pay a few bills, which is very unusual for her and has been getting lost while driving a few times. She quit work 2 years ago because she was making mistakes. Her Montreal Cognitive Assessment shows a score of 24/30 for recall of 4 items but was able to recall with cueing, 1 for drawing a cube, and the date. Her MRI brain shows mild hippocampal atrophy. Which allele of the APOE gene predisposes this patient to a higher risk of Alzheimer's Dementia?

   A. APOE episilon 1
   B. APOE episilon 2
   C. APOE epsilon 3
   D. APOE episilon 4
   E. APOE episilon 5

2. Your patient does a mental status exam. She misses points for subtracting 7 serially from 100. She also has difficulty drawing a clock and misses points for the numbers and hands placed correctly. She also has some difficulty following 3 step commands. No other deficits are identified on the mental status exam. Where would you localize her deficits?

   A. Frontal
   B. Temporal
   C. Parietal
   D. Occipital
   E. Global

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https://doi.org/10.1007/978-3-030-11132-8_5

3. Your patient does a mental status exam. She misses points for subtracting 7 serially from 100. She also has difficulty drawing a clock and misses points for the numbers and hands placed correctly. She also has some difficulty following 3 step commands. No other deficits are identified on the mental status exam. Family reports she has been less motivated to go out with family and friends and refuses to go to church anymore, which was a habit of hers for many years. Sometimes she makes offensive remarks about others and often does not care that she has not brushed her hair or teeth. What type of dementia does she have?

   A. Vascular Dementia
   B. Alzheimer's Dementia
   C. Lewy Body Dementia
   D. Frontotemporal Dementia
   E. Subcortical Dementia

4. Your patient with a history of Human Immunodeficiency Virus (HIV) infection on combined antiretroviral therapy presents with concerns about her ability to function at work as an administrative assistant for the last 1–2 years. She often finds herself asking her boss several times what the tasks were and is not able to complete the tasks in an organized manner. She also has difficulty learning the new computer program that was implemented at her workplace in the last year. She has to get help from other colleagues many times to help her figure out what buttons had to be pushed on the program to complete the reports. Her boss has commented several times that she is disappointed at how inefficient the patient has been in the last year. What is one of the prominent areas of deficits for patients with HIV-associated neurocognitive disorder?

   A. Visuospatial tasks
   B. Motor tasks
   C. Vision problems
   D. Efficiency
   E. Executive function

5. An 80 year old patient presents with memory impairment for the last year. Family complains that patient has had difficulty walking and his gait has slowed significantly. He denies any hallucinations or sleeping difficulties. He has had some urinary incontinence. CT head shows ventriculomegaly. Where will the patient see the most benefit after ventriculoperitoneal shunting?

   A. Memory
   B. Motor function
   C. Urinary incontinence

D. Executive Function
E. Visuospatial function

6. A patient presents with difficulty walking and memory loss. Her neurological exam shows intact motor strength, normal cerebellar exam, with decreased vibration and proprioception in the feet. Reflexes are slightly diminished in the legs. Her labs show a low Vitamin B12 level. What additional lab would confirm suspicion of B12 deficiency causing her symptoms?

A. Elevated Folic Acid levels
B. Hyposegmented neutrophils
C. Microcytic anemia
D. High methylmalonic acid levels
E. Low homocysteine levels

7. A 79 year old man with history of cognitive impairment presents to the ICU with headaches and weakness on the right. CT head shows a lobar hemorrhage in the left parietal region. A few microhemorrhages are also found scattered in different locations in the frontal and parietal regions. The patient has no history of diabetes, high blood pressure or strokes. The patient is not on any antiplatelet or anticoagulant treatment. CTA shows no vessel abnormalities. How would you confirm the cause of this patient's intracranial hemorrhage?

A. Magnetic Resonance Imaging (MRI)
B. Magnetic Resonance Angiography (MRA)
C. Biopsy
D. Catheter angiography of the brain vessels
E. Lumbar puncture

8. A 73 year old man presents for evaluation of memory loss for the last 3 years. The patient's family says the patient seems more disorganized, has poor attention, and often has to be reminded to do tasks. He has some right sided weakness of the face, arm, and leg from a previous stroke to the thalamus. The patient has no aphasia and no sensory loss. Which type of dementia does this patient most likely have?

A. Alzheimer's Dementia
B. Lewy Body Dementia
C. Frontotemporal Lobar Dementia
D. Small vessel vascular dementia
E. Multi-infarct vascular dementia

9. A patient with Lewy Body Dementia has some disturbing hallucinations that are interfering with her ability to interact normally with her family. She is often paranoid and delusional as well. She feels that her husband has been replaced by an impostor. She is taken to the ER for psychosis but the neurologist suggests not using haloperidol. What is the reason for trying to avoid typical antipsychotics in this patient?

   A. Haloperidol can worsen bradycardia
   B. Haloperidol can worsen her psychosis
   C. Haloperidol can worsen gastrointestinal symptoms
   D. Haloperidol can worsen bradykinesia
   E. Haloperidol can worsen aggression

10. A 76 year-old woman with history of depression and diabetes presents with her family for memory loss. Family reports that the patient is forgetful and more withdrawn. She has been relying on family members to help her get to doctor appointments and help her remember to take her medications. She previously worked as a housewife and did occasional babysitting. She did not graduate high school. Her mother had dementia starting in her early 80's. What is NOT a risk factor for dementia for this particular patient?

    A. Family history
    B. Diabetes
    C. Depression
    D. Low educational background
    E. Age

11. A 30 year-old patient presents to your office for evaluation of daytime sleepiness. She reports that often times she wakes up from sleep and feels like she cannot move for a few minutes. She is awake at this time and has no loss of consciousness. The patient tries to get 7 hours of sleep per night and wakes up feeling refreshed. However, often she still easily falls asleep during the day. She has had one episode when she could not move her limbs after having her blood drawn. The total body paralysis lasted about 2 minutes. The patient is 64 inches tall and weighs 135 pounds. What is your treatment of choice?

    A. Continuous Positive Airway Pressure (CPAP) machine use during sleep
    B. Advise her to get 8 hours of sleep per night more consistently
    C. Lose weight
    D. Modafinil
    E. Venlafaxine

12. A 67 year old woman presents with her family for memory loss. Daughter says patient seems more forgetful and repetitive during conversations. She has forgotten to pay a few bills, which is very unusual for her and has been getting lost

while driving a few times. She quit work 2 years ago because she was making mistakes. Her Montreal Cognitive Assessment shows a score of 24/30 for recall of 4 items but was able to recall with cueing, –1 for drawing a cube, and –1 for missing the date. Her MRI brain shows mild hippocampal atrophy. Her labs show a vitamin B12 of 350 picograms per milliliter (normal 200–900 picograms per milliliter), her methylmalonic acid level is 0.3 micromoles/liter (normal is 0.08–0.56 micromoles per liter), thyroid stimulating hormone of 3.5 milli-international units/liter (0.4–4.0 milli-international units per liter (mIU/L). She denies any depressive symptoms. What is your treatment plan?

A. Correct her low vitamin B12 level
B. Memantine
C. Perform an EEG
D. Galantamine

13. A 79 year old man presents for evaluation of behavioral disturbance in the last year. Family reports that he seems to have difficulty completing simple tasks. He has retired because he was unable to complete his normal job assignments. He has fallen several times for unknown reasons but has not hit his head. He also has been having a few hallucinations of his deceased mother and speaking to her. At night he often thrashes around in the bed and has fallen out of bed a few times. On exam he is slow to walk and has a stopped posture. He has no tremors, no rigidity. He has no cranial nerve deficits. MRI of the brain shows no significant atrophy or prior strokes. What is his most likely diagnosis?

A. Alzheimer's Dementia
B. Parkinson's disease dementia
C. Frontotemporal Dementia
D. Lewy body dementia
E. Progressive Supranuclear Palsy

14. The patient from the question above (#40), went to an emergency room for hallucinations. The patient was given a dose of Haldol due to symptoms of agitation while in the ER. He comes back to the ER 2 days later and the family reports he has been more confused, and has been running some fevers and seems sweaty. On exam, he exhibits increased tone throughout his limbs, he is unresponsive to questioning, and his temperature is measured at 104.2 degrees Fahrenheit. What test may increase your diagnostic suspicion?

A. Creatine Kinase
B. Erythrocyte sedimentation rate
C. Electrocardiogram
D. Electromyography and Nerve Conduction Studies
E. White Blood Cells

15. A 50 year old woman presents to your clinic with family for behavioral disturbances for the last 1 year. She has become more apathetic and family is concerned she may be depressed. She has no history of depression or psychosis. Additionally, she seems to be gaining weight because she has been craving desserts and has insisted on eating them with every meal and between each meal. She goes to church regularly and helps out with the children's ministry. Recently the patient did not seem to care much for the children, which was noted by the other volunteers. She also has had trouble recalling the children's names. She has become more childish in her own behaviors. Family members have also noticed that she often forgets to bathe and has become disheveled in her appearance. How would you treat this patient?

    A. Offer her anti-depressants
    B. Offer her anti-psychotics
    C. Offer her donepezil
    D. Offer her memantine
    E. Offer her psychiatric counseling

16. A 23 year old woman presents to the ER for 1 month of personality changes and a new onset seizure. Her mother explains that she was a hard-working sales woman at a department store and was about to be promoted. However, last month she became more abrasive with her co-workers and customers and she was asked to take some time off from work for her behavior. She returned to work briefly but was fired because she began proselytizing and proclaiming she was God. On exam, she is diaphoretic and disheveled appearing. She is disoriented and does not talk but stares blankly at you during the examination. She follows commands though very slowly. She has no focal deficits on exam but does display some occasional myoclonic jerks in her extremities and involuntary movements of her mouth and tongue. Her EEG shows diffuse slowing and some epileptiform discharges in the left temporal region. What is an important test to do?

    A. Neuropsychological evaluation
    B. Chest X-ray
    C. CT head
    D. Vasculitic panel
    E. Pelvic ultrasound

Answers

1. The correct answer is D. ApoE gene is located on chromosome 19. The allele associated with increased risk of development of Alzheimer's Dementia is ApoE epsilon 4. Carriers of ApoE epsilon 4 (epsilon 2/epsilon 4 or epsilon 3/epsilon 4) are twice as high of a risk of developing Alzheimer's dementia when compared to epsilon 3/epsilon 3 carriers. Those with epsilon 4/epsilon 4 are at an eight times higher risk than epsilon 3/epsilon 3 carriers (Slooter et al. 2004).

2. The correct answer is A. Serial 7's, following 3 step commands, and drawing a clock in an organized manner requires attention, higher order executive function to process and plan sequences of tasks to accomplish a goal. A temporal lobe deficit would manifest with primarily memory recall difficulties on the mental status exam. A parietal lobe deficit would manifest with visuospatial difficulties. An occipital lobe deficit would manifest often with visual deficits, such as homonymous hemianopsia. This person has more frontal lobe deficits and less likely global deficits based on the findings from the exam (Bang et al. 2015).

3. The correct answer is D. Frontotemporal dementia patients have disinhibition, lack motivation, may make inappropriate comments, lose empathy for others, and may neglect their hygiene. Other characteristics include a craving for sweets and overeating. In the non-fluent variant, patients have prominent signs of language dysfunction. Patients will present with symptoms similar to a patient with expressive aphasia with grammatical errors and impaired comprehension (Bang et al. 2015).

4. The correct answer is E. Patients in the era of combined antiretroviral therapy are often presenting with executive function difficulties and memory difficulties such as learning new tasks and are categorized as having HIV-associated Neurocognitive Disorder (HAND). Most patients do not have visuospatial difficulties or vision problems. Many people with severe HAND may develop motor slowing and difficulties but that is not often seen as much now with good viral control. Efficiency (answer D) is not necessarily the prominent problem. Effective treatment for HAND has not been satisfying (Clifford and Ances 2013).

5. The correct answer is B. This patient most likely is suffering from idiopathic Normal Pressure Hydrocephalus. Classic triad of symptoms are gait ataxia, urinary incontinence, and dementia. Ventriculoperitoneal shunting will help most with gait. Unfortunately, memory and urinary incontinence does not improve as well with ventriculoperitoneal shunting. Executive function and visuospatial function are not affected by ventriculoperitoneal shunting (Ghosh and Lippa 2014).

6. The correct answer is D. Confirmatory testing for low Vitamin B12 would be high methylmalonic acid levels. Folic acid levels do not necessarily correlate with B12 levels but can often also be low. Folate replacement without B12 supplementation if given in the setting of B12 deficiency can lead to worsening neurological symptoms. A peripheral smear may find hypersegmented neutrophils and low hemoglobin and hematocrit may indicate Megaloblastic anemia. These abnormalities can also be seen with folate deficiency and copper deficiency. Elevated homocysteine levels are often found with B12 deficiency (Reynolds 2006).

7. The correct answer is C. This patient is most likely suffering from Cerebral Amyloid Angiopathy, which is a common cause of lobar or cortical intracranial hemorrhage in the elderly and can be a cause of dementia. Patients can have a slowly progressive presentation or an acute presentation as seen in this patient. Biopsy of the affected tissue would show amyloid angiopathy affecting small to medium sized vessels to confirm the diagnosis. MRI and MRA imaging can easily visualize the microhemorrhages but is not confirmatory. Catheter angiography nor a lumbar puncture would be unlikely to identify amyloid angiopathy as the cause (Biffi and Greenberg 2011).

8. The correct answer is D. The patient has symptoms most attributable to small vessel dementia (subcortical vascular dementia). Patients with this type of dementia often have problems with processing information, poor attention, and frontal executive dysfunction. They may also have a history of lacunar strokes, which is evident by the patient's pure motor lacunar stroke. Muti-infarct vascular dementia is less likely since this type of dementia is defined as having cortical infarcts, which this patient does not have. Alzheimer's Dementia can be mixed with vascular dementia but is less likely to be the cause for this patient's symptoms. Presenting symptoms of Lewy Body Dementia and Frontotemporal Lobar dementia are not displayed in this patient (O'Brien and Thomas 2015).

9. The correct answer is D. Haloperidol can worsen parkinsonism symptoms, can cause orthostatic hypotension, increase sedation, increases the chance for neuroleptic malignant syndrome, and can even lead to death due to autonomic instability. Patients with Lewy Body Dementia are particularly sensitive to typical antipsychotics and thus it is important to be aware of certain medications to avoid in this condition (Gomperts 2016).

10. The correct answer is A. All other answer choices listed are risk factors that have been found to be associated with higher risks for Alzheimer's dementia. Other risk factors include obesity, vascular risk factors, smoking, and poor exercise and diet. In this patient's case, her mother having dementia starting at a later age is not unusual and is still considered most likely sporadic.

11. The correct answer is D. The patient is likely suffering from Type 1 narcolepsy. In this type of narcolepsy patients have daytime sleepiness, cataplexy (episodes of paralysis often associated with stressful situations), and a multiple sleep latency test with fast transition to REM sleep. Modafinil is a good medication treatment option for patients with narcolepsy. The patient also describes sleep paralysis, which can be seen in narcolepsy. Obstructive sleep apnea (OSA) is treated with use of a CPAP machine and is important to evaluate as well but cataplexy is not a complaint seen in OSA. Advising the patient to get more consistent sleep 8 hours a night is good advice but may not relieve her symptoms as well as answer choice D. The patient's BMI is slightly higher than average but is not likely causing her daytime sleepiness. Venlafaxine can be a good treatment option for cataplexy but since she has had only one episode it is unlikely to be helpful at this time (Scammell 2015).

12. The correct answer is D. galantamine. This patient is suffering from symptoms of Alzheimer's Dementia. Her current level of B12 is within normal range and her MMA of 0.3 confirms that this is within normal range. Her thyroid stimulating hormone is also within normal limits. Memantine is an N-methyl-D-aspartate receptor antagonist that is indicated for moderate to severe dementia. In this patient, her symptoms are still mild and thus she is likely to benefit from starting an acetylcholinesterase inhibitor, like galantamine, first. An EEG at this time may not give much additional information (Scheltens et al. 2016).

13. The correct answer is D. Lewy Body Dementia. The patient fits all criteria for Lewy Body Dementia (LBD). The core criteria requires 2 of the following: parkinsonian symptoms, fluctuating cognition, or recurrent visual hallucinations. The central features requires progressive dementia and deficits in visuospatial, attention, or executive dysfunction. The patient also exhibits symptoms of Rapid Eye Movement (REM) Sleep Behavior Disorder which is one of the suggestive features of LBD. His symptoms have all presented within a 1 year time period which would be atypical for Parkinson's disease dementia. He does not have typical features of Alzheimer's dementia. Frontotemporal dementia is on the differential but may present with more behavioral changes with apathy, disinhibition, and loss of insight. Progressive Supranuclear Palsy does often present with repeated falls and memory deficits but is also accompanied by visual disturbances including blurred vision, difficulty with vertical gaze (downgaze before upgaze is affected), and eyelid apraxia (difficulty opening eyes) (Cardarelli et al. 2010; Lubarsky and Juncos 2008; Walker et al. 2015).

14. The correct answer is A. Creatine Kinase. This patient is suffering from Neuroleptic Malignant Syndrome (NMS). The clinical syndrome displays symptoms of muscle rigidity, high sustained fevers, altered mentation, and autonomic symptoms (diaphoresis being one). The former two are considered cardinal symptoms. NMS is a rare disorder and has been reported with various atypical or typical antipsychotics. Creatine Kinase is typically >600 units/liter, often >1000 units/liter. ESR is often elevated but is nonspecific. Electrocardiogram can show heart rate instability. EMG/NCS are not usually revealing of any specific abnormalities. White blood cell count may be slightly elevated but would not account for all these symptoms. Creatine Kinase can also be used for monitoring response to treatment. For the most part, treatment is identifying the causative agent, stopping it, and providing supportive care. There is expert opinion that suggest dantrolene and bromocriptine may be helpful (Tse et al. 2015).

15. The correct answer is A. Offer her anti-depressants. Despite the fact that this patient is likely suffering from the behavioral variant of Frontotemporal dementia the treatment is unfortunately limited. Acetylcholinesterase inhibitors, such as donepezil, are unlikely to help in her case. There have been some reports of these agents helping in the progressive non-fluent aphasia types of frontotemporal dementia, which presents often with word finding difficulties and/or difficulty naming objects. N-methyl-D-aspartate receptor antagonists, such as

memantine have also not been effective. Selective serotonin receptor inhibitors can help with mood and cravings for sweets as in this lady and thus may be the best treatment option. The patient is currently not experiencing any disturbing psychotic symptoms to make the use of anti-psychotics necessary. Psychiatric counseling may be helpful to the family but is unlikely to help this patient with a progressive neurodegenerative disorder (Cardarelli et al. 2010).

16. The correct answer is E. Pelvic ultrasound. The patient fits criteria for having a limbic encephalitis. Your differential should include psychiatric disorders such as first onset of symptoms of schizophrenia or depression. However, these disorders are not accompanied by seizures or autonomic features, though catatonic movements can confuse the picture. An MRI brain may be helpful to confirm the diagnosis of a limbic encephalitis usually showing T2-weighted fluid-attenuated inversion recovery changes especially involving the medial temporal lobes but a CT scan is not as sensitive in picking up these abnormalities. A chest x-ray, vasculitic panel are usually normal. A neuropsychological evaluation is not likely to yield any more helpful information to make your diagnosis. A lumbar puncture showing pleocytosis or positive oligoclonal bands is typical and part of the diagnostic criteria. Her history and clinical picture is consistent with anti-NMDA receptor encephalitis. It is important to look for an ovarian teratoma, which is often associated with this disease and thus a pelvic ultrasound is paramount (Graus et al. 2016).

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Vertigo

6

Questions

1. A 52 year old man with history of hypertension and hyperlipidemia presents with acute onset of vertigo. On exam he has no clear cranial nerve deficits but does have some nystagmus when looking to the right. He has a bedside test including test of skew deviation with no abnormal findings and a head impulse test shows a saccade back to center when turning the head to the right. Where does this patient's vertigo localize?

   A. Right medial pons
   B. Left middle cerebral artery territory
   C. Right middle cerebral artery territory
   D. Right vestibular nerve
   E. Left vestibular nerve

2. A 45 year old woman presents with episodic vertigo for the last 6 months. She has a history of headaches associated with nausea that are often right sided and moderate in intensity. She denies hearing loss or tinnitus. Symptoms of vertigo are associated with photophobia and phonophobia. What treatment would you offer her?

   A. Verapamil
   B. Thiazide diuretic
   C. Repositioning maneuver
   D. Steroids
   E. Serotonin-reuptake inhibitor

3. A 67 year old man with hypertension and diabetes presents with vertigo. When he turns his head, he starts to feel dizzy. His exam is significant for nystagmus.

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https://doi.org/10.1007/978-3-030-11132-8_6

He denies neck pain but does have a headache. He denies hearing loss. What is the least likely diagnosis?

A. Vertebrobasilar insufficiency
B. Benign Paroxysmal Positional Vertigo
C. Vestibular migraines
D. Vestibular neuritis
E. Meniere's

4. A 67 year old man with hypertension and diabetes presents with vertigo. His exam is significant for nystagmus only. He denies neck pain but does have a headache. If this patient is suffering from a stroke, which answer choice below is less likely to be seen in a patient with stroke?

A. Older age (>60 years old)
B. Hypertension
C. Nystagmus when turning the head to the left
D. Headache not associated with neck pain
E. Imbalance and veering to one side when walking

5. A 50 year old patient presents with vertigo. He has a history of hypertension that is controlled. His symptoms are worse in the morning when he turns over in bed. He has nausea, vomiting with the vertigo lasting a few minutes and if he stays still the vertigo subsides after 1–2 minutes. He denies dysarthria, dysphagia, diplopia, weakness, or numbness. He is able to walk without difficulty. His exam shows normal cranial nerves, motor and sensory exam. He has no dysmetria. What would be a good bedside test to do?

A. Head-impulse test
B. Test of skew
C. Dix-Hallpike
D. Epley maneuver
E. Cold caloric test

6. A 70 year old patient presents to your clinic for episodic dizziness. The dizziness is provoked by turning his head. He has nausea and vomiting with these episodes for a few minutes. A Dix-Hallpike maneuver exacerbates his symptoms and rotatory nystagmus is noted. Which semi-circular canal is the most often involved?

A. Posterior canal
B. Horizontal canal
C. Anterior canal
D. Lateral canal

7. A 55 year old man presents to the ER for nausea. His blood alcohol level is elevated and reports that he was at a party tonight. He has a history of a prior stroke and seizures. He is on phenytoin and the level is 23 (normal 10–20 micrograms per milliliter). For his stroke he takes aspirin 325 mg daily but often takes more to help with his chronic back pain. He is given promethazine for his nausea. He complains of dizziness. What is the least likely cause of his dizziness?

   A. Alcohol intoxication
   B. Phenytoin
   C. Aspirin
   D. Promethazine
   E. An acute stroke

8. An 80 year-old man with melanoma and 50 pack year smoking history presents with sudden onset of episodes of dizziness for the past 2 weeks. The episodes are characterized by the room spinning (he cannot state which direction) lasting minutes to hours, worsened with movement. He feels better in between episodes. There is no aural fullness, hearing loss or tinnitus. On neurologic examination, he has persistent downbeat nystagmus that does not change or extinguish in any position. You suspect a central process. Which of the following features is most worrisome for a central process?

   A. Age
   B. Smoking history
   C. Persistent downbeat nystagmus
   D. Sudden onset
   E. Lack of hearing loss

Answers

1. The correct answer is D. This patient has a peripheral cause of his vertigo possibly from a vestibular neuritis, labyrinthitis or benign paroxysmal positional vertigo affecting the right side. The HINTS (Head Impulse, Nystagmus, and Test of Skew) exam is the bedside test that is sensitive for differentiating a peripheral from central etiology of the vertigo. In patients with peripheral causes of vertigo, the head impulse test shows an abnormal corrective saccade, unidirectional nystagmus, and normal test of skew (no corrective vertical misalignment with the cover-uncover test). In patients with central causes of vertigo, the head impulse test is normal, there is bidirectional nystagmus, and the test of skew is abnormal (Edlow et al. 2018).

2. The correct answer is A. This patient meets criteria for having vestibular migraines. Vertigo may not always correlate with the migraines but may be asso-

ciated with aura symptoms or photophobia and phonophobia. Verapamil would be a preventative option for treatment of vestibular migraines. A differential diagnosis should be Meniere's disease but in Meniere's patients have hearing loss and may complain of tinnitus or a fullness in the affected ear. A diuretic would be the treatment for Meniere's. Repositioning maneuvers would be helpful for a patient with Benign Paroxysmal Positional Vertigo. Steroids may help a patient with vestibular neuritis. Serotonin-reuptake inhibitors may help a patient with Chronic Subjective Dizziness (Swaminathan and Smith 2015).

3. The correct answer is E. Patients with Meniere's disease will complain of vertigo lasting at least 20 minutes associated with tinnitus or fullness in the ear. Patients with Meniere's should be sent to audiology and will have hearing loss in the affected ear. Vertebrobasilar insufficiency should be considered given his vascular risk factors and exam findings. Benign Paroxysmal Positional Vertigo classically is exacerbated by head turning and causes a nystagmus that is obvious on performing the Dix-Hallpike maneuver. Vestibular migraines is possible given the history of headache though may be lower on the differential. Vestibular neuritis is often accompanied by vertigo, nystagmus, and unsteadiness of gait (Swaminathan and Smith 2015).

4. The correct answer is C. Unidirectional nystagmus would be seen more often in peripheral causes of vertigo and thus this is less likely seen in a patient with stroke. The patient is at risk for having a stroke. Bidirectional nystagmus, if found on exam, would be concerning for a central cause for the vertigo. In one study, it was found that older age, greater than 60 years old, vascular risk factors, and gait difficulties were seen more often in patients presenting with vertigo due to a central cause. Headache can be seen in patients presenting with a stroke and thus is nonspecific (Navi et al. 2012).

5. The correct answer is C. The Dix-Hallpike maneuver is the best bedside test to perform in patient suspected of having Benign Paroxysmal Positional Vertigo (BPPV). Rotatory nystagmus is characteristically seen in patients with BPPV. The Head impulse test and test of skew are part of the HINTS exam and are helpful for distinguishing between a central or peripheral cause of vertigo but is not as specific for BPPV. The Epley maneuver is a repositioning maneuver for treatment of BPPV. Cold calorics would not be helpful in diagnosing BPPV (Thurtell et al. 2010).

6. The correct answer is A. This patient is suffering from Benign Paroxysmal Positional Vertigo (BPPV). The posterior canal is the most often affected (80–90% of BPPV patients). The horizontal canal is involved in 10–15% of cases of BPPV. The anterior canal is much rarer and needs to be differentiated from a central lesion with MRI of the brain. The lateral canal is not a semi-circular canal (Newman-Toker 2012).

7. The correct answer is D. High levels of alcohol can cause acute vertigo and ataxia. The vertigo due to alcohol intoxication directly affects the inner ear. Phenytoin can also cause dizziness and ataxia especially at high levels but can be a side effect of the drug even at therapeutic levels. His level is only slightly above normal and there is unlikely any need to change the dose. Salicylates, like aspirin, at high chronic doses can cause vertigo, tinnitus, and hearing loss. An acute stroke is also possible given his history of stroke. Promethazine is often used to treat dizziness and nausea and thus is probably the least likely to cause dizziness.

8. The correct answer is C. Persistent downbeat nystagmus is the most worrisome feature in the above history/examination concerning for central process (Fife 2012).

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Pediatric Neurology

7

Questions

1. A 3 year-old boy is brought to the emergency room due to a seizure lasting 10 minutes. He has never had seizures before. He and several family members have recently been diagnosed with influenza A. He was not playing or eating as much as normal in the last few days. He was born full term via normal vaginal delivery. There were no complications. He walked at 10 months and is talking well. Mom does not have any concerns about his development. His mother also had seizures when she was ill as a young child. His vital signs show temperature of 104.5 °, heart rate of 120, blood pressure 90/60. He stopped seizing in the ambulance after he was given rectal diazepam. He is groaning, but not conversant yet. He moves all limbs normally but not to command. Reflexes are normal. Which of the following is true regarding his prognosis and treatment?

   A. If EEG is abnormal, (shows a periodic spike and wave discharge), his chance of having epilepsy is very low
   B. Given that this mother had seizures when she was younger, he has a high risk of being diagnosed with epilepsy
   C. His temperature and infection likely do not play any factor in the occurrence of his seizures
   D. Overall, if other diagnostic studies are unrevealing, he has a very low chance of epilepsy

2. A 2 year-old boy presents with lethargy and not acting himself for the past 1 day. He attends preschool. Also, he recently travelled with his older, high school senior brother to visit many college campuses. His vital signs show temperature of 103.5 °, heart rate of 120 beats per minute, blood pressure 94/56.

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On examination, it is very difficult to move his neck and he cries out in pain. He is sleepy and not following commands. Otherwise, strength and reflexes are normal. A decision is made in the ER to perform a bedside lumbar puncture. This shows the following findings:

Opening pressure: 26 cm H_2O
WBC: 1581
RBC: 2
Glucose: 15
Protein: 256
Gram stain: Gram negative diplococci

Which of the following is true regarding the diagnosis?

A. This boy is infected with Neisseria meningitides, leading to acute bacterial meningitis, the most common cause in his age group;
B. This boy is infected with Haemophilus influenza, leading to acute bacterial meningitis, the most common cause in his age group;
C. This boy is infected with Listeria monocytogenes, leading to acute bacterial meningitis the most common cause in his age group;
D. This boy is infected with group b streptococcus, leading to acute bacterial meningitis, the most common cause in his age group

3. A 7 year-old girl is brought in to your clinic for staring spells. Mom reports that she notices them at home and they last less than 1 minute. She is concerned because teacher also has noticed them and is concerned about her inattention. She had normal development and was otherwise doing well in school. Her neurologic examination is normal. An EEG is ordered and shows generalized 3 HZ spike and waves brought on by hyperventilation. Which of the following is the next best treatment?

A. This is a normal part of adolescence and does not require treatment
B. Start phenobarbital
C. Start ethosuximide
D. Start Ritalin for attention deficit disorder

4. You see a newborn baby with concern for hypotonia. He has a poor suck and is not feeding well. Tone and reflexes are also reduced. EMG and nerve conduction studies were performed under anesthesia and revealed a motor neuron process. Which of the following would be the next best step?

A. Perform expedited genetic testing for spinal muscular atrophy
B. Perform routine genetic testing for Duchenne muscular dystrophy
C. Perform muscle biopsy to confirm EMG findings
D. Have the patient follow up in clinic for further evaluation and care

5. A 6 year-old boy presents with episodes of lip twitching several times a day. He has normal development and is otherwise doing well in kindergarten. EEG was performed in the hospital and showed centrotemporal spikes. Which of the following is true regarding his condition?

   A. His condition is called benign rolandic epilepsy and should respond to most agents that treat partial onset seizures
   B. His condition is benign and does not ever require any treatment
   C. His condition may need to evaluated for surgical lesionectomy
   D. His condition has no known genetic basis

Answers

1. The correct answer is D. This patient presents with a classic febrile seizure. Twenty five to forty percent of family members may also have febrile seizures as a child. However, this does not seem to significantly increase the risk of epilepsy. Patients with febrile seizures have a 1.5% chance of developing epilepsy. Choice A is not correct. An abnormal EEG with periodic spike and wave discharges would either indicate a predilection for epilepsy or ongoing non-convulsive seizures. Choice B and C are incorrect due to the explanation detailed above (Gupta 2016).

2. The correct answer is A. Gram negative diplococci is consistent with Neisseria meningitides, the most common cause of acute bacterial meningitis in patients age 2–20 years. Choice C is incorrect as Listeria is not the most common cause in his age group. It also leads to gram positive rods or coccobacilli. Choice B is incorrect. Although it is common in this age group, it leads to gram negative coccobacilli. Choice D is incorrect. It is the most common cause in the neonatal group of meningitis. It leads to gram positive coccus (Roos 2015).

3. The correct answer is C. This patient displays classic history and EEG findings for absence seizures. Ethosuximide is considered a first line treatment for absence seizures. Its mechanism of action is against the T-type calcium channels. Choices A, B and D are incorrect. Phenobarbital would be a very unusual first line agent to use in any 7 year-old patient with epilepsy (Brigo et al. 2018).

4. The correct answer is A. Given the electrodiagnostic findings, choice B would be incorrect. Duchenne's muscular dystrophy would reveal a myopathy and not motor neuron process on EMG. Choice C is incorrect, a muscle biopsy at this point would not necessarily to add to the current diagnosis. Choice D would also be incorrect. There is now an FDA-approved medication for spinal muscular atrophy, the most common type of motor neuron disease in infants which has been shown to significantly improve quality of life and respiratory function, Spinraza. Therefore, it would be inappropriate not to purse expe-

dited genetic testing at this time if the family would be amenable to considering treatment (Finkel et al. 2017; Wurster and Ludolph 2018).

5. The correct answer is A. This patient exhibits classic EEG findings for benign rolandic epilepsy. He should respond well to any anti-epileptic agent that is used to treat benign rolandic epilepsy. Although his condition is benign and is usually outgrown by the teen years, seizures can sometimes secondarily generalize and can be treated with anti-epileptic medications. Lesionectomy is not usually required for benign rolandic epilepsy. Benign rolandic epilepsy has some genetic basis, although not clearly delineated and may be one of the most common epilepsy syndromes affecting children (Park et al. 2015).

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Movement Disorders

8

Questions

1. A 65 year-old, previously healthy woman presents to your clinic due to difficulty controlling her left arm. Her symptoms are starting to affect her quality of life and daily activities. She reports that her hand often will move of its own volition. This would include stretching out (similar to levitation) or grasping on its own. It is somewhat embarrassing to her. On examination, the left upper extremity does display dystonic postures and difficulty relaxing. There is increased tone in the left upper extremity, but the right upper extremity and lower extremities appear normal. When placing a quarter and a nickel in the right hand, she is easily able to identify the coins. However, she has significant difficulty with the same tasks in the left hand. She is able to identify a "6" when written onto her right hand, but not her left. Other examination findings include a large amplitude tremor on the left hand at rest and action. Which of the following is the most likely diagnosis?

   A. Multiple Systems Atrophy
   B. Progressive Supranuclear Palsy
   C. Corticobasal Syndrome
   D. Lewy Body Dementia

2. A 70 year-old man who was previously diagnosed with Parkinson's disease 3 months ago presents to your clinic for a second opinion. He arrives in a wheelchair. He reports that he had onset of tremor about 6 months ago, but his most debilitating symptoms is his frequent falls. When he gets up from the chair, he becomes significantly light-headed. The nurse measures his blood pressure as 120/80 in seated position and when standing 85/60. His examination shows bradykinesia with a rest tremor on his right hand. He has been on levodopa medications up to 800 mg per day, but he does not feel significant

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https://doi.org/10.1007/978-3-030-11132-8_8

benefit. He feels no different today when he presents to your clinic without taking any medications. Which of the following would be a reasonable consideration for this patient?

A. Deep brain stimulation
B. Neuropsychological testing
C. Reconsider the diagnosis
D. Increase the levodopa to a goal of 1200 mg per day

3. A 75 year-old man who was recently diagnosed with Alzheimer's dementia presents to the emergency room for visual hallucinations. His wife reports that his symptoms of memory loss began 6 months–1 year ago. He has striking good days and bad days. Around the same time, she noticed that his walking changed. He does not seem to have good balance like he used to. She also noticed a tremor. Over the past 1–2 months, he has been unable to sleep as he reports to his wife that he sees a skunk or other animals in their bedroom. She brought him to the ER for further evaluation. On your examination, you notice that he has hypomimia, bradykinesia and bradyphrenia. He is actively hallucinating, complaining of animals in his ER room. His gait is shuffling and stooped. Which of the following next steps regarding medication treatment do you recommend?

   A. Start levodopa for Parkinson's disease and particularly give a bedtime dose given his hallucinations
   B. Start a combination of donepezil and memantine for classic Alzheimer's disease
   C. Refer for deep brain stimulation
   D. Consider giving an atypical antipsychotic such as quetiapine, but with caution due to this disease's known neuroleptic sensitivity

4. A 15 year-old boy presents with progressive ataxia. His examination shows dysmetria, dysdiadochokinesia, appendicular and truncal ataxia. He also has high arched feet (pes cavus) and significantly impaired vibration and proprioception. His reflexes are reduced. You suspect a form of hereditary ataxia. Which of the following is true about his condition?

   A. The mechanism of inheritance is an autosomal dominant point mutation
   B. The mechanism of inheritance is autosomal dominant, triplet repeat expansion
   C. The mechanism of inheritance is an autosomal recessive point mutation
   D. The mechanism of inheritance is an autosomal recessive, triplet repeat expansion

5. A 48 year-old Cuban man presents for progressive ataxia. His father and grandfather have similar symptoms. On examination, he has prominent gait ataxia and scanning speech (cerebellar dysarthria). In addition, his saccades appear

slow. Reflexes are reduced. His genetic testing reveals an expanded CAG repeat in the Ataxin 2 gene. Which of the following is true?

A. This patient's daughters, but not his sons, have 50% chance of getting the affected genetic abnormality.
B. This patient's children (sons and daughters) have 50% chance of inheriting the genetic abnormality. They are likely to present in their fifth–sixth decade.
C. This patient's children (sons and daughters) have a 50% chance of inheriting the genetic abnormality. They are likely to present in their third–fourth decade.
D. This patient's children (sons and daughters) have a 25% chance of inheriting the genetic abnormality

6. A 56 year-old man presents for evaluation of tremor. He notes that several family members had similar symptoms in their 50s and 60s. On examination, there is no evidence of hypomimia, bradyphrenia or bradykinesia. His chin has a fast frequency tremor. At rest, tremor is not noted. However, with arms raised straight out in front, there is a fairly symmetric, fast, wrist-flexion extension tremor. When writing a spiral, this tremor is even more prominent. Tone is normal. Gait is normal. He is not sure if alcohol improves his symptoms, as he does not drink. Which of the following would be considered first line medication to offer in this patient?

A. Propranolol
B. Clonazepam
C. Levodopa
D. Ropinorole

7. A 47 year-old woman presents with asymmetric resting tremor of right hand for 2 years. It is starting to affect her quality of life. On examination, she exhibits hypomimia and bradyphrenia. She has a 5 HZ, asymmetric, pill-rolling, right hand resting tremor. She has cogwheeling rigidity. Gait is shuffling and there are signs of reduced right arm swing. You decide to consider treatment with either levodopa or a dopamine agonist. Which of the following does NOT apply to your counseling and discussion on the medication you have chosen?

A. You explain to the patient that you are concerned, given her young age, that she may be more prone to have disabling levodopa related motor fluctuations with time.
B. You counsel the patient that starting a dopamine agonist now is paramount to slow her disease progression.
C. You discuss the risk of impulse control disorders as a side effect of dopamine agonists with the patient.
D. You discuss the risk of "sleep attacks" as a side effect of dopamine agonists

8. Which of the following patients with idiopathic Parkinson's disease would be considered the most suitable candidate for Globus Pallidus interna Deep brain stimulation treatment?

   A. A 47 year-old woman with 2 years of asymmetric resting tremor. She is on a regimen of pramipexole and amantadine and is satisfied with her quality of life.
   B. A 75 year-old man has had 10 years of gait difficulty, bradykinesia, freezing and asymmetric rest tremor. He is on high doses of levodopa. He has significant, disabling motor fluctuations due to his levodopa. In addition, he spends 4–5 hours per day in the off state. His wife reports that he is very depressed due to his current condition and has expressed "wanting to end it all".
   C. A 65 year-old woman has had 8 years of idiopathic Parkinson's disease symptoms including mostly tremor and bradykinesia. With her levodopa regimen, she is independent in her physical daily activities. She denies major motor fluctuations. She spends about 1 hour per day in the off-state. Her daughter accompanies her to this visit and reports recent visual hallucinations and missing bills.
   D. A 59 year-old woman has had 7 years of idiopathic Parkinson's disease symptoms. She is mostly affected by tremor and bradykinesia. With her levodopa regimen, she experiences significant, embarrassing levodopa-induced chorea. She is still working as a neurology professor. She also serves as a "life coach" and support to many patients in the Parkinson's disease community.

9. A 15 year-old boy presents to your clinic with abnormal movements. He reports that particularly at the end of the day, he notices that his right foot will plantar flex and invert in a sustained position. Symptoms are better in the morning. This has occurred for a few years now. You examine him as the last patient of the day and confirm this right lower extremity dystonia. Which of the following is the next reasonable consideration?

   A. Treatment trial of levodopa for hereditary primary generalized dystonia, DYT1
   B. Treatment trial of levodopa for hereditary parkinson's disease, LRRK2 mutation
   C. Treatment trial of levodopa for hereditary dopa responsive dystonia, DYT 5
   D. Treatment trial of levodopa for neuroleptic induced dystonia

10. You consult on a 25 year-old man in acute liver failure for abnormal movements. On examination, you notice the presence of green-brown ring on the upper part of the cornea. In addition, he has a "wing-beating" coarse, high amplitude tremor and chorea. Which of the following diagnostic tests will be LEAST specific in making his diagnosis?

    A. Liver enzyme tests
    B. Slit-lamp test

C. Genetic testing
D. Ceruloplasmin levels

11. A 55 year-old man presents with change in his walking to your visit. On examination, you immediately notice a slow, 4 HZ tremor at rest in the left hand asymmetrically. On tone evaluation, you notice an inconsistent resistance to passive movement (a resistance and then give repeatedly). His face does not show much expression. His gait is stooped with very small steps. When you pull backwards, he nearly falls before you are able to catch him. Which of the following is the most likely finding on brain pathology of this patient's condition?

A. Caudate nucleus atrophy
B. Loss of the dopaminergic neurons in the substantia nigra
C. Tau formation widespread in the cortex
D. Cerebellar torpedoes

12. A 52 year-old woman reports difficulty falling asleep at night due to a crawling sensation in her legs. The symptoms are worse at night, worse when lying down and improved when she gets up to walk around. Her husband has not noticed any abnormal movements in her sleep. Which of the following would NOT be a reasonable diagnostic or treatment step for this condition?

A. Sleep study (polysomnogram)
B. Iron studies in the blood
C. Initiation of a dopamine agonist, such as ropinirole
D. Reassurance that this condition is not known to increase the risk of a neurodegenerative condition

13. A 20 year-old woman is brought in by her college roommate for unusual behavior. She has been forgetting things and acting paranoid. On examination, she has constant grimacing movements of her face with a very withdrawn facial appearance. Her limbs are constantly in movement with involuntary occasionally jerky or dancer like movements. Her college roommate states that her father passed away with similar symptoms at age 30 and her paternal grandfather at age 40. Which of the following would be true regarding this patient's condition on brain pathology?

A. Caudate nucleus atrophy
B. Alpha-synuclein intracellular inclusions
C. Beta amyloid plaques in the cortex
D. Bunina bodies in the spinal cord

14. A 60 year-old man presents for evaluation of bradykinesia. He reports that for 3 years he has been slowing down. It started with falling frequently. More recently, he has noticed difficulty with his speech and even swallowing. His examination shows mild hypomimia. On testing of extraocular movements, it

appears that he has difficulty with upward saccades. On postural instability test, he almost falls until the examiner catches him. He does not have cogwheeling rigidity or tremor. He does appear to have axial rigidity with retrocollis. He has previously been tried on dopamine agonists which he had to stop due to side effects. He did not feel sustained benefit on the medications. Which of the following is the most likely diagnosis?

A. Corticobasal degeneration
B. Multiple System Atrophy- Parkinsonism subtype
C. Idiopathic Parkinson's Disease
D. Progressive Supranuclear Palsy

15. A 45 year-old woman presents with abnormal head posture. She reports that she tilts her head forward and to the right. She feels like there is a pressure to hold her head in this position. She has a trick where she is able to correct this position by touching her chin lightly on the left. She has previously been diagnosed with cervical dystonia. You suggest botulinum toxin injections as treatment. Which of the following is the mechanism of action of botulinum toxin?

A. Inhibits voltage gated calcium channels in the presynaptic nerve terminal which reduces the release of acetylcholine vesicles
B. Inhibits the binding of acetylcholine to docking proteins which reduces the release of acetylcholine vesicles
C. Blocks acetylcholinesterase allowing more acetylcholine to accumulate in the neuromuscular junction
D. Blocks post-synaptic acetylcholine receptors

Answers

1. The correct answer is C, Corticobasal Syndrome. The patient presents with a complaint consistent with the classic "alien limb phenomenon" associated with corticobasal syndrome. Other examination features include significant asymmetry, cortical sensory deficits and a coarse rest/action tremor. Choice A, Multiple Systems Atrophy, can be associated with prominent dysautonomic features. Choice B, Progressive Supranuclear Palsy, is classically associated with supranuclear gaze palsy (particularly vertical eye movements that can be overcome by cervico-ocular or vestibulo-ocular maneuvers), axial rigidity and early falls. Choice D, Lewy Body dementia, is classically associated with cognitive loss, parkinsonism and sensitivity to neuroleptic agents (McFarland 2016).

2. The next reasonable consideration for this patient would be C, reconsider the diagnosis. The presence of significant, early dysautonomia (orthostatic hypo-

tension) leading to early falls is unusual for idiopathic Parkinson's disease. Additionally, the patient reports lack of any response to a reasonable dose of levodopa. Therefore, answer choice D, would not be the *next best step* given the lack of response. Deep brain stimulation is an important consideration for prominent motor symptoms of idiopathic Parkinson's disease, but these are not the patient's primary concern. Neuropsychological testing is often utilized with Parkinson's disease patients in consideration of deep brain stimulation or prominent memory symptoms; neither of which is a reasonable *next best step* given these patient's symptoms (McFarland 2016).

3. The best choice is D. This patient displays onset of both early dementia and parkinsonism at the same time. In addition, he has classic cognitive fluctuations and visual hallucinations. These clinical characteristics are supportive of a diagnosis of Lewy Body Dementia. Choice A, levodopa, may be a reasonable choice given his parkinsonism. However, it may also worsen his bedtime hallucinations and caution should be used due to this. Choice B is not correct as prominent parkinsonism is not consistent with classic Alzheimer's disease. Choice C is not the next best step as deep brain stimulation is primarily accepted for motor symptoms of idiopathic Parkinson's disease (McFarland 2016).

4. The correct answer is D. This patient displays features of both cerebellar and dorsal column involvement. This pattern of features is seen in Friedrich's ataxia, most commonly. The age of onset is usually in the first 2 decades of life. It is caused by an autosomal recessive, triplet repeat expansion of GAA in the frataxin gene. Because of the autosomal recessive inheritance, many subsequent generations do not carry a disease-causing repeat expansion. Therefore, anticipation is not observed. Additional features include scoliosis, hypertrophic cardiomyopathy and glucose intolerance (Bidichandani and Delatycki 2017).

5. The correct answer is C. This patient has spinocerebellar ataxia type 2. This particular type of hereditary spinocerebellar ataxia is characterized by autosomal dominant inheritance. Like other triplet repeat disorders, the age of onset is inversely correlated to the number of repeats. Additionally, the number of repeats can be amplified in future generations, leading to earlier age of onset. This phenomenon is known as anticipation. Due to meiotic instability, this phenomenon of anticipation may be seen more often when the father passes on the genetic abnormality to his children. Choice A describes an X-linked genetic disorder. Choice B correctly shows the chance of inheritance, but the later age of onset is not consistent with anticipation. Choice D describes an autosomal recessive genetic condition (Pulst 2015).

6. The correct answer is A. This patient displays typical features for essential tremor. The tremor is fast, kinetic > postural, and noted in the chin and arm (parkinsonian tremors are slower and pill rolling). Additionally, there are no other parkinsonian features noted on examination (bradyphrenia, bradykinesia,

hypomimia, festinating or shuffling gait, en bloc turning or cogwheeling rigidity). Propranolol and primidone are considered first line treatment for essential tremor. Clonazepam can be considered if the first line medications are ineffective. Ropinorole (a dopamine agonist) and levodopa would be appropriate choices for a patient presenting with parkinsonian tremor (Louis 2016).

7. The correct answer is B. Unfortunately, no medications have been shown to slow the disease progression of idiopathic Parkinson's disease. Choice A is true and may be a reason why you pick either a dopamine agonist or anticholinergic rather than levodopa is an initial choice for motor symptoms. However, more recent evidence suggests that levodopa as an initial choice may also be reasonable. Choice C is true. Impulse control disorders such as "punding", gambling and pathologic shopping have been reported with dopamine agonists. Sleep attacks have also been reported (Morgan 2016).

8. The best answer is D. Choice A is not suitable given that her medications are effective and there is currently no evidence that early Deep brain stimulation offers benefit at this time. Choice B is not suitable due to the significant depression and concern for suicide which can worsen with deep brain stimulation. Choice C is not as suitable as choice D to the early concern for cognitive issues and visual hallucinations (Morgan 2016).

9. The correct answer is C. The young age of onset, lower limb foot dystonia and diurnal variation are most consistent with the diagnosis of dopa responsive dystonia. This is most commonly due to an autosomal dominant mutation in GTP (guanosine triphosphate) cyclohydrogenase deficiency. They are markedly improved with treatment of levodopa. Choice D is not correct as there is no history of neuroleptic use. Also, caution would be used with dopamine administration in a patient with a primary psychiatric disorder. Choice A and B are not correct as the patient does not have features of generalized dystonia or parkinsonism respectively. Parkinsonism can develop in patients with dopa responsive dystonia at a later age, but was not described in this patient (Malek 2016).

10. The correct answer is A. This patient is already in acute liver failure, therefore obtaining liver enzyme tests will not lead you to a specific diagnosis. Based on his symptoms of acute liver failure, chorea and coarse tremor, the concern is for Wilson's disease. Wilson's disease is due to an autosomal recessive mutation in the ATP7B gene leading to abnormal copper accumulation in the liver. Slit-lamp test may reveal the presence of Kayser-Fleischer rings, which are often present along with the neurologic manifestations of the disorder. Genetic testing is not considered a first line for diagnosis, but may reveal ATP7B mutation. Ceruloplasmin is expected to be low in patients with Wilson's disease, but can be normal in 5–10% of patients. However, it still has more specificity than liver enzyme tests in this situation (Pfeiffer 2016).

11. The correct answer is B. This patient has classic features of asymmetric rest tremor, cogwheeling rigidity, masked facies, postural instability and shuffling gait. The patient most likely has idiopathic Parkinson's disease, which is characterized by answer choice B, loss of dopaminergic neurons in the substantia nigra of the midbrain among other locations (Williams and Litvan 2013).

12. The correct answer is A, polysomnogram. A polysomnogram is not required to make a diagnosis of restless legs syndrome. Restless legs syndrome is a clinical diagnosis that occurs when the patient meets clinical criteria that include the urge to move the legs, worse in the evening, worse with recumbency and improved with movement, which the above patient meets. There is an association of restless legs syndrome with iron deficiency and it would be reasonable to evaluate this in the patient's serum. A first line agent for the treatment of RLS is a dopamine agonist which would be reasonable to start in this patient. At the current time, there is no evidence to suggest that RLS leads to neurodegenerative conditions (Wijemanne and Jankovic 2015).

13. The correct answer is A. This patient's symptoms are characterized by psychosis and hyperkinetic movement disorder with choreoathetosis. Her family history is suggestive of an autosomal dominant disorder, which displays anticipation. Anticipation is a characteristic of triplet repeat nucleotide disorders such as Huntington's disease. Each generation is affected at a younger age. Huntington's disease is characterized by caudate nucleus atrophy. Alpha synuclein intracellular inclusions are seen in Parkinson's disease. Beta amyloid plaques in cortex are seen in Alzheimer's disease. Bunina bodies in the spinal cord are seen in ALS (Govert and Schneider 2013).

14. The best answer is D, progressive supranuclear palsy. This patient displays many features consistent with progressive supranuclear palsy which is a tauopathy. The cardinal signs include difficulty with vertical gaze, axial rigidity and early falls. The lack of response and side effects with dopamine agonists are also characteristic for this neurodegenerative condition (dell'Aquila et al. 2013).

15. The correct answer is B. Botulinum toxin acts by inhibiting the binding of acetylcholine vesicles to docking proteins which reduces the release of acetylcholine into the neuromuscular junction. Answer A describes the action of autoantibodies in Lambert Eaton myasthenic syndrome. Answer C describes the action of pyridostigmine which is used to treat myasthenia gravis. Answer D describes the autoimmune pathophysiology of myasthenia gravis in causing weakness (Castelao et al. 2017).

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Neuromuscular Disorders

9

Questions

1. A 64 year-old woman presents to your clinic for slowly progressive muscle weakness. She reports since age 40 experiencing progressive weakness around her shoulders and hips. She reports that her daughter noticed similar symptoms. The patient, her daughter and granddaughter all sleep with their eyes partially open and have been teased about it by their family members. Her examination shows mild weakness of orbicularis oculi and oris. There is no ptosis and no extraocular movement impairment. She cannot whistle. She has asymmetric weakness of her right>left biceps and triceps with dorsiflexion weakness mildly in her lower extremities. When lying flat on her back, you ask her to lift her head up and her umbilicus moves rostrally (towards the head). When asked to push her arms straight against the wall, you notice prominent posterior and medial winging of her scapula. Reflexes, coordination and sensory examination are normal. Gait shows steppage. Which of the following findings are most likely to be found on the patient's genetic testing?

   A. The dystrophin gene will show a large deletion
   B. Autosomal dominant deletion in chromosome 4Q leading to reduced number of D4Z4 repeats
   C. Autosomal recessive deletion in chromosome 4Q leading to reduced number of D4Z4 repeats
   D. SMCHD mutation leading to reduced number of D4Z4 repeats

2. A 67 year-old woman with type 2 diabetes mellitus presents to your clinic with painful feet. She also has known nephropathy and retinopathy from her diabetes, which is uncontrolled. Her last hemoglobin A1C was 9.9. (Target level < 6%) She reports numbness, tingling and burning pain symmetrically in both feet. The onset was insidious and has been progressive in the last 5 years and has now

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https://doi.org/10.1007/978-3-030-11132-8_9

spread to just above both ankles. Pain level is 8/10. It is worse at night and she cannot stand the sheets to touch her feet. She is only taking Tylenol for the pain and it does not help. On neurologic examination, she has normal cranial nerves, strength and coordination examination. She has reduced sensation to all modalities below the ankle: light touch, proprioception, pinprick and vibration. Reflexes are normal throughout except for absent ankle jerks. Which of the following has NOT been shown to be effective for this type of neuropathic pain?

A. Pregabalin
B. Duloxetine
C. Mexilitine
D. Nortriptyline

3. A 35 year-old chef presents with 2 months of painless right wrist drop. He does not recall any occasion where he may have slept with his arm over a chair. He denies any new numbness associated with these symptoms. He does report that 4 months ago, he developed a left footdrop. This was also painless and has been improving without any intervention. There was no numbness at that time either. He denies any neck or back pain. He has no family members with similar symptoms. His examination shows significant weakness (4/5 MRC grade) in right wrist extension (wrist drop), finger extension and brachioradialis sparing the triceps muscle. All other muscle groups are normal in the right arm. The left lower extremity shows mild weakness (4+/5 MRC grade) in left dorsiflexion, eversion and extensor hallucins longus sparing plantar flexion and inversion. Sensory exam is normal and symmetric to all modalities in the upper and lower extremities. Cranial nerves, reflexes and coordination are normal. Gait shows mild steppage on the left. There is no evidence of pes cavus. You send the patient for electrodiagnostic studies (EMG and nerve conduction studies). The studies shows pure radial motor involvement with conduction block at the spiral groove and pure peroneal motor involvement with conduction block at the fibular head. The left superficial peroneal sensory and right radial sensory responses are normal. Laboratory studies reveal a positive anti-GM1 titer of 1:64000. Which of the following would be the most appropriate next step?

A. Intravenous Steroids 1000 mg daily × 5 days
B. Intravenous Immunoglobulin 2 grams/kilogram divided over 5 days
C. Referral to physical therapy
D. Plasma Exchange

4. A 36 year-old woman presents with right wrist drop. She reports that her 5 year-old daughter sleeps with her and will often fall asleep in the crook of her arm. One morning, 2 months ago, she awoke with numbness and weakness of her right wrist and could not lift up the wrist. When inquired whether this had ever happened before, the patient reported that she had multiple prior nerve surgeries. This included a right carpal tunnel release, right ulnar nerve release and left

peroneal nerve release. She denies any family members with similar symptoms. Neurologic examination shows normal cranial nerves and coordination. Strength examination shows mild weakness in right abductor pollicis brevis, right intrinsics, right first dorsal interosseous, left foot dorsiflexion, left foot eversion and left extensor hallucis longus. The patient reports all these areas of weakness are due to her old nerve injuries and surgeries and have improved with time. Her new findings included weakness in right brachioradialis, wrist extension and finger extension, sparing the triceps. Her sensory examination shows reduced pinprick and light touch in the right median sensory, right ulnar sensory, right radial sensory and left superficial peroneal nerve distributions. Reflexes are normal. Gait shows mild left steppage. You note pes cavus and hammer toes. Patient reports her father has similar feet. You proceed to perform electrodiagnostic studies (electromyogram and nerve conduction studies), which show multiple areas of compression neuropathies in entrapment sites (right median nerve at the wrist (carpal tunnel), right ulnar nerve at the elbow, right radial nerve at the spiral groove and left peroneal nerve at the fibular head). Which of the following abnormalities would likely be found on laboratory testing?

(a) Vitamin B12 level of 100, Methylmalonic acid level of 35,000
(b) Anti-GM1 + titer of 1:64000
(c) Peripheral myelin protein 22 deletion
(d) Myelin protein zero mutation

5. A 48 year-old woman with recent diagnosis of stage 3 ovarian cancer is admitted to the hospital for progressive weakness. She and her husband report that over the last 4 months, she has noticed progressive weakness in her arms and legs. She is now unable to lift her arms overhead and unable to walk up the stairs or get up from a chair. She denies any numbness or tingling. Her neurologic examination shows normal cranial nerves, sensation and reflexes. Her strength examination shows moderate, symmetric, proximal weakness (4−/5 MRC score) with relative sparing of the distal muscles in the upper and lower extremities. You also notice the presence of dry patches on the extensor surfaces of her elbow, metacarpophalangeal, distal interphalangeal and proximal interphalangeal joints. There is also the presence of small ulcerations in the periungual area. She has violaceous coloring around both eyes and erythema in the neckline. When you point out all these skin findings, the patient and her husband report they are all new. Which of the following statements regarding this case are NOT true?

A. Her weakness is probably related to the last chemotherapy agent she received for her ovarian cancer.
B. Her weakness is probably related to her underlying malignancy
C. Muscle biopsy may show features of perifascicular atrophy
D. Creatine kinase levels are likely to be moderately elevated, such as a CK of 600

6. A 66 year-old woman presents with painful muscles and weakness. She was recently hospitalized for an acute myocardial infarction and found to have 95% blockage of the left anterior descending artery on her coronary angiogram requiring angioplasty and stenting. During this hospitalization, she was also found to have type 2 diabetes mellitus. She started several new medications during her hospitalization including aspirin 81 mg daily, clopidogrel 75 mg daily, metformin 500 mg twice daily, amlodipine 10 mg daily, metoprolol 25 mg twice daily and simvastatin 40 mg daily. Her neurologic examination shows proximal, symmetric, mild weakness (MRC grade 4/5) in her upper and lower extremities, sparing the distal muscles. Cranial nerves, coordination, sensory exam and reflexes are normal. Gait is mildly waddling. She demonstrates some effort to get up out of the examination chair. Laboratory testing reveals creatine kinase levels of 700 with an upper limit of normal of 210. Which of the following medications is the most likely cause of the patient's symptoms?

   A. Amlodipine
   B. Metformin
   C. Simvastatin
   D. Clopidogrel

7. A 54 year-old woman with untreated hepatitis B is admitted to the hospital with difficulty walking. She reports about 2 weeks onset of painful numbness, tingling and weakness in her right upper extremity. Then a few days ago, she developed similar symptoms of painful numbness, tingling and weakness in her left lower extremity. She reports daily fevers and significant weight loss during this time. She had a temperature of 102 degrees farenheit, blood pressure of 110/70, pulse of 105 and respiratory rate of 15 during her evaluation. She appears ill and in pain. Her cranial nerves and coordination are normal. On strength examination of her right upper extremity, there is moderate weakness (MRC grade 4/5) in her right flexor carpi ulnaris, flexor digitorum profundus digits 4,5, first dorsal interosseous and intrinsics. The remaining muscle groups are normal in the right upper extremity. Her left lower extremity shows moderate weakness in knee flexion, dorsiflexion and plantar flexion. Sensation shows reduced pinprick and light touch in the right upper extremity palmar surface 4th and 5th digits. There is also reduced sensation in the left lower extremity in the posterolateral calf, anterior shin, dorsum of the foot and plantar surface of the foot. All reflexes are normal except for an absent left ankle jerk. Which of the following would NOT be considered appropriate testing to obtain a diagnosis?

   A. MRI of the cervical, thoracic and spinal cord with and without contrast
   B. Electromyography and nerve conduction studies
   C. Left sural nerve Biopsy
   D. Serology for erythrocyte sedimentation rate

8. A 55 year-old man is seen in consultation. He reports painless, progressive weakness of his left upper extremity for at least a few months. He denies sen-

sory symptoms. His neurologic examination shows weakness in his left wrist extensors and finger extensors, sparing the triceps. Other muscle groups are intact. Reflexes and sensory examination are normal. He has changed jobs about 3 years ago and now lives in a rural farmhouse on his own. He brought in some recent routine bloodwork from his primary care physician. Hemoglobin is 9. Mean corpuscular volume is normal at 88. Peripheral blood smear results shows basophilic stippling. Which of the following is the most likely cause of his left wrist drop?

A. Idiopathic neuralgic amyotrophy or parsonage turner's syndrome
B. Lead poisoning
C. Radial nerve entrapment at the spiral groove
D. Acute intermittent porphyria

9. A 32 year-old woman presented to the hospital with significant abdominal pain and vomiting. She had been feeling generally "unwell" for at least 6–8 weeks. After an extensive evaluation for her gastrointestinal symptoms and treatment of her severe abdominal pain, no etiology was found for her abdominal pain. The primary team was considering transferring the patient from the intermediate care unit to a regular bed in anticipation of discharge. That evening, the patient became hypotensive and tachycardic. Her blood pressure was 65/40 with a heart rate of >130. She was transferred to the intensive care unit emergently. Her basic metabolic panel showed significant hyponatremia of 116. Her urine pregnancy test was positive. After stabilization of her blood pressure with IV fluids, she suffered from a 60 second, generalized tonic-clonic seizure. The next day, the neurology team was consulted as the patient remained confused for more than 10 hours after the seizure.

   On neurologic exam, patient was confused and groaning. She did not follow commands. She had significant weakness of all 4 extremities distally and proximally. Her reflexes were absent throughout except 2+ at her ankles. She attempted to withdraw from painful stimuli in all 4 extremities. Given the significant weakness, electromyography and nerve conduction studies were performed. The electrodiagnostic studies showed a significant acute, axonal motor neuropathy.

   Which of the following statements pertaining to this patient would be considered TRUE?

A. This patient most likely has the AMAN (acute motor axonal neuropathy) variant of Guillain Barre syndrome. Seizures are a common manifestation of this condition.
B. This patient most likely has an acute presentation of myasthenia crisis. This was likely precipitated by her pregnancy.
C. This patient most likely has presented with an episode related to acute intermittent porphyria. This was likely precipitated by her pregnancy.
D. This patient most likely has suffered pituitary apoplexy and hemorrhage. This condition was likely precipitated by her pregnancy.

10. A 63 year-old Vietnamese man presents with painful and progressive burning feet. His symptoms have been present for 2 years. He also reports significant diarrhea alternating with constipation. He has occasionally passed out when getting up too quickly from a seated or standing position. Examination shows normal cranial nerves. Strength is normal except for distal, symmetric weakness. Sensory examination shows reduced sensation in a stocking-glove distribution to all modalities. Reflexes are absent at the ankles but 2+ and symmetric in bilateral biceps, brachioradialis, triceps and patella. Which of the following causes of progressive polyneuropathy also has significant, early autonomic involvement?

    A. Charcot Marie Tooth 1A due to peripheral myelin protein 22 duplication
    B. Multiple systems atrophy
    C. Multifocal motor neuropathy
    D. Hereditary amyloidosis due to transthyretin mutation

11. A 54 year-old man with diabetes presented to the ER. He was in his usual state of health until 3 days ago. He started to notice tingling in his fingertips at that time. Two days ago, he noticed that he was dragging his feet as he walked and today he noticed that he could not lift his arms overhead. He recently traveled to India to visit family and experienced a bout of diarrhea 10 days ago which has resolved. On your examination, you notice that he cannot close his eyes completely and also has labial dysarthria. He is weak throughout, proximally and distally. You cannot obtain reflexes. He has reduced sensation to light touch in a stocking & glove distribution. The ER physician suggests performing a lumbar puncture to assist with the diagnosis. Which of the following findings would be most likely in this patient? (Normal values: CSF 0–5 White Blood Cells (WBC), 0–5 red blood cells (RBC), 15–45 Protein, 50–100 Glucose)

    A. 4 WBC 3 RBC 78 Protein 100 Glucose
    B. 58 WBC 4 RBC 100 Protein 98 Glucose
    C. 0 WBC 0 RBC 35 Protein 200 Glucose
    D. 100 WBC 0 RBC 55 Protein 20 Glucose

12. A 38 year-old previously healthy woman presented with acute, ascending weakness and paresthesias for 1 week. She had difficulty walking when she came to the emergency room. Examination showed flaccid areflexia, symmetric proximal and distal weakness. An electrodiagnostic test (electromyography and nerve conduction studies) showed a demyelinating neuropathy. Which of the following choices would not be consistent with acceptable steps/treatments for this patient's condition?

    A. Admit patient to telemetry bed to monitor for dysautonomia
    B. Administer Methylprednisolone 1000 mg IV daily × 5 days with a prolonged steroid taper

C. Administer IVIG (Intravenous Immunoglobulin) 2 grams/kilogram given over 5 days
D. Administer Plasma Exchange 5 cycles administered over 7–10 days

13. A 21 year-old woman presents with at least 3 years of double vision. Her symptoms are worse at the end of the day and improve with a nap. Closing one eye makes the double vision resolve. Her boyfriend has noticed that occasionally her right eyelid will droop. However, she notices the eyelid drooping can also occur in the left eyelid. Examination shows fatiguable ptosis of the right eyelid on your testing after 2 minutes of sustained upgaze. Her pupils are equally round and reactive to light and accommodation. Her extraocular movements show some restriction of lateral gaze on the right eye. Otherwise, her remaining cranial nerves, motor examination, sensory examination, reflexes, coordination and gait are normal. Direct fundoscopy examination is normal. You leave the room to work on your note and present to your attending. When you return, the patient has been napping for 30 minutes. On your attending's examination, the extraocular movements are full. Otherwise, the attending finds the same neurologic exam findings that you did. Which of the following tests would be most likely (most sensitive) in diagnosing her condition?

A. MRI brain with and without contrast with orbital cuts
B. Lumbar puncture with opening pressure measurements
C. Serum testing for acetylcholine receptor antibodies
D. Electromyography testing with repetitive nerve stimulation
E. Single Fiber EMG Testing

14. A 68 year-old man presents with subacute, progressive weakness over 8 months. He reports difficulty in combing his hair, gripping a pencil and getting up from a seated position. His examination shows mild weakness in bilateral deltoids, biceps and profound wrist flexion/finger flexion weakness. You note atrophy in his forearm flexor compartment. On his lower extremities, he has significant weakness in hip flexion and knee extension bilaterally with noticeable atrophy in vastus medialis and lateralis. Reflexes are normal. Sensory examination is normal. Gait is waddling. He was previously diagnosed with inflammatory myopathy by an outside physician and treated with high dose prednisone and IVIG without improvement. Creatine kinase levels were 544. He denies ever being on statin medications. There is no rash noted on skin examination. You recommend a muscle biopsy. Which of the following diagnoses are most likely?

A. Myotonic dystrophy
B. Polymyositis
C. Dermatomyositis sine derme
D. Inclusion body myositis
E. Statin associated myopathy

15. A 4 year-old boy presents with toe-walking to a pediatric neurology clinic. On your examination, you have him sit on the floor and note that he uses his hands to climb up his body to get to a standing position. You also notice large calves. Creatine kinase levels from his local pediatrician were 10,000. Normal values at your laboratory are less than 143. He has a normal sensory exam and normal reflexes. Which of the following options would NOT be a well-studied intervention considered at some point in this boy's future?

    A. Corticosteroids
    B. Intravenous immunoglobulin serially
    C. Afterload reduction (ACE inhibitors/ARBs) for systolic dysfunction on cardiac echos
    D. Non-invasive positive pressure ventilation nocturnally

16. You see a 35 year-old woman with seropositive (Acetylcholine receptor binding antibodies), generalized myasthenia gravis, diagnosed for 3 years. She is doing well on pyridostigmine 60 mg every 6 hours while awake and low dose prednisone 10 mg daily. She currently denies any ptosis or diplopia. However, she does report both symptoms if she misses her pyridostigmine dose. Her examination shows fatiguable right eye ptosis, normal extraocular movements and fatiguable, symmetric proximal weakness. Examination shows normal sensation, gait and reflexes. Which of the following is the mechanism of action of pyridostigmine in improving the patient's symptoms in myasthenia gravis?

    A. Pyridostigmine acts by blocking the presynaptic release of acetylcholine
    B. Pyridostigmine acts by reducing the complement-mediated destruction of acetylcholine receptors in the post-synaptic membrane
    C. Pyridostigmine acts by reducing the action of acetylcholinesterase
    D. Pyridostigmine acts by activating choline acetyltransferase and allowing the components of acetylcholine to be cycled back into the synaptic bouton

17. A 40 year-old man reports 8 months of dysathria and dysphagia. He has also noticed muscle twitching and weakness in his limbs as well. His wife reports that he occasionally cries unexpectedly which is uncharacteristic for him. His examination shows tongue atrophy, active fasciculations and lingual dysarthria with a spastic component. He has weakness in his left arm and leg including fasciculations in his left quadriceps and left triceps. His reflexes are brisk throughout and demonstrated + Babinski reflexes bilaterally, crossed adductors at the knee and bilateral Hoffman's sign. He has and MRI brain, cervical, thoracic and lumbosacral spine imaging which are normal. Which of the following is true regarding this patient's diagnosis?

    A. With time, the patient can expect progressive weakness of all muscles including his urinary sphincter, which will lead to flaccid urinary incontinence

B. With time, the patient can expect continued progression of involvement of anterior horn cells and sensory neurons leading to a sensory ataxia
C. There is enough evidence at this time to recommend stem cell therapy for this patient
D. Noninvasive positive pressure ventilation or bilevel positive airway pressure (BiPAP) has been shown to improve survival and quality of life in these patients

18. A 28 year-old man presents with change in his gait. He reports for the past several years, his feet have been slapping on the floor as he walks. He also notes pain all over his body. Examination shows temporalis wasting and frontal balding. He has mild weakness of both orbicularis oculi and orbicularis oris. Examination shows distal more than proximal weakness symmetrically in his arms and legs. When testing finger flexors, it is difficult for the patient to let go once he grasps your hand. Reflexes and sensation are normal. Gait shows mild steppage. Which of the following would be true of the diagnostic test for this condition?

A. A paraneoplastic profile may show the causative autoantibody
B. Genetic testing for chromosome 3 should show the tetranucleotide repeat causing this condition
C. Genetic testing in chromosome 19 should reveal the trinucleotide repeat causing this condition
D. Heavy metal testing may demonstrate the etiology

19. A 56 year-old man with 100 pack year smoking history, hypertension and diabetes reports slowly progressive weakness over the past several months. He denies rash. His examination shows absent reflexes initially. His strength examination shows proximal, symmetric weakness in bilateral deltoids, elbow flexion and hip flexion. His strength seems to improve with repeated testing. Subsequently, your attending rechecks the reflexes and is able to obtain them without difficulty. Otherwise, sensory, cerebellar and cranial nerve examination are normal (no ptosis or diplopia). Which of the following would NOT be considered as an appropriate diagnostic step to be ordered next in this patient?

A. Serum paraneoplastic profile to identify a causative etiology
B. Electromyography and nerve conduction studies with repetitive nerve stimulation at slow rates (2 HZ) and fast rates (10 HZ)
C. CT chest without contrast to evaluate for a mass
D. Muscle biopsy to evaluate for myositis

20. A 15 year-old girl presents with progressive weakness and changes in her feet. She met all her motor milestones on time. Her examination shows symmetric, distal weakness in her feet more than hands. Reflexes are absent throughout. Sensory examination reveals stocking-glove distribution loss to all modalities. Gait shows mild steppage bilaterally. Cerebellar and cranial nerve examination is normal. She is sent to electrodiagnostic studies on the same day of the visit,

which reveal nerve conduction velocities of 20–25 meters/second in all tested motor nerves and absence of all sensory nerves. (Normal nerve conduction studies in the upper extremities are >50 meters/second and in the lower extremities >40 meters/second). Which of the following is likely to be found on her genetic testing?

A. Superoxide dismutase mutation
B. Peripheral Myelin protein 22 deletion
C. Peripheral myelin protein 22 duplication
D. Myelin protein zero deletion

Answers

1. The correct answer is B. This patient shows a classic presentation for fascioscapulohumeral muscular dystrophy (FSHD). Clinical features include muscle weakness in the facial, scapular and humeral regions (relatively sparing the deltoids) in an asymmetric pattern. In addition, there is often proximal lower extremity or tibialis anterior (dorsiflexion) involvement as well. There is often involvement of the thoracic musculature (sparing the upper abdominal muscles). This pattern of thoracic musculature involvement leads to the Beevor's sign, which is described above (umbilicus moves towards the head when the patient lies flat and lifts up the head). There are sometimes extramuscular manifestations such as Coats disease (retinal involvement-1%), peripheral telangiectias (up to ¼), respiratory involvement (up to 13%) or cardiac involvement. There are primarily 2 genetic etiologies that cause FSH. FSHD1 (the majority of patients) is caused by an autosomal dominant deletion in chromosome 4Q which leads to a reduced number of repeats in the D4Z4 region and leads to expression of a toxic gain-of-function protein called DUX4. (Therefore choice C is incorrect as it reports the genetics as autosomal recessive, which is not described in the clinical stem). FSHD2 (smaller proportion of patients) is caused by digenic genetic abnormalities: mutation in SMCHD1 that leads to significant hypomethylation along with a permissive allele in chromosome 4Q. Choice A describes Duchenne or becker muscular dystrophy, which is X-linked and therefore would not be a consideration in this clinical stem. Duchenne and Becker muscular dystrophy are the most common muscular dystrophies in the United States (Statland and Tawil 2016).

2. The correct answer is C The clinical stem describes a typical patient with distal, symmetric, painful, polyneuropathy from diabetes. Mexilitine has not yet been shown to be effective for the treatment of diabetic neuropathic pain. It's mechanism of action is the blocking of sodium channels. Pregabalin is a gaba analogue that primarily acts by binding to the alpha 2 delta subunit of calcium channels, leading to anti-nociceptive effects. Duloxetine is an SNRI (serotonin and norepinephrine reuptake inhibitor). Nortriptyline is a tricyclic antidepressant that is also used for neuropathic pain (Waldfogel 2017).

3. The correct answer is B. This patient has a classic presentation for a rare, immune-mediated, multifocal motor neuropathy (MMN). This is characterized by multifocal motor conduction blocks. 60–80% of patients have the presence of anti-GM1 antibodies. The only treatment with support from randomized controlled trials is IVIG. There are some case reports of corticosteroids worsening MMN. Case reports do not support efficacy of plasma exchange for MMN. Choice C (referral to physical therapy) would be inappropriate as there is a proven treatment for this condition (Nguyen and Chaudhry 2011).

4. The correct answer is C. This patient has signs of multiple entrapment neuropathies at compression sites. Given her young age and pes cavus, there is a suspicion for HNPP, hereditary neuropathy with liability to pressure palsies. HNPP is caused most commonly by a deletion in PMP-22. Choice A can cause a polyneuropathy or myeloneuropathy with involvement of dorsal columns and corticospinal tract. Choice B would be associated with either multifocal motor neuropathy (not consistent with the case due to prominent sensory involvement) or Guillain Barre syndrome. Choice D is consistent with a form of hereditary polyneuropathy, Charcot-Marie-Tooth. It is often symmetric and can be either demyelinating (CMT 1B) or axonal (CMT type 2) (Bird 2014).

5. The correct answer is A. This patient has typical features of dermatomyositis, which is not likely related to any chemotherapy agent. Statement for B is likely to be true. There is a known increased risk of malignancy with dermatomyositis. The tumors can occur within 2 years before or after the appearance of dermatomyositis. The incidence of cancer ranges from 6–45%. Statement for C is also true. Pathognomonic, histopathologic features of dermatomyositis include a pattern of atrophy that surrounds the fascicles, perifascicular atrophy. Statement D is also true, creatine kinase levels are moderately elevated in dermatomyositis (Mammen 2016).

6. The correct answer is C. Statins (HMGCoA reductae inhibitors) are important for the lowering of cholesterol levels in patients with significant vascular risk factors. However, statin-related toxic necrotizing or immune-mediated myopathy is a serious concern. The risk of statin-induced myopathy is increased with age, dose of medication and concurrent administration of certain medications. Medications that when co-administered with statins can lead to increased risk of myopathy include fibrates, amlodipine, amiodarone and ezetimibe (Katzberg and Kassrdijan 2016).

7. The correct answer is A. This patient's history and physical exam are concerning for mononeuritis multiplex, which is a lower motor neuron condition. There are no clinical features or examination findings to suggest upper motor neuron involvement. The examination, along with systemic features of weight loss and fevers are concerning for vasculitis. With the history of hepatitis B, concern would be high for polyarteritis nodosa (which can affect the small and medium sized vessels). Choice B, electromyography and nerve conduction studies would

be considered an appropriate next step. This would likely reveal involvement of the right ulnar nerve (sensory and motor) and the left sciatic nerve (sensory and motor), consistent with multiple mononeuropathies. The left sural nerve biopsy may reveal transmural inflammation and vessel wall destruction, consistent with vasculitic neuropathy or supportive of pathologic diagnosis of mononeuritis multiplex. Serology for ESR (erythrocyte sedimentation rate) is expected to be elevated (Schaublin et al. 2005).

8. The correct answer is choice B, lead poisoning. This patient recently moved to a rural farmhouse. His source of water could be inquired which may have been contaminated by lead. The basophilic stippling and pure motor neuropathy are clues to lead poisoning. Lead poisoning can be treated with chelators. Answer choice A does not fit this story. Often, idiopathic hereditary neuralgic amyotrophy begans with the onset of pain, followed by numbness and weakness. Patient does not report many sensory symptoms and the distribution of the weakness appears to be restricted to the left radial nerve. Choice C is an anatomic possibility. However, it would not explain the "basophilic stippling" on the patient's peripheral blood smear. Additionally, a radial nerve entrapment at the spiral groove usually involves the sensory distribution of the radial nerve, which was spared in this question stem. Acute intermittent porphyria would generally cause a more widespread motor axonal neuropathy. It also often presents with a distribution of non-neuropathic symptoms such as abdominal pain, hyponatremia, confusion and even seizures (Pickrell et al. 2013).

9. The correct answer is C. This patient has a classic presentation for acute intermittent porphyria, one of the hepatic porphyrias. Answer choice A is a diagnostic possibility, but it is not true that seizures are a common manifestation of Guillain Barre Syndrome. Answer choice B is not the correct choice. Myasthenic crisis does not explain her extramuscular manifestations. It also does not explain her absent reflexes. Answer choice D is not true. It does not explain her loss of reflexes are acute axonal motor neuropathy on electrodiagnostic testing (O'Malley et al. 2018).

10. The correct answer is D. Of the above choices, hereditary amyloidosis due to transthyretin mutation causes both a progressive polyneuropathy and has early, significant involvement of autonomic fibers as described in this patient. Choice A does cause a slowly progressive sensory-motor polyneuropathy, but without significant autonomic involvement early. Choice B, multiple systems atrophy has early autonomic involvement, but does not have a prominent progressive polyneuropathy related to it. Choice C, multifocal motor neuropathy does not classically have length-dependent polyneuropathy. Additionally, it does not have early and significant autonomic involvement (Loavenbruck et al. 2016).

11. The correct answer is A. This patient most likely has the Guillain-Barré Syndrome. This is the most common cause of acute, flaccid, neuromuscular

paralysis in the United States. The history of antecedent infection (diarrhea-associated with Campylobacter Jejuni or a respiratory infection) can be found in up to 60% of cases. The lumbar puncture in GBS tends to reveal classic albuminocytologic dissociation (found in up to 75% of GBS cases-only about 50% in first week and increasing in the subsequent 2 weeks), WBC count that is normal and elevated protein, answer choice A. Answer choice B shows a mildly elevated WBC count and elevated protein, which can be seen in viral CNS infections (such as HIV among either viral infections) and should prompt other diagnostic considerations. Answer choice C shows an essentially normal CSF profile except for glucose which is elevated. This CSF profile may be seen in a diabetic patient with high serum sugars. (In general CSF glucose is about 2/3 of serum glucose). Answer choice D with elevated WBC, elevated protein and very low glucose may be suggestive of tuberculosis CNS infections, among other possibilities; and would not be expected in this patient (Willison et al. 2016).

12. The correct answer is B. This patient most likely has Guillain-Barré syndrome. IVIG and Plasma exchange have been shown in randomized controlled trials to be equally effective for the treatment of GBS and improving outcomes. It is recommended to admit Guillain-Barré syndrome patients to at least telemetry monitoring to monitor for dysautonomia ("Randomised trial of plasma exchange, intravenous immunoglobulin, and combined treatments in Guillain-Barre syndrome. Plasma Exchange/Sandoglobulin Guillain-Barre Syndrome Trial Group," 1997; Yuki and Hartung 2012).

13. The correct answer is E. This patient most likely has ocular myasthenia gravis. Most patients with myasthenia gravis will present with ocular symptoms prior to generalization (involvement of other muscles). However, after a patient has restricted ocular symptoms for 2–3 years, it is very unlikely they would generalize. The most sensitive test to diagnose ocular myasthenia gravis is single fiber electromyography. This is an electrodiagnostic test designed to measure communication between muscle fiber action potential pairs, consider >93% sensitive for ocular MG, particularly when performed in a weak muscle. For ocular myasthenia gravis, most practitioners will test for acetylcholine receptor antibodies. However, these antibodies are only found in 50% of patients with ocular MG. Electromyography (EMG) testing with repetitive nerve stimulation is also 50% sensitive in diagnosing ocular MG. A lumbar puncture with opening pressure evaluation would be important in pseudotumor cerebri or idiopathic intracranial hypertension. Pseudotumor tends to present with transient visual obscurations (particularly with maneuvers that increase intracranial pressure such as Valsalva or bending over), can cause papilledema on fundoscopic examination and occasionally bilateral 6th nerve palsies due to intracranial pressure and the long course of the 6th cranial nerves intracranially. However, the fatiguability and ptosis are not characteristic features. MRI brain with and without contrast with orbit cuts may be helpful if the patient presented with subacute,

painful visual loss (such as optic neuritis) or concern for demyelinating central nervous system disease such as Multiple Sclerosis (Gilchrist et al. 1994).

14. The correct answer is D. This patient has a very classic pattern of weakness for inclusion body myositis with predilection for wrist flexors, finger flexors, and quadriceps out of proportion to other muscle groups. The findings of lack of response to treatment would be unusual for either dermatomyositis or polymyositis. There is no history of prior statin use to suggest statin myopathy. Myotonic dystrophy is the most common muscular dystrophy in adults, but would be unusual to present in such a subacute and rapid manner at the age of 68. Additionally, there is no description of myotonia on the clinical examination (Amato and Greenberg 2013).

15. The correct answer is B. This boy presents with significantly elevated creatine kinase levels, calf pseudohypertrophy and a Gower's maneuver. He likely has Duchenne's muscular dystrophy (DMD), which is the most common muscular dystrophy. It is X-linked and due to a large deletion in the DMD gene leading to a complete absence of dystrophin muscle biopsies. Well-studied interventions for these patients include corticosteroids, which, if tolerated can prolong ambulation for 1–3 years. Serial echocardiograms, usually in multidisciplinary clinics, monitor for systolic cardiac function which is most commonly found. In the case of systolic dysfunction, cardiologists may be prescribe ACE inhibitors or ARBs for afterload reduction. Noninvasive positive pressure ventilation for nocturnal hypoventilation increased the proportion of DMD patients surviving to age 25. The option above that is not studied for DMD is intravenous immunoglobulin and does not currently have a role in the treatment of Duchenne's muscular dystrophy (Eagle et al. 2002; Fenichel et al. 1991; Flanigan 2014; Mendell et al. 1989; Viollet et al. 2012).

16. The correct answer is C. In answer A, the action of blocking the presynaptic release of acetylcholine is characteristic of botulinum toxin. In answer B, there is no medication that is known to reduce the complement-mediated destruction of acetylcholine receptors in the post-synaptic membrane (Gilhus and Verschuuren 2015).

17. The correct answer is D. This patient most likely has sporadic amyotrophic lateral sclerosis based on his combined upper and lower motor neuron involvement. In general, ALS selectively spares some certain motor neuron such as Onuf's nucleus which controls the urinary sphincter and flaccid urinary incontinence is not a typical feature. As a rule, ALS does not generally have sensory involvement. Stem cell therapy is currently being studied in trials, but there is not enough evidence to make a recommendation at this time except as a participant in a clinical trial. BiPAP has been shown to improve survival and quality of life (Mitsumotoet al. 2014; Tiryaki and Horak 2014).

18. The correct answer is C. Myotonic dystrophy is the most common muscular dystrophy in adults. It is due to a trinucleotide repeat expansion in chromosome 19. Classic features are clinical myotonia (as described with difficulty letting go of grasp in the question), distal weakness and mild facial weakness. Besides the temporalis wasting and frontal balding, other non-motor manifestations include cataracts, arrhythmias and endocrine abnormalities (impaired glucose tolerance, impaired infertility, etc) (Thornton 2014).

19. The correct answer is D. It would not be reasonable as a NEXT step to order a muscle biopsy at this time. This patient likely has a paraneoplastic neuromuscular junction disorder, classically Lambert Eaton Myasthenic Syndrome. P/Q type calcium channel antibodies can be found in most patients, up to 90%. EMG and NCS would reveal characteristics findings of decrement on slow rate stimulation and increment on fast rate stimulation. A CT chest without contrast would be reasonable because of the patient's significant smoking history and the association of Lambert Eaton Myasthenic syndrome with small cell lung cancer (Titulaer et al. 2011).

20. The most likely finding on her genetic testing would be C, Peripheral myelin protein 22 duplication (PMP 22 duplication) on chromosome 17. Superoxide dismutase mutation can be found in a small subset of familial ALS patients, about 10%. PMP 22 deletion is found in patients with hereditary neuropathy and liability to pressure palsies. Myelin protein zero deletion can be found in patients with Charcot Marie tooth, but is less common than PMP-22 duplications which make up 70–80% of all CMT patients (Harel and Lupski 2014).

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Spinal Cord/Cauda Equina

10

Questions

1. A 31 year-old woman presents to the ER with weakness of her bilateral lower extremities, difficulty with urination and constipation for 3 days, which is unusual for her. A post-void residual Foley catheterization reveals 1 liter of urine. On examination, she has a sensory level to her umbilicus, weakness in her bilateral lower extremities (proximally and distally), and clonus at her bilateral ankles. Her rectal tone is reduced. Examination of her upper extremities includes normal strength, sensation and reflexes. Which of the following is the next best step for this patient?

   A. Lumbar puncture
   B. Electromyography and nerve conduction studies
   C. MRI of the lumbar spine with and without contrast
   D. MRI of the thoracic spine with and without contrast
   E. MRI of the sacral spine with and without contrast

2. A 42 year-old woman presents with difficulty walking and numbness/tingling. She underwent gastric bypass surgery 10 years ago and has not been compliant with diet instructions since then. She lost 200 pounds with her surgery. Her examination shows sensory loss to vibration and proprioception in a stocking-glove distribution with hyperreflexia in her bilateral upper extremities and patella (with crossed adductors). Her ankle jerks are absent. Strength examination shows mild weakness in bilateral dorsiflexion, plantar flexion, toe flexion and toe extension. Gait has both steppage and some spasticity observed. Cerebellar examination is normal. Some of her laboratory studies are pending. However, her hemoglobin is slightly low at 10.4 grams/deciliter with an MCV of 118. Her methylmalonic acid is quite elevated at 1000. MRI of the cervical spine shows non-enhancing hyperintensities in the posterior and lateral spinal cord. Which of

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the following is the most likely etiology of the patients' symptoms, examination, available laboratory test results and imaging?

A. Zinc deficiency
B. Copper Deficiency
C. Cobalamin Deficiency
D. Thiamine Deficiency
E. Neurosyphillis

3. A 45 year-old veteran presents to the emergency room with severe back pain and fevers. He has chronic lower back pain, but he reports this current pain is more severe and in a different location. His temperature on admission is 102 degrees Farenheit. Initial laboratory studies show a WBC count of 16 k with a leftward shift and elevated ESR of 102. His examination shows severe point tenderness to palpation in the thoracic spine region of the spinal cord. Reflexes are hyperactive, including upgoing plantar responses. Sensation is lost at the level of the umbilicus. Which of the following is the most appropriate treatment for this condition?

A. Surgical decompression
B. High dose steroids
C. IV antibiotics
D. CT myelogram

4. A 32 year-old medical student presents with acute, severe, lower back pain radiating to the bilateral posterior thighs. Her neurologic examination shows normal strength, sensation and reflexes. She came to the emergency room because she had read about a spinal emergency called cauda equina syndrome. Which of the following is NOT true regarding cauda equina syndrome?

A. It is a lower motor neuron disorder
B. It can cause both urinary/fecal incontinence and retention
C. It tends to be acute in presentation
D. It tends to be symmetric

5. A 21 year-old man presents after an accident involving his all-terrain vehicle. He was not wearing a helmet and the vehicle rolled over. He did not lose consciousness. 4 months after this injury, he reports progressive pain in his bilateral upper extremities and weakness. His MRI cervical spine shows a fluid filled cavity in the center of the spinal cord without enhancement extending from C5–6 levels. Which of the following would be expected as a manifestation of this patient's MRI imaging?

A. Involvement of loss of pain and temperature of one side of the body corresponding to the C5 and C6 dermatomes
B. Involvement of both of the C5 and C6 dermatomes, affecting loss of vibration and proprioception

C. Involvement of both of the C5 and C6 dermatomes, affecting loss of pain and temperature
D. Lower motor neuron involvement of the bilateral lower extremities

Answers

1. The correct answer is D. This patient has a sensory level at her umbilicus, which correlates to T10 dermatome. Along with her paraparesis, hyperreflexia and urinary/bowel changes, this indicates an upper motor neuron lesion at the thoracic region or higher. One might consider MRI of lumbar or sacral spine if concerned about conus medullaris or cauda equina syndrome, but these are both lower motor neuron syndromes and do not fit with her clinical examination. An MRI of the thoracic spine would be the more appropriate next step than a lumbar puncture as there could be an epidural mass or abscess visualized on imaging. Electromyography and nerve conduction studies are normal and not useful in upper motor neuron lesions. (Kirshblum et al. 2011).

2. The best answer is C, cobalamin or B12 deficiency. B12 deficiency commonly affects the dorsal columns and lateral corticospinal tracts in the spinal cord as well as the peripheral nerves, leading to a combined myeloneuropathy. The high MCV (macrocytic anemia) and high methylmalonic acid (a precursor in vitamin B12 conversion in the SAM pathway) also are clues to B12 deficiency. Zinc deficiency, choice A, does not have known myeloneuropathy as a manifestation. On the flip side, zinc toxicity may indirectly lead to copper deficiency which can present with a similar clinical picture. Copper deficiency can present with a similar clinical picture, but the finding of high methylmalonic acid level in this case (due to B12's role in converting methylmalonic acid to succinylcoA) is more indicative of B12 deficiency. Neurosyphillis classically leads to tabes dorsalis, a chronic complication of atrophy of the dorsal columns. This involvement is rarer currently. Thiamine deficiency classically leads to Wernicke's encephalopathy (mental status changes, ophthalmoplegia, ataxia and nystagmus, occasionally with mammillary body hyperintensities on brain imaging) or an axonal sensorymotor neuropathy, rather than a myeloneuropathy. (Goodman 2015).

3. The best answer is A, surgical decompression. This patient likely has a spinal cord abscess. Risk factors for this condition are IV drug abuse or diabetes. The source of infection is usually hematogenous spread. The most common organisms or gram positive cocci. Choice B would not be appropriate in this condition. Choice C will often be used but cannot preserve neurologic function. A CT myelogram would be an appropriate diagnostic procedure, but only if an MRI could not be obtained. Additionally, a CT myelogram is not a treatment. (Lener et al. 2018).

4. The correct answer is D. Cauda Equina syndrome is characterized by a classically lower motor neuron disorder, often with lower back pain radiating, asymmetric weakness/sensory loss and urinary/fecal incontinence or retention. It often presents acutely. (Todd 2017).

5. The correct answer is C. A syringomyelia would usually affect the crossing levels of the spinothalamic tract initially and the sensory loss would be dissociated, primarily affecting pain and temperature (mediated by spinothalamic tract) rather than proprioception and vibration (dorsal columns) (Kakigi et al. 1991).

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Ischemic Stroke and Hemorrhagic Stroke 11

Questions

1. A 57 year old right-handed man is found collapsed behind the wheel of his vehicle by bystanders. Upon ED evaluation he is drowsy, able to follow commands, with left homonymous hemianopsia, right mild facial paresis, right upper extremity and right lower extremity pronator drift, moderate spatial hemineglect. INR is 1.2, platelets 230. EKG shows sinus bradycardia. CT head demonstrates a hyperdensity in the M1 right middle cerebral artery and moderate cerebral edema in lateral temporal lobe. What is the next immediate step in management?

   A. Administer IV alteplase
   B. Begin full dose parenteral heparin
   C. Give aspirin 325 mg once
   D. Urgently refer for implantable cardiac monitoring.

2. A 59 year old man, with uncontrolled diabetes mellitus, hypertension, heavy active smoker, presents with acute headache, vertigo, and facial numbness. Upon further exam he has evidence of right ptosis, anisicoria, right facial decreased sensation to pinprick, dysphagia, left arm and leg decreased sensation to pinprick. Which artery ischemia gives rise to this clinical stroke syndrome?

   A. Anterior spinal artery
   B. Posterior inferior cerebellar artery
   C. Anterior inferior cerebellar artery
   D. Basilar artery

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https://doi.org/10.1007/978-3-030-11132-8_11

3. A 60 year old man with diabetes mellitus type 2, hyperlipidemia and hypertension presents to his primary care provider with 2 day onset of left numbness. Sole deficit is decreased sensation from left V1–V3, entire left arm and left leg to pinprick, vibration, proprioception and light touch. He is able to ambulate without difficulty, no hemiparesis or ataxia. His PCP considers small vessel transient ischemic attack as highest on his differential. Where does this localize?

   A. Midbrain
   B. Posterior limb of internal capsule
   C. Pons
   D. Thalamus

4. A 60 year-old woman with uncontrolled hypertension, active smoker, alcohol abuse, presents to the emergency room with severe headache, nausea and droopy left eyelid. On exam she has evidence of left eyelid ptosis, left pupil 5 mm and sluggishly reactive, right pupil 3 mm brisk, extraocular movements abnormal with preserved left eye abduction, at rest appearing "down and out". She suddenly becomes obtunded, and with respiratory depression, left pupil fixed and dilated. Stat CT head shows diffuse subarachnoid hemorrhage. She is emergently taken to the angiography suite to evaluate for treatment of which suspected source of aneurysmal rupture?

   A. Left anterior communicating artery
   B. Left middle cerebral artery
   C. Left ophthalmic artery
   D. Left posterior communicating artery

5. A 52 year-old woman with coronary artery disease, chronic kidney disease and uncontrolled diabetes mellitus presents with recurrent episodes of right hemiparesis and aphasia each lasting 20 minutes resolving spontaneously in a single day. Last month she had several minutes of transient vision loss in the left eye, with graying of vision like a "curtain shade." MRI brain demonstrated acute infarct in left middle cerebral artery and anterior cerebral artery watershed territory in a wedge-shaped pattern. Magnetic Resonance Angiography (MRA) shows 70–79% stenosis of the proximal left internal carotid artery confirmed with carotid Doppler. Echocardiogram has no obvious cardiac source for stroke. What is the appropriate next step?

   A. Six month observation on medical management
   B. Cardiac catheterization
   C. Consultation for carotid endarterectomy
   D. Begin warfarin for INR goal 2–3

6. A 33 year-old man with no history presents with abrupt onset severe headache, neck pain and left weakness to the emergency room. His only history is of past hernia surgery and knee dislocation. Physical exam shows he is tall and thin,

with hyperextensible joints, with pain over the right eye, right eyelid drooping and small right pupil 2 mm. CT brain is normal. What diagnostic test would be the appropriate for this condition?

A. CTA head and neck
B. Transesophageal echocardiogram
C. Chest X-ray
D. EKG

7. A 70 year-old woman with hypertension begins to have new headache over 2 months. She notes as well pain in her shoulders when reaching up, and pain with chewing. She subsequently develops double vision and then vision loss in the left eye. On exam she is noted to have a left relative afferent pupillary defect, decreased visual acuity in the left eye 20/100, no papilledema, with weakness in proximal muscles in arms and legs. What measures are appropriate to prevent further vision loss?

A. Begin high dose IV solumedrol for 5 days
B. Obtain temporal artery biopsy
C. Begin aspirin and Plavix
D. Begin low dose prednisone 20 mg daily
E. Obtain ESR, CRP and platelet count

8. A 52 year-old man with history of hypertension, alcohol use, and cigarette smoking, begins having severe vomiting in the night. When his wife awakens he has severe headache and cannot sit up in bed. Upon clinical examination, he has evidence of complete left upper and lower facial palsy, left horizontal gaze palsy, dysarthria, right hemiplegia, and dysmetria. CT brain upon arrival to the emergency room reveals a brainstem intracranial hemorrhage. Which syndrome best characterizes these clinical features?

A. Benedikt syndrome
B. Weber syndrome
C. Foville syndrome
D. Wallenberg syndrome

9. A 72 year-old woman with metastatic breast cancer, undergoing chemotherapy with tamoxifen presents to the emergency room with a headache, vomiting, and severe blurred vision. Her examination reveals a drowsy level of consciousness, left hemiparesis and papilledema. A CT of the brain is completed revealing a right lateral temporal-parietal lobe intracranial hemorrhage. A delta sign is present in the superior sagittal sinus. What are the next steps in diagnosis and treatment?

A. Obtain MR Venogram with and without contrast
B. Obtain serum antithrombin III, protein S and C, and prothrombin mutation
C. Obtain MRI brain with and without contrast in 3 months

D. Initiate anticoagulation with low molecular weight heparin
E. A and D
F. All of the Above

10. A 47 year-old woman with heavy smoking and alcohol use presented to the emergency room with worsening headache for the past 1 week, now characterized as the worst headache she has ever experienced. On examination blood pressure is 170/110 and heart rate is 101. She has reduced left eye abduction and neck stiffness. Laboratories are normal. CT brain non-contrast is unremarkable. What is the next diagnostic step?

A. Perform catheter angiography
B. Obtain stat MRI brain with and without contrast
C. Perform lumbar puncture.
D. Obtain non-invasive CT angiography.

11. A 61 year-old man with uncontrolled diabetes mellitus, chronic kidney disease and hypertension presented as an emergent acute stroke with witnessed time of onset of symptoms 4 hours prior to admission. On examination he is aphasic with right facial droop and right hemiparesis. National Institutes of Health Stroke Scale is 12. CT brain without contrast demonstrates a dense left middle cerebral artery suggestive of acute ischemic stroke, otherwise is unremarkable. He is given IV recombinant tissue plasminogen activator. Overnight he has a sustained blood pressure 190/110 and deterioration in neurologic examination with NIHSS 16. Differential diagnosis includes:

A. Acute onset thrombocytopenia
B. Acute malignant cerebral edema.
C. Hemorrhagic transformation
D. None of the Above

12. An 82 year-old man with history of alcoholism and chronic warfarin use for deep venous thrombosis presents to clinic because of 3 months of progressive falls. He has had a new onset of low –grade headache and admits to nonspecific lightheadedness and gait imbalance. His family feels overall his speed of speaking and motor function has slowed. Examination is with mild dysarthria, left hemiparesis and bradykinesia. He has a CT brain performed urgently. What is the imaging likely to show?

A. Right basal ganglia intracerebral hemorrhage
B. Right sided subarachnoid hemorrhage
C. Right middle cerebral large acute ischemic stroke.
D. Right subdural hematoma

13. An 82 year-old man chronic smoker, with hypertension and diabetes, is found unresponsive by family members and brought to the emergency room. On examination he is obtunded and intubated. CT brain non-contrast demonstrates a large intracranial hemorrhage with fluid level in the right posterior horn of the lateral ventricle. What is the most likely cause of the intracranial hemorrhage?

    A. Metastases at the gray-white cortical junction
    B. Amyloid angiopathy
    C. Uncontrolled hypertension
    D. Coagulopathy from anticoagulation

14. A 45 year-old man with end-stage kidney disease on dialysis has had a prolonged hospitalization due to endocarditis and sepsis, requiring long term antibiotics and exchange of his dialysis catheter. Neurology is consulted due to a new onset moderate headache. Exam is non-focal. He undergoes a non-contrast CT head with evident small frontal cortical sulcal subarachnoid hemorrhage. What is the most probable cause of subarachnoid hemorrhage in this case?

    A. Mycotic cerebral aneurysm
    B. Intracranial artery dissection
    C. Sickle cell disease
    D. Central nervous system vasculitis.

15. A 26 year-old man with no known medical history abruptly loses consciousness in the shower. When he is brought to the emergency room he has a flaccid weakness in the body and is unresponsive with GCS 3. CT head shows diffuse subarachnoid hemorrhage in the suprasellar cistern and in the brain hemisphere sulci, with right basal ganglia intracranial hemorrhage. Which cause of subarachnoid hemorrhage should be considered?

    A. Arteriovenous malformation rupture
    B. Cocaine use
    C. Saccular aneurysm rupture
    D. All of the above.

16. A 55 year-old man with heavy smoking history, hypertension not on medication, and alcoholic cirrhosis collapses while driving a truck. He has right hemiplegia on exam and CT reveals a large 30 ml volume left putamen intracerebral hemorrhage. What are the major modifiable risk factors that are targeted for prevention of recurrent intracerebral hemorrhage?

    A. Hypertension
    B. Cigarette smoking cessation
    C. Alcohol cessation
    D. All of the above

17. A 60 year-old man presents to the hospital 3 weeks after discharge for a subarachnoid hemorrhage. He had sudden collapse and new inability to use the right leg. He has some weakness of the right arm. On examination he has a gaze deviation towards the left and flaccid weakness of the right leg. CT of the brain shows no further intracranial hemorrhage however shows ischemia of the:

    A. Left anterior cerebral artery
    B. Right anterior cerebral artery
    C. Left middle cerebral artery
    D. Right vertebral artery

18. A 20 year-old HIV positive man with alcoholism, presents because of headache and neck stiffness that developed in the past 3 weeks. On examination he has aphasia, and right hemiparesis. Imaging identifies a left middle cerebral artery ischemic stroke. What are possible infectious causes of stroke?

    A. Syphilis
    B. Mycobacterium tuberculosis
    C. Varizella-zoster virus
    D. All of the above

19. A 57 year-old woman presents to the hospital with recurrent aphasia and headaches over several weeks. She is a nonsmoker, does not drink alcohol and has no other known medical conditions. Blood pressure is normal. CT brain shows a region of hemorrhage in the left lateral hemisphere with a large amount of surrounding hypodense edema and mass effect, suspicious for tumor. What type of tumor is most likely to be causative of intracranial hemorrhage?

    A. Glioblastoma multiforme
    B. Melanoma
    C. Choriocarcinoma
    D. Renal cell carcinoma
    E. None of the above
    F. All of the above

20. A 46 year-old woman is brought by ambulance because of sudden onset of left body hemiplegia without known trauma. On examination she has gaze deviation to the right, substantial spatial neglect and left flaccid weakness. CT brain demonstrates a region of hypodensity in the right deep basal ganglia and with mottled, hyperintensities in the right gyral cortex, with no significant mass effect. What is the cause of this hemorrhage?

    A. Intracerebral hemorrhage
    B. Subarachnoid hemorrhage
    C. Ischemic stroke with hemorrhagic conversion
    D. Traumatic brain injury

Answers

1. The correct answer is C. As the exact time of onset of this right middle cerebral artery stroke symptoms is unknown, the patient at this juncture does not meet criteria for thrombolytic therapy with intravenous alteplase. Recombinant tPA (alteplase) has been shown to improve several measures of clinical outcome when treatment was initiated within 3–4.5 hours of stroke onset. There is no evidence of active atrial fibrillation to begin full anticoagulation with heparin, and indeed may contribute to hemorrhagic conversion. Cryptogenic stroke can be evaluated with intensive cardiac monitoring though is typically reserved for latter hospitalization care or discharge setting. (Hacke et al. 2008; Sanna et al. 2014; "Tissue plasminogen activator for acute ischemic stroke," 1995; Tommaso Sanna et al. 2014).

2. The correct answer is B. The patient has a Wallenberg syndrome, or lateral medullary stroke with likely thrombosis of the right posterior inferior cerebellar artery versus vertebral artery. Lateral medullary syndrome is a complex of clinical "crossed" findings without significant motor findings: ipsilateral facial numbness/pain due to trigeminal nucleus effect, contralateral body numbness (lateral spinothalamic tract), vertigo (vestibular nuclei), dysphagia (nucleus ambiguous with vagus and glossopharyngeal nerve nucleus) and Horner's syndrome (descending sympathetic fibers). Medial medullary syndrome involves ischemia of the anterior spinal artery with ipsilateral tongue weakness (hypoglossal nucleus), contralateral hemiplegia (medullary pyramids) and contralateral vibration and proprioceptive loss (medial lemniscus). Anterior inferior cerebellar strokes are unique in in that they can cause unilateral hearing loss. Top of the basilar artery occlusion can cause visual disturbance, somnolence, and vivid visual hallucinations "peduncular hallucinosis". (Ogawa et al. 2015; Blumenfeld 2002).

3. The correct answer is D. thalamus. Pure sensory lacunar stroke or TIA localizes to the ventral posterior lateral nucleus of the thalamus and with facial numbness, ventral posterior medial nucleus involvement. Posterior limb of the internal capsule or pontine lacunar strokes can cause sensorimotor, pure motor, ataxia-hemiparesis or dysarthria-clumsy hand syndromes. Midbrain stroke syndromes such as Claude, Weber and Benedikt includes ipsilateral oculomotor palsy. (Chen et al. 2017; Biller and Espay 2013).

4. The correct answer is D. Ptosis and pupillary involvement of left oculomotor nerve palsy is highly suggestive of left posterior communicating artery aneurysm. Compression of the pupillary fibers of the third cranial nerve on the dorsomedial surface in the subarachnoid space between the internal carotid artery and Pcomm artery make them particularly vulnerable to injury. Majority of spontaneous subarachnoid hemorrhage is from aneurysm rupture typically at bifurcations in the anterior circulation: anterior communicating, middle cerebral artery and posterior communicating artery aneurysm. Anterior communicating artery aneurysm rupture can present as abulia and mutism. Middle

cerebral artery aneurysm rupture can present as temporal lobe seizure. Ophthalmic artery aneurysm sign may be visual field cut. (Zelman et al. 2016; Zakaria 2013).

5. The correct answer is C. The patient demonstrates transient ischemic attacks attributable to a symptomatic left internal carotid artery stenosis with acute stroke in the anterior circulation, watershed infarct. Though cardiac etiology is still possible the history also of amaurosis fugax in the left eye supports extracranial artery symptomatic stenosis as the source. Revascularization with carotid endarterectomy (CEA) is preferred within 2 weeks of the ischemic event, rather than delaying intervention. CEA or stenting is contraindicated in those with 100% or complete occlusion of internal carotid artery. Cardiac catheterization might be necessary for assessing pre-operative risk but is not the immediate next step in stroke prevention. There is no advantage in oral anticoagulation over antiplatelets in the secondary prevention of ischemic stroke in non-cardioembolic strokes (WARSS-Warfarin-Aspirin Recurrent Stroke Study). (Yavagal and Haussen 2011).

6. The correct answer is A. CTA head and neck would be appropriate for the evaluation of right internal carotid artery dissection. This young man presents with nonspecific symptoms of headache and neck pain however his physical examination is suggestive of ptosis and meiosis, a partial painful Horner's syndrome. In addition his history of hernia, knee dislocation and physical features are characteristic of connective tissue disorder, or Marfan's syndrome (Ehlers-Danlos another connective tissue disorder). Carotid artery dissections can occur in setting of blunt trauma such as hyperextension neck injury, or more minor trauma coughing, sneezing. Dissection is an important cause of stroke in young persons. (Mackey 2014).

7. The correct answer is A. Begin high dose IV solumedrol for 5 days then prednisone 60–80 mg daily for treatment of temporal arteritis. This patient has clinical scenario suspicious of arteritic ischemic optic neuropathy. The rAPD: swinging flashlight test shows dilation rather than constriction in pupillary response. Temporal arteritis is an important cause of stroke in older persons and can rapidly progress to vision loss in the contralateral eye, thus empiric treatment and high index of suspicion are necessary. Temporal artery biopsy can be obtained within 2 weeks of steroid initiation without decrease in yield of results. Timing of biopsy should not delay treatment with steroids. ESR can be elevated in only 50% of persons with TA. Antiplatelets are the mainstay of stroke treatment but in TA are insufficient to prevent further stroke. Low dose prednisone is useful in treatment of polymyalgia rheumatica but will not be sufficient treatment. (Biousse and Newman 2014).

8. The correct answer is C. Foville Syndrome, a syndrome of the dorsal pons. It is described as an ipsilateral facial palsy, inability to move the eyes in a conjugated fashion to the ipsilateral side and contralateral hemiplegia, and ataxia

(mid cerebellar peduncle). Benedikt syndrome and Weber syndrome occur from midbrain localization both involving CN III palsy. The Wallenberg syndrome comes from lateral medullary localization. (Selvadurai et al. 2016).

9. The correct answer is E obtain MR Venogram as well as initiate anticoagulation. The delta sign is apparent on CT (a hyperintense triangular shape in the location of the cerebral venous sinus on noncontrast CT) An MR venogram with contrast is more sensitive to deep and cortical vein thrombosis than CT venogram. Metastatic cancer is present thus further search for alternative hyercoagulable causes is less valuable in this case. There is Class IIA American Heart Association Guideline Recommendation to treat CVT with anticoagulation despite the presence of intracranial hemorrhage. A recent randomized control trial to compare LMWH and unfractionated heparin for CVT treatment showed a non-significant lower chance of ICH with the LMWH group with that group more likely to be functionally independent at 6 months. (Bushnell and Saposnik 2014; Weimar 2014).

10. The answer is C perform diagnostic lumbar puncture for the evaluation of cerebrospinal fluid xanthochromia and red blood cell count in sequential tubes. The patient presents with worrisome signs of thunderclap headache and cranial nerve six palsy, a false localizing sign of elevated intracranial pressure. CT head non-contrast has a sensitivity within 12 hours of symptom onset of 98–100% for detection of subarachnoid hemorrhage, but falls with time thereafter to 93% after 24 hours and 50% at 7 days. A lumbar puncture is recommended in any patient with suspicion of subarachnoid hemorrhage in which CT head is negative or equivocal. CT angiography, and catheter angiography can be utilized to determine the presence of a cerebral aneurysm once SAH is determined. (Suarez 2015).

11. The answer is C. Intracranial hemorrhage secondary to IV tissue plasminogen activator occurs symptomatically in 2.4% of patients treated in the extended time window 3–4.5 hours. Hemorrhagic risk in those treated with IV tpa is affected by various factors including diabetes mellitus, atrial fibrillation, advanced age and kidney dysfunction as well as hypertension in the first 24 hours after administration. Malignant cerebral edema is more likely to occur 72–96 hours after large volume infarct. (Huang 2017).

12. The answer is D. Right subdural hematoma. Subdural hemorrhages occur as a result of venous bleeding between the dura and the arachnoid space. Subdural hemorrhages typically occur in elderly patients, are traumatic or spontaneous in origin and with a slower tempo of clinical symptoms. (Kranz et al. 2018).

13. The answer is D. Coagulopathy from anticoagulation. Fluid levels occur in hemorrhages associated with coagulopathic causes, which are indicative of repetitive bleeding and tend to be more unpredictable extending, in the ventricular system. Metastases do occur along gray-white matter junctions and can have hemorrhagic

transformation seen more clearly on MR imaging. Amyloid angiopathy imaging findings also are better seen on MR gradient echo sequencing with microhemorrhages visualized at the cortical junctions. (Kranz et al. 2018).

14. The answer is A. mycotic aneurysm. The patient demonstrates prolonged sepsis and intra-cardiac infection. There is suspected septic embolic forming cerebral aneurysms, small in character, few millimeters, and occurring at distal branches of large intracranial arteries MCA, which can rupture to cause intracranial hemorrhage. Outcome is to treat with antimicrobial therapy rather than a surgical intervention as typical with aneurysmal subarachnoid hemorrhage. (Silver et al. 2016).

15. The answer is D. All of the above. Saccular or berry aneurysms cause 80% of all subarachnoid hemorrhage. Non-aneurysmal causes include other vascular malformations such as arteriovenous malformations. The abuse of cocaine promotes hypertensive surges without evidence of vascular aneurysm. In chronic use, the development of vasculitis and pathologic arteriole changes can appear. (Suarez 2015).

16. The answer is all of the above D. Refractory untreated hypertension can increase the risk of intracerebral hemorrhage 3–4 times, and modest reduction of hypertension can produce a 50% decrease in ICH recurrence. Cigarette smoking increases the risk of ICH 1.5–2.5 fold Excess alcohol intake can increase the risk of ICH recurrence. (Kase and Kurth 2011; Williams 2004).

17. The correct answer is A. Anterior cerebral artery strokes are less common, but can follow a subarachnoid hemorrhage as a late complication with vasospasm of the intracranial vessels. This vasospasm can cause ischemia or infarct in a territory unrelated to prior region of localized subarachnoid hemorrhage. The localization described with flaccid leg weakness greater than arm, as well as gaze deviation toward the side of the lesion is suggestive of a left anterior cerebral artery infarct. (Suarez 2015).

18. The correct answer is D. All of the above. Several infections have been identified and are important to recognize as causative. Pathophysiology involves intracranial vasculitis such as syphilis. Neurotuberculosis affects the basilar meninges predominantly. Varicella-zoster can cause arteritis with stroke as a consequence. (Carod Artal 2016).

19. The correct answer is F all of the above. Intracranial hemorrhage that occurs due to an underlying mass lesion is relatively rare. The most common types of tumors to hemorrhage within the brain are metastatic melanoma, bronchogenic carcinoma, choriocarcinoma or renal cell carcinoma. Primary gliomas such as glioblastoma multiforme are causative of intracranial hemorrhage as well. (Wang and Tuhrim 2012).

20. The correct answer is C. Ischemic infarct with hemorrhagic infarction is the pattern seen on CT imaging. The appearance of hemorrhage of petechial hemorrhagic infarction is in contrast with intracerebral hemorrhage. ICH is homogeneous, dense in the deep part of the brain. Rather hemorrhagic transformation is described as petechial or punctate, spotted and irregular, and more along the cortex gyri, without mass effect. (Katramados et al. 2018).

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Increased Intracranial Pressure (ICP)

12

Questions

1. A 43 year-old man with chronic cryptococcal meningitis presents to the hospital for markedly increased headache and worsened blurred vision requesting a spinal tap. He has had 3–4 lumbar punctures in the last several months. Examination is significant for papilledema, and formal visual field testing reveals loss of vision in the right eye. CT head confirms communicating hydrocephalus. Neurosurgery is consulted for evaluation and placement of ventriculoperitoneal shunt placement. What are the two component pressures that maintain cerebral perfusion pressure?

   A. Mean arterial pressure and intracranial pressure
   B. Systolic blood pressure and intracranial pressure
   C. Internal jugular venous pressure and intracranial pressure
   D. Diastolic blood pressure and intracranial pressure

2. A 52 year-old woman with metastatic cancer presents to the ER obtunded with a large hemorrhagic cerebral lesion. On examination GCS is 3, blood pressure is 210/60, heart rate is 45 and she has irregular respirations. There is significant midline shift seen on CT brain imaging. What is the phenomena described in this scenario?

   A. Bell phenomena
   B. Charcot's triad
   C. Cushing's reflex
   D. Whipple's triad

3. A 52 year-old man has severe headache, sudden collapse and is brought by ambulance while having convulsive seizures. He is obtunded and minimally

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https://doi.org/10.1007/978-3-030-11132-8_12

responsive to painful stimuli. CT of the brain shows a hyperdense well-circumscribed lesion in the third ventricle, with marked dilatation of the lateral ventricles. What is the name of this lesion causing near-fatal obstructive hydrocephalus?

A. Choroid plexus cyst
B. Dermoid cyst
C. Pineal gland cyst
D. Colloid cyst

4. A 20 year-old woman with history of headaches for the last 6 weeks has noted increasing headaches. The headaches are pressure-like, bilateral, and associated with some blurry vision occasionally. She has some nausea and reports occasional non-pulsatile tinnitus. Her MRI shows an empty sella. Her LP shows an opening pressure of 30 cmH_2O. What is an important diagnostic test to do next?

A. CT head
B. MR venogram
C. CT angiogram
D. Carotid ultrasound
E. Detailed ophthalmologic exam

5. A 56 year-old man is brought in after a severe MVA as an unrestrained passenger. On exam he is comatose and his pupils are poorly reactive and midpoint. His CT shows global cerebral edema. What would not be a valid treatment for increased ICP for this patient?

A. Mannitol
B. 23% Sodium Chloride Hypertonic Saline
C. 3% Sodium Chloride Hypertonic Saline
D. Pentobarbital
E. Corticosteroids

6. A 51 year-old man with long-standing hypertension presents with abrupt onset headache, nausea, vomiting and difficulty walking. On initial examination BP is 240/120, he is confused, moving all extremities, with dysmetria in the right arm and right leg. He has difficulty sitting up, and stance is wide based. Initial CT shows a right cerebellar hemorrhage with mass effect upon the 4th ventricle. What are findings in the CT that explain the symptoms?

A. Subfalcine herniation
B. Ascending transtentorial herniation
C. Uncal herniation
D. Tonsillar herniation
E. Central herniation

7. A 26 year-old obese woman, actively smoking, post-partum several months, required abdominal surgery for cholecystitis. Several days after discharge from the hospital she returned to the ED with new onset explosive headache not responsive to pain medications, blurred vision and left sided numbness. Examination was significant for papilledema in the left eye, decreased visual acuity, left facial decreased sensation to pinprick. CT head non-contrast imaging revealed hyperdensity in left transverse and sigmoid venous sinus suggestive of thrombosis, with area of modest hemorrhage suspicious for venous infarct. What is the next urgent step?

   A. Factor V Leiden and Protein S level serum studies
   B. Counseling on smoking cessation
   C. Anticoagulation with IV heparin
   D. Lower extremity dopplers
   E. Ophthalmology consultation
   F. CT body screening for malignancy

8. A 35 year-old man presents with new onset generalized convulsive seizure. After recovering he states that he has had new headache for the past 3 months. Examination shows he is alert, has a flat affect and positive jaw jerk. Imaging shows a dural-based homogeneously enhancing mass. What treatment options would be necessary to improve outcome?

   A. Placement of external ventricular drain
   B. Start mannitol
   C. Induce hypothermia
   D. Surgical resection of mass.

9. A 24 year-old woman with acromegaly and several years of progressive visual loss in the right eye, presents for marked worsening of headache awakening her from sleep and new left vision loss. On exam she is in moderate distress and with no light perception in right eye, relative afferent pupillary defect of the right eye, and diffuse optic nerve pallor. Left eye visual acuity is 20/40 with temporal field deficit. Her MRI Brain shows mass effect from a large suprasellar mass compressing the right medial temporal lobe. What increased intracranial pressure syndrome (s) is seen?

   A. Subfalcine herniation
   B. Uncal herniation
   C. Tonsillar herniation
   D. Kernohan's notch phenomena
   E. B and D

10. An 84 year-old woman with a 30 pack-year smoking history presents with progressive left hemiparesis over 3 months. She has not seen a doctor in several years. She states that she has never had headaches in her life but most recently has developed daily headache, often awakening her from sleep. She

has nausea, anorexia, difficulty with concentration and short-term memory as well. Brain imaging is recommended, and obtained showing extensive white matter involvement in the right frontal centrum semiovale region without gray matter involvement on T2 and FLAIR with no DWI changes. She is given a short course of dexamethasone 4 mg every 6 hours with marked improvement in motor and cognitive function. What type of cerebral edema is seen?

A. Vasogenic edema
B. Cytotoxic edema
C. Osmotic edema
D. Interstitial edema

Answers

1. The correct answer is A. Cerebral perfusion pressure is calculated by subtracting intracranial pressure from mean arterial pressure. (MAP – ICP). When intracranial pressure is elevated overall or mean arterial pressures are elevated, cerebral perfusion pressure diminishes (Marion 2008).

2. The correct answer is C. the Cushing's reflex. The Cushing reflex is the sign of hypertension, with or without bradycardia seen with increased intracranial pressure (Bell et al. 2016).

3. The correct answer is D. Colloid cyst. Obstruction of the third ventricle, which can occur rapidly in a ball-valve tumor, can cause marked elevation in intracranial pressure, hydrocephalus and in this case new onset seizure and stupor (Boes et.al 2008).

4. The correct answer is B. MR venogram. It is important to rule out cerebral venous sinus thrombosis in any patient presenting with signs of increased intracranial pressure. Patients with Idiopathic Intracranial Hypertension (aka pseudotumor cerebri) are typically young women, of fertile age, overweight or with recent weight gain. Pseudotumor cerebri patients present with headaches, transient visual loss, papilledema, and elevated opening pressure on lumbar puncture. Patients with cerebral venous sinus thrombosis also have similar clinical presentations and is an important differential from pseudotumor cerebri since the treatment is dramatically different. Thus a venogram is necessary to differentiate the two. (Sylaja et al. 2003).

5. The correct answer is E. Corticosteroids. All of the above choices are appropriate options for lowering increased intracranial pressure. However, corticosteroids are best indicated in cerebral edema caused by brain tumors, whether primary or metastatic. Corticosteroids are not indicated in traumatic brain-injury related cerebral edema and has been found to increase mortality. Mannitol is an osmotic agent and can be a good first line treatment. It is given 1 g/kg IV bolus and then with repeat maintenance. The osmolar gap should be

monitored regularly and doses lowered if the gap is above 15 mOsm/L or keeping serum osmolality from exceeding 320 mOsm/L. Hypertonic saline can be used and interchangeably with mannitol. 23.4% Sodium Chloride (NaCl) Hypertonic saline or 3% NaCl can be given as a bolus every 4–6 hours or 3% NaCl as a continuous infusion. Hypertonic saline cannot be given through peripheral IV and requires a central line for administration. Pentobarbital is also another option but requires continuous EEG monitoring. The patient should be kept in burst suppression while receiving this treatment to ensure that there is adequate decreased metabolic demand. (Alderson and Roberts 2005).

6. The correct answer is B. A right cerebellar hemorrhage causing mass effect can result in ascending transtentorial herniation. Compression of the brain in the closed posterior compartment can be life-threatening as autonomic nervous functions such as respiration are housed in the brainstem. Large cerebellar infarcts or hemorrhage require surgical decompression (suboccipital craniectomy) to relieve increased intracranial pressure. Acute confusion, headache and emesis are signs of increased intracranial pressure and mass effect from intracerebral hemorrhage and cerebrospinal fluid obstructed flow. Unilateral cerebellar hemisphere lesions causes ipsilateral limb dysmetria. Truncal ataxia can be seen with more midline vermian cerebellar lesions such as difficulty with sitting balance and wide-based station. (Blumenfeld 2002, Nakagawa and Smith 2011).

7. The correct answer is C. Initial anticoagulation with heparin is thought to stop the progression of thrombosis in cerebral venous sinus thrombosis. Acute severe headache and papilledema are indicative of increased intracranial pressure, unchecked can lead to herniation syndrome and can be fatal. Pregnancy and postpartum period, smoking while on oral estrogen treatment are conditions that are frequent risk factors associated in development of CVT. Other coagulopathic predispositions should be considered in the diagnosis for recurrent risk of CVT such as prothrombin mutation G20210, Protein C deficiency, antithrombin III, hyperhomocysteinemia in addition to Factor V leiden and Protein S, antiphospholipid syndrome and disseminated intravascular coagulation. Malignancy is a cause, though less commonly seen of CVT. Though ophthalmology consultation, smoking cessation and cancer screening are reasonable steps in management, first line is anticoagulation even in the setting of intracranial hemorrhage. (Weimar 2014).

8. The correct answer is D. Measures to alleviate elevated intracranial pressure are dependent on the clinical status and etiology of mass effect, and which compartment is affected: brain, blood or CSF. There is no evidence of obstructive hydrocephalus thus external ventricular drain is not necessary. Mannitol would be useful for substantial cytotoxic or vasogenic edema—here an intradural focal mass effect of probable meningioma causes subfalcine shift however does not cause parenchymal edema. Thus, surgical resection would be the most effective measure for reduction of intracranial pressure. Hypothermia would be indicated if hyperemia were the cause of elevated ICP. For example, in diffuse vasodilation secondary to cerebral dysautoregulation after anoxic brain injury, hypothermia can decrease arteriole diameter to decrease ICP. (Nakagawa and Smith 2011).

9. The correct answer is E. Both B and D are true. The right medial temporal lobe is compressed upon by a large suprasellar mass. The contralateral temporal lobe as well may be compressed upon, leading to in the near future to central herniation. Though currently the patient exhibits no motor weakness she may develop Kernohan's notch phenomena, a false localizing sign in which a brain mass causes compression of the opposite side crus cerebri of the midbrain (where corticospinal tracts run) thus causing hemiparesis in the body ipsilateral to the side of the brain mass. This patient has a clinical presentation concerning for pituitary apoplexy with abrupt headache and acute on chronic vision loss. (Nakagawa and Smith 2011).

10. The correct answer is A. The patient most likely has a metastatic brain tumor from a primary systemic malignancy. Any adult with new onset headache, particularly with wakening from sleep merits further diagnostic workup with brain imaging. The subcortical finger-like hyperintensity seen in the right hemisphere is characteristic of vasogenic edema. Intravascular fluid escapes into extracellular space because of break down in the blood-brain barrier, occurring because of insufficiency of the endothelial tight junctions. Corticosteroids are thought to alleviate vasogenic edema by diminishing this permeability of tumor capillaries. Cytotoxic edema is intracellular swelling of neuronal and glial cells thus involving the gray matter with no role for glucocorticoids. Osmotic edema occurs when there is a difference between the solutes of the brain parenchyma and blood plasma, dilution or plasma or increased brain tissue osmolarity. Interstitial edema is seen in hydrocephalus when transependymal flow of CSF leaks into the extracellular space of brain tissue with fluid volume increased around the ventricles. (Bebawy 2012; Ho et al. 2012).

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Head Trauma and Brain Tumors

13

Head Trauma

Questions

1. You are asked to evaluate a patient in the ICU for altered mental status. The patient has had a large intracranial hemorrhagic stroke. On exam, you note he has a fixed dilated pupil on the right. He is not responsive to stimulation. He is not moving the left side. Where is the lesion that is causing his right pupil dilation?

   A. Cerebellar tonsil displacement
   B. Cingulate gyrus displacement on the left
   C. Diencephalon
   D. Uncal herniation on the left
   E. Uncal herniation on the right
   F. Cingulate gyrus displacement on the right

2. A 60 year-old man suffered a ruptured subarachnoid hemorrhage with diffuse bilateral hemisphere involvement and major midline shift. On examination, off sedation, eyes are closed with no spontaneous vocalizations or movements, and no response to any painful stimuli. Pupils are nonreactive, corneal reflexes, gag and oculocephalic reflexes are absent. Cold caloric testing shows absence of response. He has spontaneous respirations on ventilation. What are ancillary tests which can be utilized in the determination of brain death?

   A. Electroencephalogram
   B. Single photon emission computed tomography or SPECT
   C. Catheter cerebral angiography
   D. All of the above

D. Kung et al., *Absolute Case-Based Neurology Review*,
https://doi.org/10.1007/978-3-030-11132-8_13

3. A 55 year-old woman presents to the ED out of therapeutic window for IV tissue plasminogen activator with right hemiplegia and global aphasia and was found to have a large left middle cerebral artery ischemic stroke. Her National Institutes of Health Stroke Scale is 20. On day 3 of her hospitalization she has deterioration of her neurologic exam becoming obtunded, with left pupil dilation and fixation. What is the next step in managing malignant cerebral edema from ischemic stroke in this case?

   A. Observation of examination
   B. Intra-arterial nicardipine
   C. Decompressive hemicraniectomy
   D. Intra-arterial tissue plasminogen activator

4. A 34 year-old man presents with loss of consciousness greater than 1 hour. He is lethargic with flat affect and left hemiparesis. CT head is with bi-frontal hemorrhagic contusion and no hydrocephalus. What are the most common causes of traumatic brain injury?

   A. Motor vehicle accidents
   B. Falls
   C. Sport-related injury
   D. All of the above

5. A 75 year-old man with 10 years of progressive Parkinson's disease begins to have recurrent falls at home. His family becomes worried about signs of "dementia" presenting over one month. He is more forgetful, not talking as much, and increasingly taking naps during the day. His family takes him to the doctor's office. A change in his mental status is seen. He is drowsy, disoriented, inattentive and with mild right hemiparesis. A CT head is ordered, so what is the most likely finding?

   A. left subdural hematoma
   B. left epidural hematoma
   C. left middle cerebral artery stroke
   D. left basal ganglia intracerebral hemorrhage.

6. A 68 year-old woman with alcohol abuse trips and falls sustaining a laceration to her scalp. She has a few minutes of loss of consciousness at the time of injury. Her exam is non-focal with Glasgow Coma Scale 13, with mild drowsiness and disorientation at the time of injury. CT head shows a bifrontal subarachnoid hemorrhage over convexities. One month later her CT brain is showing resolution of the traumatic hemorrhage and no new focal area of ischemia or hemorrhage. She complains of neurologic symptoms attributable to mild traumatic brain injury such as:

   A. persistent headache
   B. short-term memory impairment

C. concentration difficulty
D. imbalance
E. All of the above.

7. A 22 year-old man has a mechanical fall and strikes his head against a pavement. He has a scalp laceration, but is lucid following commands and moving all extremities. Three hours later he reports new onset headache, then rapidly becomes unconscious unable to be aroused. Suspicion is that the patient has epidural hematoma. What are features that are compatible with an epidural hematoma?

A. On CT is a biconvex extra-axial hyper-intensity
B. On CT crosses the falx cerebri
C. On CT is a crescent-shaped extra-axial hyper-intensity
D. On CT cannot cross the falx cerebri and tentorium
E. A and B
F. B and D

8. A 78 year-old woman is found collapsed in her driveway by her neighbor. Upon arrival, respirations are shallow, blood pressure is elevated, and she is bradycardic. Her eyes are closed and with vigorous stimulation she does not grimace to pain or spontaneously move her extremities. Pupils are sluggish 3 mm, corneal reflex, gag and oculocephalic reflex are absent. She has right facial weakness and flaccid tone in right body. CT head demonstrates a large hemispheric left middle and anterior cerebral artery stroke with 5 mm midline shift. What element(s) of her examination is NOT consistent with brain death?

A. pupillary reflex
B. comatose state
C. corneal reflex
D. gag reflex
E. respiratory drive
F. A and E

Answers

1. The correct answer is E. Uncal herniation on the right. This patient's 3rd nerve palsy is likely due to stretch on the right 3rd nerve as the right side of the brain is swelling and pushed to the left. Cerebellar tonsil displacement is often seen in Chiari malformation or in an acute situation can result in compression of the upper cervical cord or lower medulla causing respiratory arrest. Cingulate gyrus displacement results in what is called subfalcine herniation, presenting with decreased level of consciousness and often medial frontal lobe injury causing contralateral leg weakness. Diencephalon herniation, also called central herniation is a downward displacement of the diencephalon and/or midbrain through

the tentorium causing symptoms of midpoint pupils and decorticate posturing. Uncal herniation is due to the medial temporal lobe or uncus pushing down through the tentorium and stretching on the 3rd nerve, causing ipsilateral 3rd nerve symptoms often affecting pupils or causing full ophthalmoplegia and can cause decerebrate posturing (Young 2011).

2. Answer D. All of the above testing can be used in determination of brain death. AAN guidelines advise that ancillary tests be used when uncertainty exists about parts of the neurologic exam or when the apnea test cannot be performed. These tests do not replace the clinical examination. EEG testing must show 30 minutes of electrocerebral silence in brain death. Nuclear cerebral blood flow testing or SPECT must demonstrate complete absence of cerebral perfusion in brain death. Catheter angiography shows absent intracranial blood flow above the level of the proximal internal carotid and vertebral arteries in brain death (Webb and Samuels 2012).

3. The answer is C Decompressive hemicraniectomy for large hemispheric ischemic stroke involves a removal of the temporal-parietal bone flap and opening the dura ipsilateral to the side of infarction to allow outward herniation of the brain. This surgery lowers mortality in patients with malignant MCA infarction. Intra-arterial nicardipine is utilized in subarachnoid hemorrhage to manage vasospasm. Intra-arterial thrombolytic therapy is reserved for treatment of ischemic stroke in the therapeutic window 6 hours from time of onset. Observation is incorrect as the patient has had a clinical deterioration with herniation signs on examination, a fixed and dilated pupil (Huang 2017).

4. The correct answer is D. Traumatic brain injury is a common cause of death and chronic disability. Causes of TBI include falls, MVA, contact sports and non-accidental trauma. Falls are common in the very young and in older adults. Non-accidental trauma should be sought as a cause in younger age patients. Sports injuries and motor vehicle accident as cause of traumatic injury are more common in adolescents (Ling et al. 2010).

5. The correct answer is A. He has likely a subacute to chronic subdural hematoma accumulating from weeks to months. Subdural collections are extra-axial and can have mass effect on brain parenchyma. Clinical signs appear insidiously with decreased level of consciousness, changes in personality, language and potential focal signs, aphasia or motor weakness. It is thought that older patients are more at risk for traumatic subdural hematomas due to brain atrophy, which allows more shear force against bridging veins immediately after impact. The size of a subdural hematoma may spontaneously resolve if absorption of fluid exceeds rebleeding or may enlarge otherwise. Burr holes are the first line treatment for subdural hematomas versus conservative serial imaging and close neurologic exam monitoring (Lee 2016; Katz and Zafonte 2006).

6. The correct answer is E. All of the above are symptoms of non-penetrating blunt head trauma, the sequela of mild traumatic brain injury. Neurocognitive symptoms, headache, tinnitus, imbalance, anxiety and depression are common nonspecific symptoms that may persist. Late symptoms such as seizures are often another reason post TBI patients seek care. Though not evident on imaging studies such as CT, there can be diffuse axonal injury—or shearing effect of neuronal axons, occurring with displacement of the brain against the skull. Hypoxia, oxidative stress, and inflammation are contributors to this cellular process (Grandhi et al. 2017; Stippler 2008).

7. The correct answer is E. On CT an epidural hematoma is a biconvex extra-axial hyper-intensity which can cross the falx cerebri. Epidural trauma is bleeding between the dura and skull, which is often bleeding from a lacerated artery, direct bone bleeding or middle meningeal artery or vein. The clinical course is suggestive of epidural hematoma with a brief lucid period and abrupt deterioration in mentation. C and D describe subdural hematoma imaging features. Subdural hematomas occur between the dura and the brain (Maugeri et al. 2015; Brant and Helms 2007; Stippler 2008).

8. The correct answer is F. Reactive pupils and lack of apnea are the elements of the examination not compatible with brain death. For determination of brain death, an irreversible cause to neurologic injury proximate to coma is established; here a major ischemic stroke causing cerebral edema and midline shift. Examination is done when the patient is normothermic and normotensive. In the clinical evaluation there is no evidence of responsiveness to external stimuli. Brainstem reflexes are tested, with absence of pupil constriction, corneal reflex, lack of gag and any oculocephalic maneuver to meet criteria. Additionally, for formal brain death evaluation the oculovestibular reflex can be tested with cold caloric testing, implemented with water irrigation into the ear canal. Apnea is the absence of the respiratory drive that is a component of brain death assessment (Wijdicks et al. 2010).

Brain Tumor

Questions

1. Your patient with breast cancer was treated with chemotherapy and soon after developed painful numbness and tingling, burning sensations in her feet. Her exam shows decreased reflexes in her legs and decreased proprioception in the feet. Which medication may be at fault?

   A. Doxorubicin
   B. Cyclophosphamide
   C. Paclitaxel

D. Methotrexate
E. Etanercept

2. A 64 year-old man with history of cancer presents with headaches and some numbness in the right arm and leg. He has not noted much weakness but on exam you do note some mild distal weakness in the right hand and foot with a pronator drift on the right. Out of the answer choices, which of these primary cancers is most likely to metastasize to the brain?

A. Colon
B. Renal cell
C. Pancreatic
D. Multiple Myeloma
E. Melanoma

Answers

1. The correct answer is C. Paclitaxel. Many chemotherapy drugs can cause peripheral neuropathy, particularly the taxanes, platinum-based agents, and vinca alkaloids. Platinum-based agents like cisplatin or oxaliplatin can cause large fiber sensory neuropathy and sometimes even worsen after stopping treatment. Taxanes like paclitaxel often cause a large and small fiber stocking-glove distribution neuropathy. Less often motor fibers are involved as well. Vincristine, a vinca alkaloid, can also cause a sensorimotor neuropathy but also autonomic involvement, mononeuropathies, and CNS toxicity has been reported. Doxorubicin and etanercept can actually cause a myasthenic type syndrome. Cyclophosphamide can cause leukopenia. Methotrexate can cause white matter changes in the CNS and even cause severe demyelination resulting in cognitive dysfunction (Sioka and Kyritsis 2009).
2. The correct answer is E. Melanoma. Melanoma has a high propensity for brain metastasis, up to 50% of patients. Lung and breast cancers also very commonly metastasize to the brain. Colon cancer, renal cell carcinoma, and gynecologic cancers are close seconds to metastasize to the brain (Lu-Emerson and Eichler 2012).

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Meningitis and Encephalitis

14

Questions

1. A 33 year-old man with AIDS (CD4 count 160) presents because of malaise, low-grade fever and headache for several months. He has no prior headache history. He states he has been having night sweats, chills and weight loss for 4 months. He has a fever of 100 F, photophobia and mild neck stiffness, and no other focal signs on examination. Labs show no leukocytosis or thrombocytosis. CT head shows no focal lesions. CSF shows an opening pressure of 30, wbc 132, protein 113, and glucose 33. What other testing would NOT be relevant in this clinical case?

   A. Mycoplasma tuberculosis PCR CSF
   B. Cryptococcus neoformans antigen CSF
   C. Toxoplasmosis IgG and IgM CSF
   D. VDRL CSF

2. A 46 year-old man presents to the hospital because of severe headache, fever, light sensitivity and stiff neck. He had been playing with his children in the backyard during the summer evenings and had a number of mosquito bites. On exam, he has a temperature of 99.9, appears drowsy, with modest nuchal rigidity, no rash, and a new mild flexion-extension tremor in his extremities. CSF demonstrated normal opening pressure, wbc 225, with a neutrophil predominance, rbc 2, protein elevated and glucose normal. MRI brain shows minimal leptomeningeal enhancement and hyperintensities in the basal ganglia and bilateral thalami. Which virus below is responsible for the patient's meningoencephalitis?

   A. St. Louis Encephalitis
   B. West Nile Virus

D. Kung et al., *Absolute Case-Based Neurology Review*,
https://doi.org/10.1007/978-3-030-11132-8_14

C. Epstein Barr Virus
D. Lymphocytic choriomeningitis virus

3. A 19 year-old man is witnessed by his college-dorm roommate to have incomprehensible speech for 3 minutes and then began having generalized convulsions. He is febrile, with neck stiffness and right-sided hemiparesis. HIV status is negative and urine drug screen is normal. Imaging shows an abnormality in the left temporal lobe. EEG is significant for periodic lateralized epileptiform discharges (PLEDS). CSF is significant for lymphocytic predominance of white blood cells, 210 red blood cells, protein 50 (mildly elevated), glucose 84 (mildly elevated). What CSF diagnostic test would likely be positive?

A. Herpes simplex virus PCR
B. West Nile IgG and IgM
C. Enterovirus PCR
D. Cytomegalovirus PCR
E. HHV-6 PCR

4. A 40 year-old man comes home from work because of feeling malaise, in the morning. At lunch his wife comes home and finds him in bed, sweating and ill-appearing. Upon arrival to the ED his temperature is 102 F, he is awake but lethargic, and has a non-blanching purpuric rash throughout his body. Both Kernig's and Brudzinki signs are positive. CT brain is negative for acute findings. A lumbar puncture is done with opening pressure 30, turbid CSF, wbc 432, rbc 3, protein 100 (elevated) and glucose 24 (low). What step(s) is/are needed in management?

A. Cefepime 2 grams every 8 hours IV and Vancomycin IV
B. Obtain blood cultures
C. Start Dexamethasone
D. Obtain CSF gram stain and culture
E. All of the above

5. A 20 year-old previously healthy young woman comes to the emergency room because of fever, headache, and rash. She is a nanny and recently took a position in the summer to care for toddlers, both of whom were sick with a diarrheal illness. She has been taking ibuprofen the last 3 days for pain. On exam she is febrile 100.4 F, alert, in modest distress, sitting in a dark room due to light sensitivity. Neck is slightly stiff with passive range of motion diminished head flexion to chest and side-to-side. Visual acuity is normal and on fundus exam there is no papilledema. She has a blanching macular rash on her torso and back as well as her hands. CT head is normal. Lumbar puncture is performed due to suspicion of meningitis. Cerebrospinal wbc is 150, predominant lymphocytes, rbc 3, protein 40, glucose 60. Gram stain negative. What is the most likely cause of this presentation?

A. Neisseria meningitis
B. Enterovirus meningitis
C. Cytomegalovirus meningitis
D. Non-steroidal anti-inflammatory aseptic meningitis
E. Behcet's disease

6. A 42 year-old woman, with history of migraines presents to the hospital with 1 week of intractable headaches different in quality than her prior migraines, severe photosensitivity, neck stiffness and fever 101 degrees Farenheit. Three days later she suddenly develops a right flaccid leg weakness. She went into respiratory failure and required intubation thereafter. She has had no recent travel abroad, has no history of animal bites, and states her occupation is that of pest control. She has CT and MRI brain imaging which appears normal and lumbar puncture with cerebrospinal white blood cell 200, predominant neutrophils, protein 120, glucose within normal limits. Bacterial latex antigen, HSV PCR and Cryptococcus antigen were negative. Cultures were pending. What is likely the diagnosis?

A. Varicella virus meningitis
B. Amyotrophic lateral sclerosis
C. West Nile meningitis
D. Guillain-Barre syndrome

7. A 43 year-old man recently released from incarceration presents to the hospital because of months of worsening headaches, chills and weight loss. He has had a persistent cough and on occasion hemoptysis. On examination he has left 6th nerve palsy, nystagmus and papilledema on fundus examination. Chest xray shows calcified granulomas. CT brain shows a central calcification surrounded by a hypodense area with ring of IV contrast. A lumbar puncture is performed with protein 200, wbc 123 and glucose 20, minimal fluid is obtained. What pathogen is likely responsible for this presentation?

A. Toxoplasmosis
B. Taenia solium
C. Tuberculosis
D. Cryptococcus

8. A 20 year-old medical student goes for an international rotation in Central America for 3 months. He returns because of a new onset seizure. His examination is non-focal. CT brain without contrast shows mild hydrocephalus, and cystic lesions in the left temporal lobe, CSF shows a lymphocytic pleocytosis, presence of eosinophils and increased protein 180. What pathogen is responsible?

A. Toxoplasmosis
B. Taenia solium

C. Tuberculosis
D. Cryptococcus

9. A 62 year-old woman with remote aortic valve replacement collapses while playing tennis. She becomes increasing lethargic. On route to the hospital she has a new onset generalized convulsive seizure. On examination she has temperature 102, heart rate 110, respiratory rate 24, and no other focal features on exam. White blood cell count is 22 k. CT and MRI brain are performed. MRI brain shows multiple small enhancing well-circumscribed lesions in the bilateral hemispheres. Blood cultures are positive for staph aureus. A transthoracic echocardiogram reveals a small hypermobile vegetation along the aortic valve. What is the cause of the MRI findings and presentation?

A. Metastatic cancer
B. Cerebral abscess
C. Toxoplasmosis
D. Tuberculosis.

10. A 40 year-old man with AIDs, not on HAART, presents with a subacute decline over the last 3 weeks: slurred speech, headaches and recurrent falls. His CD4 count is 32. On examination he has moderate dysarthria and right hemiparesis. CT brain is remarkable for a large well-circumscribed 3 cm left basal ganglia mass lesion with mass effect, which on MRI brain has a thin linear enhancement and significant vasogenic edema surrounding. What is the leading differential of infectious origin?

A. Toxoplasmosis
B. Coccidiomycosis
C. Lymphoma
D. Aspergillosis

Answers

1. The correct answer is C. In this immunocompromised patient, central nervous system disease can present as an indolent course with the concern for tuberculosis, cryptococcus and neurosyphilis being high on the differential. Patients often present without fever. Toxoplasmosis causes focal mass lesions in the CNS. Neurosyphilis can present as asymptomatic meningitis and is an important cause of meningitis in AIDS patients that can be treated with a long course of high dose penicillin. Both Cryptococcus and tuberculosis can present with very high CSF protein and low glucose mimicking a bacterial infection. Both can cause hydrocephalus as well. Tuberculosis has a predisposition for the basilar meninges, often demonstrating enhancement on MR imaging (Koshy and Roos 2008; Mara 2006; Panackal and Williamson 2015).

2. The correct answer is B. West Nile virus can cause meningitis, encephalitis and an acute flaccid paralysis (affecting the motor neuron). Here the patient has classic features of the infection with tremor and parkinsonism a characteristic that can distinguish this viral infection from others. MR brain imaging is consistent with bilateral thalamic, basal ganglia or cerebellum hyperintensity or can be normal. St. Louis encephalitis virus is an arbovirus that can cause encephalitis but has a lymphocytic predominance and incidence is higher in an older population. Lymphocytic choriomeningitis (LCMV) is transmitted through mice and is not an arbovirus. Less than one percent of infectious mononucleosis EBV infections can manifest as meningitis and encephalitis. EBV virus is found in several lymphoproliferative disorders as well (Athar et al. 2018; Popovic et al. 2014; Beckham et al. 2008).

3. The correct answer is A. Herpes simplex virus encephalitis is the correct diagnosis. It can be a fatal encephalitis thus prompt diagnosis is important as treatment with antiviral medication reduces morbidity and mortality. The clinical presentation is typical for a complex partial seizure with generalization. Multiple CNS infections can mimic HSV, such as focal cerebral abscess. Herpes simplex encephalitis is often hemorrhagic with red blood cells or xanthochromia present in cerebrospinal fluid. A lymphocytic predominance is present. CMV encephalitis is rare in immunocompetent hosts. HHV-6 encephalitis has been seen more commonly in organ transplant patients. Though enterovirus can cause encephalitis in immunodeficient hosts (i.e. hypogammaglobulinemia) the presentation is most consistent with HSV encephalitis. Arbovirus encephalitis has different imaging characteristics and CSF profile (Beckham et al. 2008; Roos and Greenlee 2011).

4. The correct answer is E all of the above. In an immune competent adult the most common cause of bacterial meningitis is Neisseria meningitidis and Streptococcus pneumoniaie. In individuals older than 55 or immune-compromised (i.e. chronic alcoholism or AIDS) coverage for Listeria is appropriate with ampicillin. Most common route of spread of infection to the central nervous system is through the blood. In persons with mastoiditis, or otitis as route of CNS spread, it is appropriate to cover for anaerobes with the addition of metronidazole. Before starting antibiotics it is ideal to obtain blood cultures to appropriately diagnose the condition. However, due to the life-threatening and rapidly progressive nature of CNS bacterial meningitis, treatment should be promptly begun empirically. Thus, treatment should not be delayed for diagnostic lumbar puncture. High dose antibiotics are necessary to penetrate the blood-brain barrier. Neurologic injury in bacterial meningitis is often the result of the host inflammatory response thus high dose dexamethasone for 4 days in the initial treatment of bacterial meningitis is recommended (Roos and Greenlee 2011).

5. The correct answer is B. Enterovirus meningitis is the most likely cause of this viral meningitis presentation. The time of year in summer and early fall is when this group of viruses predominant. The fecal-oral route of transmission and

occurrence in children under the age of 10 is common. The non-polio enterovirus family includes echovirus, and coxsackie virus. The blanching macular rash particularly in the hands may be suggestive of or hand-foot-mouth disease. Bacterial meningitis would not have such a benign presentation. CMV meningitis is more common in immune-compromised individuals. The patient does not have significant NSAID use, but medications can be a cause of aseptic meningitis. Non-infectious meningitis can present in persons with autoimmune and systemic vasculitic conditions like lupus or Behcet's disease (Roos and Greenlee 2011).

6. The correct answer is C. West Nile virus infection can manifest with symmetric or asymmetric flaccid limb and facial weakness similar to an acute poliomyelitis. West Nile infection with meningitis shows a neutrophilic pleocytosis seen in cerebrospinal fluid. Amyotrophic lateral sclerosis is a condition of motor neurons, not an infectious central nervous system disease. Guillian-Barre can affect the neuromuscular system and cause respiratory failure however is not accompanied by such headache and neck stiffness. Varicella zoster reactivates in persons causing rash and pain, rarely seen in immunocompetent individuals (Solbrig and Tyler 2008; Harati and Bosch 2008).

7. The correct answer is C. Tuberculosis. The CT finding of a tuberculoma is a "target sign" resulting from central calcification surrounded by a hypodense area with peripheral ring of IV contrast. CSF findings of tuberculosis typically include a markedly elevated protein (Bell et al. 2016).

8. The correct is C Taenia solium. Neurocysticercosis is a common cause of epilepsy. The larval form of the pork tapeworm Taenia solium is the causative agent of neurocysticercosis, caused by ingestion of undercooked pork with the cystic larvae. Both epilepsy and intracranial hypertension can occur with lesions located in the parenchyma as well as extraparenchymal lesions (Cho 2018).

9. The correct is B. Cerebral abscess. The patient has a prosthetic valve related endocarditis. She has likely had hematogenous seeding from a distant source, such as her endocarditis. Hematogenous infection often leads to multiple cerebral abscesses (Chow 2018).

10. The correct answer is A. Toxoplasmosis. Toxoplasmosis occurs commonly in HIV patients with CD4 counts less than 200 cells/$mm^{3.}$ CNS toxoplasmosis has a predilection for the basal ganglia and can be a ring-enhancing lesion with mass effect. Lymphoma is in the differential but is not an infectious cause. Coccidiodes and aspergillosis are fungal infections that can cause CNS infection but have alternative radiographic features (Saylor 2018).

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Toxic and Metabolic Encephalopathy

15

Questions

1. A 42 year-old man, accountant, with chronic alcoholism presents to the emergency room because of blurred vision and falls increasing over the last 3 weeks. He admits to recently losing his job and having increasing consumption of alcohol in this period. On exam he is disoriented to time and place, with marked short-term memory impairment, has gross dysconjugate gaze, nystagmus in all extremes of gaze, and an inability to move his eyes fully up or down. He has a very wide based gait, and is unable to tandem walk. On MRI brain he is found to have bilateral thalamic hyperintensities. What is the most urgent treatment needed to reverse symptoms and prevent progression?

   A. IV Dextrose
   B. B Lactulose 30 grams three time daily PO
   C. Thiamine 500 mg three times daily IV
   D. Phenytoin 300 mg at bedtime IV

2. A 45 year-old woman with Hepatitis C induced cirrhosis presents to the hospital after numerous falls. Her family is concerned about her increasing confusion over the past week. She has not been consuming alcohol. She began a new medicine 3 weeks prior by her primary care physician, a diuretic and recently has been feeling lightheaded when standing. In the past she has had similar episodes of altered mentation in the setting of gastrointestinal bleeding. Physical exam is notable for dry mucous membranes, skin tenting, jaundice, scleral icterus, spider angiomas and protruberant abdomen. Neurologic findings reveal her to be somnolent with marked psychomotor slowing, inattention, and asterixis. Pertinent labs show normal ALT and AST, normal ammonia level, low albumin, INR 1.4, hemoglobin 10, and platelets 50. CT head is unremarkable. In addition to advising IV hydration, what other acute treatment is warranted?

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A. IV Dextrose
B. Lactulose 30 grams three time daily PO
C. Thiamine 500 mg three times daily IV
D. Phenytoin 300 mg at bedtime IV

3. A 30 year-old woman with recently diagnosed lupus nephritis is seen in the emergency room because of abrupt onset vision loss in both eyes over several hours. She has had difficult to control hypertension in the last several weeks with increasing kidney dysfunction, and has been on multiple blood pressure medications. She appears in moderate distress due to headache, cushingoid in appearance, with a supple neck, afebrile, and her blood pressure is 212/105. On neurologic exam she is awake, following commands, but does not appear to be tracking, with decreased blink to threat in all fields, and visual acuity is hand motion at 1 foot. Creatinine is 2.4 and BUN 32. MR imaging shows bilateral parieto-occipital vasogenic edema as hyperintense T2 signal, but with no evidence of acute stroke or arterial dissection. What is the clinical syndrome in this case?

A. Hypertensive urgency
B. Uremic encephalopathy
C. Aseptic meningitis
D. Reversible leukoencephalopathy syndrome
E. Vasculitis

4. A 42 year-old woman with lung cancer is transferred from an outside hospital due to confusion and diffuse weakness. She denies recent illness, has no history of cardiac, liver or renal disease. She is mildly somnolent, disoriented to place and time, with poor attention and on exam has moderate quadriparesis, mild spasticity and hyperreflexia. She appears euvolemic on exam. Laboratories from the outside hospital reveal an initial sodium of 119 and after 24 hours her subsequent sodium is 140. She reports since her diagnosis of cancer she has chronically had a sodium in range of 129–133. What choice does NOT fit in her case?

A. rapid correction of hyponatremia
B. syndrome of inappropriate antidiuretic hormone
C. osmotic demyelination
D. cerebral salt wasting syndrome

5. A 23 year-old woman is transferred to the intensive care unit because of altered mental status, nausea and vomiting and unstable condition. She is febrile with temperature 101.5 F, tachycardic, with periodic episodes of atrial fibrillation. She develops initial confusion, psychosis and tremulousness, moving all extremities with brisk reflexes. Urine drug screen is negative, alcohol level normal, and kidney and liver function normal. Infectious workup is negative. CT

brain shows no abnormality. Her only other sign on exam is proptosis and lid retraction. What laboratory may reveal her diagnosis?

A. sodium
B. ammonia
C. thyroid stimulating hormone/T3/T4
D. parathyroid hormone and calcium

6. A 41 year-old man, heavy smoker presents because of confusion, headache and chest pain to the emergency room. He is tachycardic and with BP 170/60. On exam his pupils are dilated, he is restless, responding to visual hallucinations, tremulous and with pruritis. Laboratories reveal elevated CK, myoglobin and creatinine levels. CT head shows no acute abnormality. A urine drug screen is ordered. Which substance can cause these symptoms?

A. cocaine
B. barbiturates
C. benzodiazepine
D. narcotics

7. A 62 year-old man is brought to the hospital by his family due to concern for insidious onset of memory loss over 6 months, impairing activities of daily living. He describes pins and needles in his hands and feet and has been requiring a walker, also new in this time. On exam he has a Montreal Cognitive Assessment of 15/30 with deficits in all domains of cognition including memory, attention, and exhibits a flat depressed affect. His exam shows a spastic paraparesis, decreased proprioception and vibration in distal limbs, hyperreflexia, and ataxic gait. Labs show a macrocytic anemia. Treatment is started immediately and after 7 days improves mentation and weakness, such that on discharge he is independently ambulating and with cognitive exam 26/30. What nutritional deficiency does NOT cause cognitive impairment?

A. Vitamin B12
B. Folic acid
C. Vitamin A
D. Niacin

8. A 42 year-old woman with uncontrolled diabetes mellitus is found collapsed outside a fast food restaurant. When emergency personnel arrive she has recovered and states that she had eaten a large meal then suddenly felt flushed, and lightheaded prior to collapsing. Witnesses at the restaurant state she had no convulsive movements, and once on the ground returned to consciousness within seconds. She reports this has happened previously on several occasions after eating a large meal. Blood glucose is 75 and blood pressure 90/53. Urine and blood are negative for ketones. What clinical diagnosis best fits this scenario?

A. Diabetic ketoacidosis
B. Hyperosmolar hyperglycemic nonketotic syndrome
C. Postprandial hypoglycemia and hypotension
D. Hypoglycemic seizure

9. A 32 year-old woman with no medical problems is found on the street by bystanders brought in because of unresponsiveness. Her only other history known is a remote major vehicle accident. On examination she is lethargic with shallow respirations, pinpoint pupils which are reactive, she can localize extremities, and has lower extremity furuncles and excoriations. CT brain is unremarkable. Lactic acid is elevated. What substance is likely to be demonstrated in the urine drug screen and causative for this patient's altered mentation?

A. Cocaine
B. Opiates
C. Marijuana
D. Amphetamine

10. A 40 year-old woman with metastatic multiple myeloma presents because of confusion, abdominal pain and personality changes reported by her family. She has generalized weakness and recent hospitalization for kidney stones. On examination she is lethargic, and the only finding on exam is proximal muscle weakness. MRI brain is normal. Notable labs causative for encephalopathy and presentation are:

A. Hypokalemia
B. Hypercalcemia
C. Hypocalcemia
D. Hypernatremia

11. A 52 year-old man with hypertension, diabetes, and end-stage-renal-disease presents due to an acute change in mentation with increased confusion. His family states that over the last week he has missed two dialysis sessions. He is disoriented, tremulous, with asterixis and with complaint of fatigue. Laboratories show normal white blood cell count and normal thyroid stimulating hormone. Electrolyte derangements are seen with hyperkalemia and BUN 70 above baseline 50. CT head does not show acute changes. EEG is significant for triphasic waves. What is the likely cause of altered mentation?

A. Reversible leukoencephalopathy syndrome
B. Dialysis dementia
C. Epilepsy
D. Uremic encephalopathy

12. A 34 year-old man with epilepsy comes to the emergency room because over the last two days he is confused and cannot walk without falling. On examination he is disoriented to year, has pronounced nystagmus with central gaze, slurred speech, wide-based station, and ataxic gait. Urine drug screen is normal and alcohol level is normal. CT brain is non-focal. Toxic levels of which antiepileptic medication has caused this scenario?

    A. Valproic acid
    B. Levetiracetam
    C. Gabapentin
    D. Phenytoin

13. A 67 year-old man with history of recent kidney transplant collapses while on the golf course. Within hours he becomes increasingly lethargic. On examination he has a temperature of 101.5, heart rate 100, blood pressure 90/68, respiratory rate 24, and with eyes closed, he moves all extremities without focal findings. GCS is 13. White blood cell count is 16k. CT brain is unremarkable. Chest xray shows a hazy opacity in the right middle lobe. What is the most likely cause of altered mentation?

    A. Embolic stroke
    B. Non-convulsive status epilepticus
    C. Sepsis-associated encephalopathy
    D. Drug intoxication

14. A 32 year-old woman, who has long-standing alcoholism, chronic pain and anxiety was found by her roommate unresponsive. Several empty pill bottles were found next to her at the scene when paramedics arrive. GCS is 6, blood glucose is 113, blood pressure 102/68, and respirations are shallow. What potential agents can be administered to attempt to improve her condition?

    A. Midazolam
    B. Naloxone
    C. Flumazenil
    D. Dextrose
    E. B and C

15. A 62 year-old man with prostate hypertrophy on oxybutynin is admitted to the hospital because of generalized weakness, abdominal pain and fever for suspicion of sepsis. He is given broad-spectrum antibiotics. He has insomnia and cannot sleep and is given diphenhydramine. For abdominal pain he is given IV morphine. Within 24 hours he develops acute disorientation, has visual hallucinations and believes the hospital staff is trying to poison him. Which categories of medications are associated with delirium?

A. antihistamines
B. opiates
C. cephalosporins
D. anticholinergics
E. A and D
F. All of the above

Answers

1. The correct answer is C. High dose thiamine three times daily IV. The patient presents with most like Wernicke's encephalopathy. The clinical triad of altered mental status, ophthalmoplegia, and gait ataxia are the classic features of this treatable disorder of vitamin B1 deficiency. Alcoholism is the commonly associated condition with Wernicke's, however it occurs in those with hyperemesis of pregnancy, systemic malignancy, and after bariatric surgery as well. MRI brain can show T2 increased signal in mammillary bodies, medial thalami and peri-aqueductal gray area. Treatment is with parenteral thiamine high dose. Glucose administration may actually precipitate Wernicke's encephalopathy if given prior to thiamine. Lactulose is given in hepatic encephalopathy and phenytoin is an antiepileptic, which would not treat nutritional deficiency syndrome (Scalzo et al. 2015).

2. The correct answer is B. Lactulose is used to treat portosystemic encephalopathy induced by dehydration, leading to confusion. She has orthostatic hypotension symptoms as well which is contributing to falls. Constipation, or non-adherence to the medication lactulose may lead to hepatic encephalopathy (HE) as well. She has had episodes of gastrointestinal bleeding and encephalopathy with similar presentation supporting this diagnosis. Physical signs are present of stigmata of chronic liver disease as well of dehydration, a common precipitator of HE. Mental status shows probable mild hepatic encephalopathy: somnolence, psychomotor slowing, and sleep cycle disturbances. Other exam findings include tremors, hyperreflexia and asterixis. Laboratories show normal liver function and ammonia, anemia, thrombocytopenia and coagulopathic dysfunction. A normal ammonia level does not exclude the diagnosis of hepatic encephalopathy. Hepatic encephalopathy is a clinical diagnosis excluding all other causes of altered mental status (Elwir and Rahimi 2017).

3. The correct answer is D. Reversible leukoencephalopathy syndrome is the best choice. The clinical presentation is most suggestive of this syndrome previously known as PRES or posterior reversible encephalopathy syndrome. Nomenclature has changed to reflect the wider effect of this syndrome on other parts of the brain rather than exclusively the posterior region. Cerebral perfusion dysautoregulation and endothelial disruption are considered the physiologic basis for this syndrome. Clinically presentation includes disturbed

consciousness, present with headaches, visual loss, seizures, or other focal neurologic symptoms. Hypertension, autoimmune disease such as lupus and high dose steroids are associated with this condition in this case. Pre-eclampsia and organ transplant recipients are individuals at risk. Tacrolimus or cyclosporine and numerous other medications can precipitate this syndrome. Hypertensive urgency, uremic encephalopathy and vasculitis would not have the above imaging findings (Legriel et al. 2011; Samuels and Seifter 2011).

4. The correct answer is D. Cerebral salt wasting syndrome is a hypovolemic hyponatremia that is inconsistent with this case. Lung cancer commonly is associated with SIADH, considered a paraneoplastic disorder causing a euvolemic hyponatremia. Chronic hyponatremia may be asymptomatic but acute and large changes in sodium can result in changes in level of consciousness and may precipitate seizures or develop into coma due to cerebral edema. In overcorrection of sodium, rapid serum sodium shifts can cause brain cells to decrease in size causing osmotic demyelination previously known as central pontine myelinolysis. This process can occur in cerebral white matter as well. In this case the quadriparesis, spasticity and hyperreflexia represent this osmotic demyelination in the pons that has occurred as a consequence (Samuels and Seifter 2011).

5. The correct answer is C. The clinical case is one of thyroid storm. Thyrotoxicosis can have constitutional and neurologic manifestations including concentration difficulty, tremors, anxiety, proximal muscle weakness, ophthalmoparesis, proptosis and lid retraction. Thyroid storm is inclusive of autonomic instability in which there are elevated thyroid hormones characterized by fever, tachycardia and even atrial fibrillation. Neurologic symptoms can be severe in thyroid storm and include delirium, psychosis, seizures and coma. Myxedema coma, a hypothyroid emergency can be distinguished by hypothermia, delayed deep tendon reflexes, macroglossia and pretibial myxedema (localized skin lesions on tibia and elsewhere in the body). Though hypercalcemia can manifest with similar symptoms and atrial fibrillation but does not have the orbital findings. Sodium and ammonia abnormalities should not cause the above findings (De Leo et al. 2016; Park and Abraham 2014).

6. The correct answer is A. Cocaine can cause rhabdomyolysis, renal insufficiency and the clinical syndrome above. Cocaine can cause vasospasm resulting in headache and chest pain. Cocaine can with chronic use cause a cerebral vasculitis. An autonomic disturbance is seen via the stimulant effect, and can lead to seizures, cerebral and cardiac ischemia, intracerebral hemorrhage as well. Opioids have a depressant effect thus one would expect the opposite effects of what are described: respiratory depression, bradycardia and pupillary constriction. Benzodiazepine withdrawal may cause some of the symptoms described above except for the pruritis. “Cocaine bugs” in users of the drug is the intense sensation of creeping, crawling or itching, which causes individuals to scratch

sometimes causing excoriations. Barbiturates act as a central nervous system depressant. Methamphetamine, phencyclidine can produce similar stimulatory effects to cocaine (Buttner 2011; Aminoff and So 2008).

7. The correct answer is C. Nicotinic acid (Niacin) or pellagra can cause cutaneous manifestations, as well as cognitive impairment: "diarrhea, dermatitis and dementia," is the well-known triad. Encephalopathy in cobalamin and folic acid deficiency can present with psychiatric manifestations, commonly depression and cognitive dysfunction. Involvement of corticospinal tracts and posterior column tracts in the spinal cord can cause the clinical picture of myeloneuropathy seen in B12 and copper deficiency. Immediate diagnosis and treatment with high dose intramuscular/subcutaneous vitamin B12 for a period can lead to reversal of cognitive and motor deficits. Vitamin A can cause night blindness but not cognitive impairment (Goodman 2015; Staff and Windebank 2014; So and Simon 2008a, b).

8. The correct answer is C. Postprandial hypoglycemia and hypotension is the correct answer. Encephalopathy in persons with diabetes can occur for various reasons—in settings of extreme hyperglycemia or profound hypoglycemia. Brain glucose concentrations are normally low and the brain's metabolic demand high, thus the cerebrum is highly vulnerable to changes in systemic glucose. Hypoglycemia can lead to seizures and coma if not corrected immediately. Prolonged hypoglycemia can lead to irreversible neurocognitive injury. Hyperglycemia can lead to various levels of delirium from lethargy to coma. Hyperglycemia in DKA or HHNS can lead to cerebral edema. Here the patient has an episode of syncope and collapse with reactive hypoglycemia and hypotension returning to normal cognition thereafter. The prodrome to the event and rapid recovery are less consistent with seizure (Park and Abraham 2014).

9. The correct answer is B. History denotes a major motor vehicle accident and possible long-term pain for which narcotics are typically prescribed. Tolerance develops rapidly requiring higher doses to produce effect. Heroin crosses the blood-brain barrier more rapidly than morphine and is then metabolized to morphine. Examination shows evidence of pinpoint pupils seen with opiate use and cellulitis/boils often a complication of Staph infection from intravenous injection of heroin. Cocaine and amphetamine are sympathomimetics, which produce dilated pupils on examination, seizures and psychosis. Marijuana intoxication can cause euphoria, paranoia or hallucinations (Brust 2004).

10. The correct answer is B hypercalcemia. Symptoms can be common in those with metastatic cancers, affecting level of consciousness, a pseudo-dementia, and causing body weakness and gastrointestinal disturbance. Commonly also

seen are renal and cardiovascular sequela. Hypocalcemia causes perioral paresthesias, cramping, and more severely seizures. Hypernatremia can be seen with dehydration and instances of elevated sodium or more commonly in diabetes (Ishii 2017).

11. The correct answer is C. Uremic encephalopathy. The change in mentation is acute thus dementia is unlikely. No other accompanying focal neurologic signs are present such as vision loss or seizures to suggest reversible leukoencephalopathy syndrome. Epilepsy is unlikely and EEG shows triphasic waves a common non-focal result in persons with an encephalopathy. A metabolic encephalopathy due to excess accumulation of toxins is seen with missed sessions of renal dialysis (Lockwood 2008).

12. The correct answer is D. As concentrations of phenytoin above therapeutic levels greater than 20 mcg/dL can cause adverse effects of clinical toxicity: lethargy, nystagmus, dysarthria and ataxia. Valproic acid excess levels can lead to tremors, alopecia, hepatotoxicity and pancreatitis. Gabapentin in high doses can cause dizziness, somnolence and myoclonus. Levetiracetam can cause depression, headache, somnolence and psychosis (French 2007).

13. The correct answer is C. Sepsis-associated encephalopathy. Vital signs are abnormal and suggestive of a systemic inflammatory syndrome. Clinical presentation is suggestive of a immunocomprised state with the patient likely on immunosuppression medications to protect his kidney transplant, so he is susceptible to infection. Severe sepsis occurs with an infection that is suspected leading to end-organ dysfunction such as altered mentation. Risk factors for sepsis include advanced age and immunosuppression. In this case pneumonia is suspected. No focal features are identified to imply stroke or non-convulsive status (Hocker and Wijdicks 2014).

14. The answer is B and C. The acute treatment of opiate overdose include close monitoring of vital signs and administration of an opioid antagonist, naloxone, to be used immediately in any suspected opioid overdose. One to two mg of naloxone is given intravenously. Benzodiazepines cause confusion and slowed psychomotor slowing. Flumazenil is a specific antagonist for benzodiazepines, which can rapidly reverse coma (So 2008).

15. The correct answer is F. All of the above medications can cause delirium. Medications are one of the most common causes of delirium. There is a much higher risk of developing delirium in elderly patients and medications are often the cause of delirium in as many as one-third of the cases. All of the above medications including antihistamines, anticholinergics, as well as many antibiotics cause delirium, apart from known analgesics such as opiates (Bhattacharyya et al. 2016; Douglas and Josephson 2010).

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