You're the Flight Surgeon

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You're the flight surgeon waiting for your medical technician to exit the room so you can keep your clinic schedule on time. While waiting, you take the opportunity to review your next patient's health history. She is a 41-yr-old Caucasian woman with no significant past medical or surgical history. The lieutenant colonel pilot, KC-135 squadron commander denies taking any medications or changes to her health via an online questionnaire. She is current with her clinical preventative services. The technician eventually emerges and presents the patient. Acknowledging the normal vision and hearing screening tests, you inquire what the delay was in obtaining the vitals. He responded that it took several attempts to get her blood pressure down. Her initial blood pressure reading was 166/98 mmHg, which was taken several minutes after she had been in the exam room. Before entering the room, you queried the electronic medical record and confirmed that she previously had zero elevated blood pressures in the past.

During your exam, she relates that she is under a lot of stress this week with some disciplinary actions she must administer. She denies any chest pain, headaches, or shortness of breath. Her exam is unremarkable: normal thyroid, normal cardiopulmonary exam including heart sounds, distal pulses, and absence of carotid and abdominal bruits. Her parents both have hypertension, but are in their 70s without having any heart attacks or strokes.

1. How does the United States Preventive Services Task Force (USPSTF) recommend that you confirm a diagnosis of hypertension?

A. Have the patient return to your clinic twice a day for the next 3 d.
B. Have the patient acquire an ambulatory blood pressure monitor (ABPM) to record her blood pressure for 24 h.
C. Have the patient return and confirm the diagnosis on a second visit.
D. She already has met the definition today: a reading above 140/90 mmHg.

ANSWER/DISCUSSION

1. B. In 2015 the USPSTF found that 24-h ambulatory measurements correlated more with outcome measures than office measurements. An ABPM is a device that records blood pressure (BP) every 20 or 30 min during an entire day and night. These multiple measurements allow for variation due to stress, pain, drugs (caffeine and nicotine), emotion, and physical activity. Home BP measurements were also found superior to office measurements as they more correlated with adverse outcomes. The majority of BP outcome studies defined a single BP measurement as the average of at least two clinical readings taken at the same visit.[8] The BP measurement should be taken at least 5 min after arrival, with the inflatable portion of the cuff covering 80% of the extremity's circumference resting at the heart level.[2] Thus, all measurements taken during a single office visit should be averaged as a single event. The Joint National Committee (JNC) has endorsed multiple readings (more than two) to confirm the diagnosis of hypertension. The USPSTF recommends the use of the ABPM as the gold standard of blood pressure measurement because office measurements lead to false positive hypertension diagnoses 5–65% of the time.[8]

It should be noted that the USPSTF is currently the only organization to fully endorse the ABPM in routine medical care. Availability, cost, and insurance reimbursement are concerns for widespread practice. Individuals with white coat hypertension or obstructive sleep apnea (OSA) and smokers are excellent candidates for ABPM over routine clinical screening. There is a consensus that ABPM hypertension is defined as > 135/85 mmHg, but treatment goals have not yet been established using the ABPM.[2]

Your patient is convinced that the stress of her job is the reason for her elevated blood pressure. She appreciates your concern in suggesting lifestyle modifications. She finally agrees to purchase a home cuff, take serial measurements, and follow up in 1 wk. You remind her to obtain fasting labs prior to her return visit. The routine evaluation of hypertension can be thought of as looking for end organ damage and disproving a secondary cause for the elevation.

2. In this clinical vignette, what part of the history is most suggestive of a secondary cause of hypertension?

A. Resistant hypertension defined as elevated blood pressure despite three antihypertensive agents.
B. Early onset of hypertension (age less than 30 yr).

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C. Children diagnosed before puberty.
D. Accelerated elevation (either onset or from previously controlled).

ANSWER/DISCUSSION

2. D. Every clinical clue mentioned above is concerning for a secondary cause of hypertension. However, only the accelerated elevation is present in this specific scenario. Hypertensive children who have not reached puberty have underlying secondary causes over 70–85% of the time.[13] Renal pathology from parenchymal disease and fibromuscular dysplasia causing renal artery stenosis and hyperthyroidism are two of the most common causes of hypertension in 18- to 39-yr-olds.[13]

The distal pulses should be checked to see if the femoral and radial pulses are equal. If there is a delay in the femoral pulse, then coarctation of the aorta may be considered. This condition is most often found in children by the age of 5 and confirmed with an echocardiogram.[13]

A clinician should suspect a secondary cause whenever blood pressure was previously controlled and there is a sudden increase. Hypertension that cannot be controlled despite compliant use of a diuretic and two additional classes of antihypertensive medications is also suggestive of a secondary cause.

The pilot returns the following week with dozens of measurements averaging 162/94 mmHg. Within a few minutes of discussion, your patient agrees she has modified her lifestyle with greater than 150 min of physical activity and reduction of salt in her diet. You review her normal urinalysis and serum chemistries (sodium, potassium, and creatinine) and complete a physical exam, which does not demonstrate any end organ damage. Because of the drastic change in her pressures, you recommend starting pharmacotherapy. In accordance with JNC 8, you choose an angiotensin converting enzyme inhibitor.[5]

3. Which of the following statements is correct regarding the evaluation of hypertension?

A. Primary aldosteronism is a very rare cause of increased blood pressure.
B. Evidence of hypokalemia (potassium wasting) should be documented prior to obtaining an aldosterone/renin ratio.
C. OSA is not associated with hypertension.
D. Reviewing other symptoms may elicit a secondary cause of hypertension.

ANSWER/DISCUSSION

3. D. Reviewing symptoms for a secondary cause is the only correct choice. Clinicians should always maintain an index of suspicion for secondary causes in patients described in the previous discussion. Aldosteronism, OSA, and pathognomonic symptoms should be reviewed for common secondary causes of hypertension.

Primary aldosteronism or hyperaldosteronism may be found in up to 6% of hypertensive patients. For resistant patients (requiring more than three medications), aldosteronism is causal in nearly 20% of this subgroup, making it the largest cause of secondary hypertension in adults 40–64 yr of age.[13] Although hypokalemia is commonly associated with aldosteronism, it is present in less than half of hypertensive patients.[3] The morning aldosterone/renin ratio is much more sensitive than aldosterone alone in evaluating for primary aldosteronism and should be considered with all resistant hypertensive patients.[13]

OSA may be an independent risk factor for the development of hypertension. The Wisconsin Sleep Cohort Study found a linear dose-relationship between OSA and blood pressure.[9] Middle-aged patients are more likely to see rises of blood pressure with OSA than older adults.[9,13] ABPM is also recommended for patients with OSA, as their circadian blood pressure is altered.[9] A good history should elicit daytime sleepiness, snoring, or apneic events.

Several symptoms are associated with specific diseases. Cushing syndrome should be suspected with physical exam findings of a buffalo hump, central obesity, moon facies, and skin striae. If the patient has not recently taken large amounts of glucocorticoids, a 24-h urinary free cortisol test has a positive likelihood ratio (LR) of 10.6 and a negative LR of 0.16.[13] Thyroid disorders are a common cause of inappropriate regulation of blood pressure. A new diagnosis of hypertension should involve questioning the patient about thyroid symptoms. Changes in heart rate, temperature intolerance, diarrhea, constipation, or changes in skin, hair, or menstrual cycles should be investigated.[13] Pheochromocytoma should be considered with a history of flushing, frequent headaches, labile blood pressures, palpations, sweating, and syncope. This secondary cause is confirmed with 24-h urinary fractionated metanephrines. This test has a positive LR of 8.0 and a negative LR of 0.13.[13] A parathyroid disorder may be considered with an elevated serum calcium level.

The aviator returns to the clinic in 2 wk with a reduction of home blood pressure, down to 144/88 mmHg, which matches the office measurement. She admits to a mild cough, but states the cough does not interfere with her daily activities. Updated laboratory results show her serum creatinine has doubled from her baseline 2 wk ago. Her potassium and thyroid stimulating hormone are normal. Her abdominal exam continues to be unremarkable, without bruits on auscultation.

4. From this visit, what is the most appropriate course of action?

A. She is at JNC-8 treatment goals; continue treatment.
B. She should be switched to an angiotensin receptor blocker because of the cough.
C. The creatinine should not be that elevated, and concern for renovascular disease should be investigated.
D. The lack of abdominal bruits eliminates renovascular disease from the differential.

ANSWER/DISCUSSION

4. C. Creatinine will peak after starting an angiotensin-converting enzyme inhibitor (ACEI) in the first week. Although an increase is not always seen, up to a 30% increase is normal for starting this class of medications. Patients with heart failure, dehydration, and renal artery stenosis are more likely to see a larger increase. Increases of 0.5 to 1 mg · dL^{-1} (44.20–88.40 nmol · L^{-1}) after initiating an ACEI should prompt an evaluation of the renal vasculature.

JNC 8 updated its recommended treatment goals in 2014. The general population over 60 yr of age should be treated to less than 150/90 mmHg. Adults less than 60 yr of age should be treated to below

140/90 mmHg. Individuals with chronic kidney disease should attempt to reach less than 140/90 mmHg.[5] Your patient has a goal of < 140/90 mmHg in accordance with JNC 8. She has not reached the therapeutic goal. A common side effect of ACEI is a dry cough, which is present 10% of the time.[1] A common rationale to use the angiotensin receptor block is because of the cough; however, the cough is of less importance than the rise of serum creatinine with generalized risk of secondary hypertension.

The absence of abdominal bruits does not eliminate renovascular disease from the differential. The presence of abdominal bruits is highly specific to abnormal renal arteriograms. The presence of a systolic bruit has a positive likelihood ratio of 6.4. However, this exam discovery is not as sensitive. Fewer than half of patients with a surgically correctable renal vascular disease process have abdominal bruits.[11] The decision on what type of imaging study to use to investigate renovascular pathology is beyond the scope of this article, but, briefly, noninvasive options such as duplex Doppler, computed tomography angiography, and magnetic resonance angiography should be considered before proceeding with the more invasive gold standard renal arteriogram. There are substantial risks, including kidney injury, nephrogenic fibrosis, and atheroembolism. Only patients who are surgical candidates should undergo diagnostic testing.[14]

In this otherwise heathy aviator, an ultrasound evaluation was the chosen modality. The ultrasound detailed unilateral reduced flow with concerning masses surrounding the right kidney. Pursuing this abnormality, a computed tomography of her abdomen was obtained that was suggestive of widespread metastatic carcinoma. Pathology from a debulking surgery confirmed adenocarcinoma from the large colon. She had no family history of colon cancer and she never had any changes in her bowel habits.

She started radiation and chemotherapy. Her military career became secondary to her treatment. She was transferred to another base to ensure family support and she never flew again. After 18 mo of varying treatment protocols, the pilot transitioned to palliative care and died within 2 yr of her first hypertensive measurement.

All aeromedical dispositions are based on the underlying disease pathology. Secondary hypertension is a prime example, in which the disease causing the hypertension determines the aeromedical impact. The military waiver requirements and civilian issuance standards require evaluations that reduce concern of secondary causes.

Essential hypertension is addressed by all U.S. military services and the Federal Aviation Administration in their respective medical guidelines. Primary hypertension is associated with a lower aeromedical impact if controlled. There is no sudden risk of incapacitation with hypertension without signs or symptoms of ongoing target-organ damage.[10] The principal aeromedical risk hypertension confers is associated with heart disease and stroke, of which blood pressure is only a single factor.[10] The Federal Aviation Administration uses a three-medication limit in its hypertension certification criteria.[4] The U.S. Air Force provides for single-agent use without requiring a waiver.[7] The U.S. Navy and Army require waivers for flying duties with any medical treatment.[6,12] The conferred risk of hypertension to the aviator is minimized with appropriate control.

Secondary hypertension conveys the same increased risk for cerebral vascular accident or myocardial infarction. However, there are additional pathophysiology concerns beyond reducing the cardiovascular risk. OSA, aldosteronism, pheochromocytoma, thyroid disorders, and Cushing syndrome have further risks that jeopardize an aviator's health or flight safety. The underlying cause of the hypertension must be fully understood to appropriately render an aeromedical disposition. The underlying pathology of this case does not often present as secondary hypertension, but the importance of recognizing when to consider secondary causes from essential hypertension is a learning objective that is transferable to all flight surgeons.

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Morning sick call was uneventful; you breezed through a stack of 469s, then 422s, returned flyers updating their 2992s, and added the finishing touches for a complicated waiver. It was just another day in the clinic, and now you are putting on warm gear for this snowy winter evening to enjoy a well-earned low-level night vision goggle flight on a C-17. As you gather your gear, preparing to leave the clinic, a nurse pops in and asks you to see a patient. She is a 32-yr-old reservist living in Connecticut and a new Air Force nurse on active duty orders at this base for aeromedical evacuation training. She complains of right postauricular numbness that started about 2 h ago. Upon questioning, she states the only difference in her normal routine was the altitude chamber training and exposure given to her class to help them understand their individual symptoms of hypoxia. The chamber ride was entirely uneventful, reached an altitude of 25,000 ft, and occurred approximately 28 h ago; no one else from the class has presented to the flight medicine clinic. The remainder of the history as well as the physical exam is unremarkable.

1. What diagnosis is your primary consideration?

A. Fibromyalgia.
B. Lyme disease.
C. Decompression illness (DCI).
D. Multiple sclerosis.
E. Mixed connective tissue disorder.

ANSWER/DISCUSSION

1. C. Decompression illness (DCI). Decompression sickness (DCS) is a clinical syndrome associated with formation of bubbles from gases dissolved in body tissues after a reduction in ambient pressure. Arterial gas embolism occurs when gas enters the pulmonary vasculature as a consequence of pulmonary barotrauma. Although separate clinical entities, DCS and arterial gas embolism are difficult to distinguish, frequently coexist, and have similar treatment regimens, so they are grouped by some into a larger category of DCI.[13]

There is no pathognomonic symptom or specific laboratory test, so DCI is a diagnosis of exclusion. Therefore, other possible etiologies, including the choices above of fibromyalgia, Lyme disease, multiple sclerosis, and mixed connective tissue disorder, should be investigated during the history and physical as any of these could present to the flight clinic with identical symptoms. However, a high index of suspicion for DCI is needed in this setting because the nature of the symptoms at onset does not predict the ensuing severity of the case. Consequently, a low threshold to transport the patient to a hyperbaric facility, the definitive treatment, is prudent. Fortunately, hyperbaric therapy is a relatively low-risk intervention, so it can be used in equivocal cases. However, caution is needed so appropriate therapy is not withheld as a result of misdiagnosis. For example, mistaking chest pain and respiratory distress from myocardial ischemia as "the chokes" risks morbidity and mortality.

Do not be misled by the long onset to symptoms in this patient. While it's uncommon for symptoms to begin so long out, 28 h in this case, DCS should remain in the differential diagnosis even after 24–48 h for any patient with credible exposure.[9]

2. Which is NOT a characteristic manifestation of DCS?

A. Bends.
B. Chokes.
C. Staggers.
D. Burns.
E. Skin bends.

ANSWER/DISCUSSION

2. D. Burns. The bends, or Caisson disease, is the most familiar condition. It results when nitrogen bubbles come out of solution and into a joint—predominantly large joints, including the shoulders, elbows, wrists, hips, knees, and ankles. The pain can range from a mild dull ache to an excruciating sharp pain exacerbated by movement of the joint. The chokes occur when nitrogen bubbles come out of solution and into the lungs, which causes a deep, substernal chest pain usually described as burning and exacerbated by breathing. Associated symptoms are dyspnea and dry cough.

The staggers, or neurological DCS, occurs when nitrogen bubbles come out of solution and into the brain, resulting in vertigo, dizziness, diplopia, confusion, headache, seizure, scotoma, extreme fatigue,

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