You're the Flight Surgeon

This article was prepared by Robert B. Woolley, M.D., M.P.H.

A 35-yr-old Caucasian male military transport pilot comes into your office for a routine flight physical. He has been flying for 12 yr and has no significant medical problems to report. He denies using tobacco in any form and drinks occasionally, consuming one beer approximately three times a week and three to four beers or mixed drinks once a month or less at social events. He exercises regularly and alternates days of strength training with cardio for 30 min, 5 days per week. He reports that he is usually careful about his diet, but occasionally consumes fast food, salty snacks, and desserts, but considers it to be in moderation. His body mass index is 24. He drinks one cup of coffee and one or two caffeinated soft drinks most days. His reported initial blood pressure is measured at 153/97. He reports that for the past 3 yr almost every time he comes in to be seen his blood pressure (BP) is high; he was told to take it at the drug store, where he claims it was less than 140/90 on the two times he did so. He believes that it all started when his father had a heart attack at age 67, and now he just gets nervous going to the clinic. He denies any changes in vision, chest pain, or excessive stimulant use, including decongestants, dietary supplements, or energy drinks. He takes no medications regularly other than occasional ibuprofen for knee pain. Other than his father, who rarely went to a doctor and was not diagnosed with hypertension until the time of his myocardial infarction, he has no family history of hypertension, renal disorders, or cardiovascular disease.

1. What would be the best next step in evaluating the patient's BP?

- A. Repeating the BP measurement several times and recording the lowest.
- B. Initiating medical therapy.
- C. Referral for specialty evaluation.
- D. 24-h ambulatory BP monitoring (ABPM).

ANSWER/DISCUSSION

1. D. Although repeating the BP measurement is appropriate in this case, there are very specific guidelines for the process and how it must be recorded.⁹ The first step is to ensure that the measurement is taken appropriately; unfortunately, due to time and space constraints as well as inadequate training, this is seldom the case. The BP should be taken

with an appropriately sized cuff on bare skin at the level of the heart, sitting upright with the arm being measured supported by an armrest and feet flat on the floor. The first measurement should be taken after at least 5 min of rest and at least 4 h since the last tobacco or caffeine use. If this measurement is elevated, at least 1 min is allowed to pass until a repeat measure is taken. If the second measure is more than 10 mmHg different than the first, a third is taken. The two closest measurements are then averaged. Although all measurements taken may be recorded, only the first, or the average (if additional measurements are taken), is considered when diagnosing hypertension.

Medical therapy may be indicated for this patient in the future, but is not necessarily the best option at this time, since his reported history brings up the question of reactive or "white coat" hypertension. Treatment at this point may lead to orthostatic hypotension or other adverse effects if he is truly normotensive.⁵

Referral for specialty evaluation is not necessary at this time. Although there is a possibility that the member has a congenital or acquired condition causing hypertension, such a workup is typically only indicated if hypertension is refractory to primary therapy (a first and second line or two first-line drugs) or if other history or exam findings suggest that it is a secondary hypertension.⁸

ABPM for 24 h is an underutilized but highly effective noninvasive study that can evaluate the presence or absence of reactive "white coat" hypertension, as well as the converse condition called masked hypertension.¹² It is also very useful for assessing effectiveness of medical therapy and may help isolate causes such as increased nocturnal sympathetic tone, as may be seen with obstructive sleep apnea. ABPM has been shown to be more sensitive and specific for risk of cardiovascular disease than in-office BPs.

Therefore, the appropriate next step in this case would be to order a 24-h ABPM. This is generally inexpensive and may be available through a variety of specialty or primary care offices. In some cases, 24-h ABPM may not be readily available; it would therefore be appropriate to consider multiday in-office BP checks. The Navy recommends use of 3-d, twice-daily BP checks.¹⁰ In practice, these serial measurements may be better for assessing the effect of treatment than for diagnosing hypertension.

DOI: https://doi.org/10.3357/AMHP.4841.2017

The 24-h ABPM revealed a mean daytime systolic BP of 145 and diastolic BP of 93 with preserved nocturnal dipping. Typically, blood pressure drops by approximately 10-15 mmHg for both systolic and diastolic BP. The loss or reversal of this physiology is believed to be evidence of greater end-organ involvement and may suggest secondary rather than primary or "essential" hypertension. The 24-h ABPM report for this patient establishes the diagnosis of hypertension according to the guidelines established by the Eighth Joint National Committee (JNC 8)⁶ due to the elevated mean daytime blood pressure.

2. According to JNC 8, there is insufficient evidence other than expert opinion to establish a treatment threshold for elevated systolic blood pressure in which age group?

- A. 18–29 yr.
- B. 30-59 yr.
- C. 60–79 yr.
- D. 80+ yr.

ANSWER/DISCUSSION

2. B. JNC 8 differed from its predecessor in that it simplified the recommendations to only one diastolic and one of two systolic BP targets dependent on age and comorbidities.⁷ The committee clarified that for several groups, insufficient high-quality evidence exists to support anything more than grade E (expert opinion) recommendations. The vast majority of BP studies have been accomplished using high-risk populations. These individuals are typically elderly or have comorbid conditions, making it somewhat difficult to generalize to a younger, healthier population. For the group older than 30 but less than 60, there is grade A (randomized controlled trial data) evidence that a diastolic BP less than 90 mmHg is associated with a reduced risk of cardiovascular endpoints, but the same level of evidence does not exist regarding any systolic target. Thus, the recommendation for a treatment threshold of 140 mmHg in this group is based on expert opinion only.

Based on the diagnosis of hypertension in this pilot, you discuss lifestyle modifications and determine that he is already largely in compliance with those recommendations for both diet and exercise. Based on this history, you determine that any additional changes would be unlikely to get him to his goal BP and decide it is best to start medical therapy now.

3. Of the following, which would be the least desirable initial therapeutic drug for this patient?

- A. Lisinopril 10 mg daily.
- B. Amlodipine 5 mg daily.
- C. Hydrochlorothiazide 12.5 mg daily.
- D. Telmisartan 40 mg daily.
- E. Ramipril 2.5 mg daily.

ANSWER/DISCUSSION

3. B. Hypertension in this relatively young pilot poses almost no risk for incapacitation while performing his flight duties. Left untreated, however, his risk will progressively increase to the point where the

chance of an incapacitating cardiovascular or cerebrovascular event becomes unacceptable. Additionally, the end-organ effects of the untreated hypertension may lead to damage to the eyes, heart, and kidneys, disqualifying him for aviation duties. The goal in medical therapy is to effectively treat the hypertension and reduce its potential adverse consequences without exposing the patient to unacceptable adverse effects of medication.

Since the publication of the Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT) in 2002,¹⁶ the general consensus for initial therapy in the majority of patients with essential hypertension has been the use of a thiazide or thiazide-type diuretic. While these drugs are considered safe and effective, there remains some disagreement regarding long-term use, which has been linked to the development of type II diabetes, electrolyte disturbances, and elevated lipids.¹⁴ While many pilots may be concerned about the diuretic effect causing them to void more frequently, this effect is short lived, and intravascular volume typically stabilizes within a matter of days when taken regularly. That being said, it would be wise to avoid taking the short-acting agents such as chlorothiazide or hydrochlorothiazide before flight.

Both angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs) are considered first line and are assumed to be similarly effective at reducing BP as well as being cardio- and reno-protective. Both classes are generally well tolerated, but may cause a rise in serum creatinine with or without impaired renal function and hyperkalemia. The ACE inhibitors in particular have been associated with angioedema, dry cough, and loss of effectiveness in some patients who have demonstrated a nonenzymatic pathway for cleavage of angiotensinogen to angiotensin I. ARBs are also associated with angioedema, but less so.⁷

According to JNC 8,⁶ dihydropyridine-type calcium channel blockers such as amlodipine may be used as first-line agents in black patients, as they demonstrated an overall reduction in the risk of stroke in a subset analysis of the ALLHAT study. In a nonblack patient, treatment should not typically be initiated with a calcium channel blocker. It is important to note that the patient population in ALLHAT comprised individuals 55 yr and older, with a mean age of 66.9, dramatically reducing confidence that a similar benefit would be seen in young aircrew members, even if they were black.¹ Adverse effects of this class of medication include dependent lower extremity edema and fatigue.

The three classes above are the generally accepted first-line agents, although there are a number of other classes of antihypertensive drugs. For a limited number of patients with comorbid conditions, other classes may be used first line, as they may have a therapeutic effect on both conditions. Only a few such cases would be aeromedically acceptable and should receive careful scrutiny from the flight surgeon.

4. Although a full secondary hypertension workup is not warranted in most cases, a preliminary workup should routinely include all of the following except:

- A. Complete blood count.
- B. Polysomnography.
- C. Urinalysis.
- D. Electrocardiogram.
- E. Thyroid function studies.

ANSWER/DISCUSSION

4. B. A thorough physical examination and baseline studies must be done prior to initiating therapy. These are generally easy to obtain and may be accomplished during an office visit. Not only will a good workup provide clues to some of the more common causes of secondary hypertension and assess for end-organ damage,² but it will also provide a good reference for effect once treatment has started. Laboratory studies should include a complete blood count, CHEM-7, thyroid function studies, uric acid, as well as a urinalysis. Physical examination should include pulses, heart sounds, auscultation for bruits, assessment for presence of edema, BPs on each arm, a fundoscopic exam, as well as an electrocardiogram.

Only if the patient presents with history or symptoms suggestive of obstructive sleep apnea would polysomnography be considered appropriate for an initial hypertension evaluation. It would not be wrong to administer a test such as the Epworth sleepiness scale or the STOP-BANG questionnaire³ and subsequently obtain polysomnography if adequate pretest probability exists, but this is not generally required.

One thing all of the recommended first-line agents have in common is the possibility of renal function and electrolyte changes. It is incumbent on the practitioner to reassess with at least a CHEM-7 and abbreviated physical exam 10 to 14 d after initiating therapy. ACE inhibitors and ARB drugs may cause an elevation in serum creatinine of up to 25% from baseline that may be considered a marker of therapeutic effect and should not be confused with renal insult or insufficiency. If such an elevation is noted, the best course is to check again for stability in another 5 to 7 d. Hyper- or hypokalemia or hyponatremia may also be seen and may indicate the need to change therapy.

Commensurate with a diagnosis of hypertension and the initiation of treatment, it is important to understand the aeromedical implications of this condition.

5. Which of the following organizations require a special issuance or waiver for the diagnosis of hypertension, regardless of therapy?

- A. Federal Aviation Administration (FAA).
- B. Air Force.
- C. Army.
- D. Navy.

ANSWER/DISCUSSION

5. C. Each of the groups mentioned has differences in the requirement for hypertension management and waiver requirements.

The FAA allows issuance of a certificate if the pilot has not taken antihypertensives for 30 d or more and has a BP of less than 155 mmHg systolic or 95 mmHg diastolic. These numbers are not in line with the current treatment guidelines, but likely address the relatively low risk for incapacitation at that level of hypertension. For those requiring medication to achieve a BP lower than 155/95, the FAA has a CACI (Certificate the AME Can Issue), which permits use of up to three medications of any class except centrally acting agents and the nitrates. The applicant must demonstrate stability on medications for 7 d and be free of any adverse side effects. For those who do not meet these standards, the decision must be deferred.⁴ The Air Force, as with the other service branches, uses the standards recommended by the JNC of less than 140 mmHg systolic and 90 mmHg diastolic as the acceptable upper limits of BP in an aviator. The Air Force is the only branch that permits use of antihypertensives without a waiver. The use of a single thiazide or thiazide-type diuretic alone or in combination with the potassium-sparing diuretic triamterene or monotherapy with one of the four select ACE inhibitors or ARB drugs is acceptable for all flying classes, as long as there are no adverse effects. For asymptomatic hypertensives with a blood pressure less than 160/100, flying duties may be continued for up to 6 mo while implementing lifestyle modifications according to the Air Force Waiver Guide. Initiation of monotherapy would require appropriate ground testing and, if effective, would not lead to disqualification; however, add-on therapy or second-line medications would be disqualifying until the waiver had been approved.¹³

The Army, likewise, considers hypertension disqualifying for aviation duties and is the only service requiring a waiver for all aircrew who meet the diagnostic criteria, whether or not it is successfully managed with lifestyle modification alone. Grounding is required to adequately assess response to and tolerance of medications; otherwise, the flight surgeon and commander may approve a temporary flying duty upslip of up to 365 d while the waiver is being processed. Class 3 medications include the thiazides, ACE inhibitors, ARBs, and alpha blockers. Most others are nonwaiverable for aircrew.¹⁵

The Navy does not disqualify aviators who are successfully managed with lifestyle modification alone and, like the Air Force, permits up to 6 mo of continued flying duties while lifestyle modifications are being implemented. Unlike the Air Force, the upper limit for this grace period is a systolic BP of 150 mmHg, and any initiation of medical therapy would be immediately disqualifying and necessitate a waiver. In these cases, the member may be returned to flying duties by a local board of flight surgeons pending official endorsement by the Navy Bureau of Medicine and Surgery. The U.S. Navy Aeromedical Reference and Waiver Guide specifically recommends ACE inhibitors as the preferred first-line therapy due to the tolerability and favorable side effect profile, although thiazides are also acceptable and ARBs may be used with justification.¹⁰

Hypertension is a major factor in death and disability and has a prevalence of up to 30% among adults in the United States.¹¹ Early identification and treatment are essential to preventing major cardio-vascular and cerebrovascular events, which may result in sudden inca-pacitation later in life. With proper management, the vast majority of aircrew diagnosed with hypertension will be able to successfully continue their aviation careers. The pilot in this case was successfully treated with a low dose of lisinopril, which was well tolerated, and did not require a waiver for continued service in the U.S. Air Force.

Woolley RB. You're the flight surgeon: hypertension. Aerosp Med Hum Perform. 2017; 88(10):967–970.

ACKNOWLEDGMENTS

The author would like to thank Maj. Brian Snow, nephrologist, Wright-Patterson Medical Center, for his professional review of this article. The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government.

REFERENCES

- ALLHAT Officers and Coordinators for the ALLHAT Collaborative Research Group. Major outcomes in high-risk hypertensive patients randomized to angiotensin-converting enzyme inhibitor or calcium channel blocker vs diuretic: The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT). JAMA. 2002; 288(23):2981–2997.
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003; 289(19):2560–2572.
- Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology. 2008; 108(5):812–821.
- Federal Aviation Administration. Item 55. Blood pressure. In: Guide for aviation medical examiners. Washington (DC): Federal Aviation Administration; 2016. [Accessed 16 Oct. 2016]. Available from http://www. faa.gov/about/office_org/headquarters_offices/avs/offices/aam/ame/guide/.
- Gorostidi M, Vinyoles E, Banegas JR, de la Sierra A. Prevalence of whitecoat and masked hypertension in national and international registries. Hypertens Res. 2015; 38(1):1–7.
- James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014; 311(5):507– 520.
- Li EC, Heran BS, Wright JM. Angiotensin converting enzyme (ACE) inhibitors versus angiotensin receptor blockers for primary hypertension. Cochrane Database Syst Rev. 2014; (8):CD009096.

- Makris A, Seferou M, Papadopoulos DP. Resistant hypertension workup and approach to treatment. Int J Hypertens. 2010; 2011:598694.
- National Health and Nutrition Examination Survey. Health tech/blood pressure procedures manual. Atlanta (GA): Centers for Disease Control and Prevention; 2009:28. [Accessed 16 Oct. 2016]. Available from http:// www.cdc.gov/nchs/data/nhanes/nhanes_09_10/BP.pdf.
- Naval Aerospace Medical Institute. 3.14 Hypertension. In: U.S. Navy aeromedical reference and waiver guide. Pensacola (FL): Naval Aerospace Medical Institute; 2016. [Accessed 16 Oct. 2016]. Available from http://www.med.navy.mil/sites/nmotc/nami/arwg/Pages/ AeromedicalReferenceandWaiverGuide.aspx.
- Nwankwo T, Yoon SS, Burt V, Gu Q. Hypertension among adults in the United States: National Health and Nutrition Examination Survey, 2011– 2012. NCHS Data Brief. 2013; (133):1–8.
- 12. O'Brien E, Coats A, Owens P, Petrie J, Padfield PL, et al. Use and interpretation of ambulatory blood pressure monitoring: recommendations of the British hypertension society. BMJ. 2000; 320(7242):1128–1134.
- Pizzino D, Keirns C, Van Syoc D. Hypertension (Jan 14). In: Air Force waiver guide. Wright-Patterson AFB (OH): U.S. Air Force School of Aerospace Medicine; 2016:454–460. [Accessed 16 Oct. 2016]. Available from http://www.wpafb.af.mil/afrl/711hpw/USAFSAM.
- Salvetti A, Ghiadoni L. Thiazide diuretics in the treatment of hypertension: an update. J Am Soc Nephrol. 2006; 17(4, Suppl 2):S25–S29.
- U.S. Army Aeromedical Activity. Hypertension (ICD9 401.9). In: Flight surgeon's aeromedical checklists. Aeromedical policy letters. Ft. Rucker (AL): U.S. Army Aeromedical Activity; 2014. [Accessed 29 Oct. 2016]. Available from http://glwach.amedd.army.mil/victoryclinic/documents/ Army_APLs_28may2014.pdf.
- Wright JT, Jr., Probstfield JL, Cushman WC, Pressel SL, Cutler JA, et al. ALLHAT findings revisited in the context of subsequent analyses, other trials, and meta-analyses. Arch Intern Med. 2009; 169(9):832–842.

This article was prepared by Robert P. McCoy, D.O., M.P.H.

You are the flight surgeon at a large Air Mobility Command base. You are dreaming about your upcoming cargo mission, knowing that in the heavy community you only go to places where they have really nice hotels, when your last patient shows up. He is a 32-yr-old flight engineer who comes in complaining his low back hurts. He says his pain is so severe that he is unable to walk very far without increased discomfort and it is very difficult for him to bend over. You talk to him further and find out he was involved in a motor vehicle crash approximately 2 wk ago.

You begin to question him further regarding the crash and find out he had been stopped at a traffic light and was rear ended by another car. He states the other car was only going about 10 mph prior to hitting his car. He says there was no significant damage to either car and no intrusion into the vehicular compartment. He was also wearing his seatbelt at the time of collision.

1. What other questions should you ask that may indicate possible serious underlying pathology?

- A. Significant trauma.
- B. Motor or sensory deficit.
- C. New-onset bowel or bladder incontinence or urinary retention.

- D. Saddle anesthesia.
- E. All the above.

ANSWER/DISCUSSION

1. E. Any affirmative answer to the above questions would indicate the possibility of serious pathology and the potential need of additional work-up. In this case, from the patient's description, he did not have significant trauma. Significant trauma would be concerning for the possibility of a compression fracture. In someone with osteoporosis, it would take significantly less force to cause a compression fracture. In addition, he was wearing his seatbelt and was provided additional protection from significant trauma. Motor or sensory deficits would be concerning for the possibility of a herniated nucleus pulpous or a mass-type lesion compressing the nerve. Changes in bowel and bladder habits and/or saddle anesthesia would be concerning for cauda equina syndrome and would require an immediate neurosurgical consultation and magnetic resonance imaging (MRI) of the lower back.²

During your physical exam, you find he has diffuse pain in the lower back without specific pinpoint tenderness. Deep tendon reflexes are 2/4 bilaterally and strength is 5/5 bilaterally. Light touch sensations

DOI: https://doi.org/10.3357/AMHP.4835.2017