You're the Flight Surgeon

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You're the flight surgeon for a C-17 squadron deployed to an undisclosed location in the Middle East. The clinic from which you are operating has very limited capabilities. A urine dip/pregnancy, rapid strep test, and an iSTAT complete your list of available on-site ancillary testing. You do have access to a fairly robust pharmacy that includes several broad-spectrum antibiotics, both oral and intravenous (IV). It becomes readily apparent that you will need to rely on your astute clinical acumen to guide your diagnoses and treatments. Aeromedical evacuation is available; however, even an urgent patient movement request will require a minimum of 12–24 h from the time of submission for a patient to reach the closest definitive care facility.

As the installation's Chief of Aerospace Medicine, you quickly realize the importance of determining the capabilities of the available host nation medical resources. After visiting the closest host nation medical treatment facility (MTF) located within 2 h ground travel time, you find that there are sufficient inpatient medical services, but no emergency surgical services available.

On the Saturday morning before you are supposed to return home from your 6-mo deployment, a 28-yr-old male pilot presents to the clinic complaining of 8-10 h of nausea without vomiting, nonbloody diarrhea, and anorexia. It is his third day on station and he states that his roommate is also having some diarrhea, but otherwise feels fine. This is not the patient's first deployment and he recalls his gut needing to "acclimate" to the local diet with previous deployments. On physical exam his vital signs are stable and he is afebrile. His abdomen is mildly distended and bowel sounds are normal. There is mild diffuse tenderness with no rebound or guarding. The remainder of his focused physical exam is unremarkable, with the exception of trace ketones on urine dipstick.

You determine that the pilot is most likely presenting with the self-limiting symptoms of gastroenteritis commonly seen in personnel during their first week or so on station. In light of the patient's non-acute abdominal exam, you decide to treat him symptomatically with sublingual ondansetron for nausea, oral loperamide (Imodium) for diarrhea, and a liter of IV fluid. You also place him on duties not to include flying status and advise him to return to the clinic for a recheck tomorrow with strict orders to call you immediately should he begin to feel worse.

He returns to the clinic the next morning. His diarrhea is a little better, but the nausea has progressed to include two episodes of vomiting in the last hour. Just prior to vomiting he experienced the onset of significant abdominal pain. He states that the discomfort, which was more generalized yesterday, is now most intense in his lower abdomen on the right side. When you enter the exam room he is laying on his side with his knees drawn up. On physical exam he remains normotensive, but is now borderline tachycardic with an oral temperature of 100.0°F. His abdomen is still mildly distended, but now bowel sounds are hypoactive and he now has tenderness to palpation of the right lower quadrant (RLQ) over McBurney's point. Rovsing, obturator, psoas, and Dunphy signs are all absent, but there is a positive Markle sign.

1. Which of the following statements is FALSE regarding your concern of acute appendicitis in this patient?

A. The absence of a psoas sign should never be used to rule out appendiceal inflammation.
B. Diarrhea or constipation is noted in as many as 18% of patients with appendicitis.
C. The presence of ketones on urinalysis is a factor used to calculate the Alvarado score.
D. The patient's pain migration history alone has a very low sensitivity and specificity.

ANSWER/DISCUSSION

1. D. Patients with acute appendicitis may show some accessory signs that include Rovsing sign (RLQ pain with palpation of the left lower quadrant, which suggests peritoneal irritation in the RLQ), obturator sign (RLQ pain with internal and external rotation of the flexed right hip, suggesting a deep pelvic location of the inflamed appendix), psoas sign (RLQ pain with flexion of the right hip against resistance, suggesting the inflamed appendix is near the right psoas muscle), Dunphy sign (pain in the RLQ elicited by cough, also suggestive of localized peritonitis), and finally the Markle sign (or "hop test," which is pain elicited when the standing patient drops onto his or her heels from tiptoe position). While any of these signs when present may aid in the diagnosis and more precise localization of an inflamed appendix, their absence should never be used to rule out acute appendicitis. Diarrhea, while not commonly seen in association with acute appendicitis, does not rule out the diagnosis. The Alvarado score for the diagnosis of acute appendicitis assigns a point value for each of the following findings: oral temperature >99.1°F (1 point), rebound pain (1 point), RLQ abdominal tenderness (1

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point), anorexia or ketones in urine (1 point), nausea and vomiting (1 point), pain migration (1 point), leukocytosis (>10,000 cells/mm^3) (2 points), and shift to the left with >75% neutrophils (1 point). A total Alvarado score of 1–4 = appendicitis unlikely, 5–6 = possible, 7–8 = probable, and 9–10 = very probable. The most common symptom of appendicitis is abdominal pain. Usually, symptoms begin as epigastric or periumbilical pain, which migrates to the RLQ of the abdomen. This pain migration has a sensitivity and specificity of approximately 80%, making it the most discriminating component of the patient's history.[10]

This pilot presented initially with what appeared to be the typical, self-limiting condition common to personnel upon first arriving at this deployed location, especially given the similarity of symptoms present in his roommate. Uncommonly, appendicitis may be preceded by gastroenteritis, likely due to appendiceal lumen occlusion from lymphoid hyperplasia. Additional causes of lymphoid hyperplasia include other viral illnesses such as upper respiratory infection and mononucleosis. Lymphoid hyperplasia tends to be more common in children and young adults, which may account for the increased incidence of appendicitis in these age groups.[4] Appendiceal lumen obstruction can also be caused by fecaliths, parasites, foreign bodies, Crohn's disease, primary or metastatic cancer, and carcinoid syndrome.

Even though you aren't able to perform a complete blood count, you decide to calculate a "partial" Alvarado score on the pilot, knowing that the real score may be (and likely is) higher. At the time of his initial evaluation, the score was 1 (anorexia or ketones in urine) out of the possible 7 points that you could evaluate. This score places him in the "appendicitis unlikely" category. His score has now jumped to 7, making "appendicitis probable." Remember, this is the best-case scenario, since it was impossible for you to evaluate for the final three additional points due to the inability to obtain a complete blood count.

2. You decide to start IV ertapenem (Invanz), analgesics, and fluids. What is the best transport plan for this patient?

A. Transport by ground to the nearest host nation MTF (2 h away) with inpatient medical services but no surgical capabilities.
B. Transport by ground to the nearest host nation MTF with imaging capabilities (1 h away) to confirm the diagnosis.
C. Transport by aeromedical evacuation to an MTF (12–24 h away) with imaging, inpatient medical, and surgical capabilities.
D. None of the above. Observe the patient and initiate movement only if he becomes hemodynamically unstable.

ANSWER/DISCUSSION

2. C. Based upon the patient's clinical presentation and minimum Alvarado score of 7, the diagnosis of acute appendicitis is probable. Not every patient with suspected acute appendicitis requires abdominal imaging.[1] Although ultrasound equipment is frequently available in deployed locations, the technique is very operator dependent and requires significant training and experience to identify appendicitis. While computed tomography may be helpful to confirm the diagnosis, your clinical suspicion is high enough to forego expending time on additional diagnostics, and you should instead focus on treatment options for the patient. Host nation inpatient care is only 2 h away; however, this patient may require emergent surgical intervention. An "urgent" patient movement request should get the patient to a definitive care facility within 24 h. While this option comes at the expense of a longer delay in reaching surgical care, you have covered the patient with an antibiotic proven to successfully treat up to 73% of patients with uncomplicated acute appendicitis.[5] Given the limitations of your facility and the possibility that the patient could deteriorate despite your evidence-based treatment approach, observing the patient is not a good option.

This case highlights the treatment nuances of common diseases in an austere environment. Appendectomy remains the most widely accepted and used treatment approach for acute appendicitis. There is, however, growing evidence to support the use of antibiotic therapy (ertapenem 1 g IV every day for 3 d followed by levofloxacin 500 mg oral daily and metronidazole 500 mg oral three times a day for 7 d) as an alternative to surgical intervention. In 2015, Salminen et al.[6] published a study comparing antibiotic therapy vs. appendectomy in the treatment of computed tomography-confirmed, uncomplicated acute appendicitis. All 257 patients in the antibiotic group were reevaluated within 12–24 h after initiating antibiotic therapy and underwent appendectomy if the evaluating surgeon suspected progressive infection, perforated appendicitis, or peritonitis. Only 15 of the 257 patients required appendectomy during their initial hospitalization. An additional 55 patients developed recurrent acute appendicitis requiring appendectomy within 1 yr.[6] This evidence supports your decision to proceed with aeromedical evacuation within 12–24 h to an MTF capable of surgical intervention should antibiotic therapy fail or the case progress into complicated acute appendicitis.

3. Assuming the field elevation of your air base is 5000 ft above mean sea level (AMSL) and the destination MTF is 800 ft AMSL, which of the following actions should be considered to mitigate the stresses of flight on this patient?

A. Insertion of a nasogastric tube set to low suction.
B. Adequate pain control with analgesics.
C. Cabin altitude restriction (CAR).
D. All of the above are reasonable actions.

ANSWER/DISCUSSION

3. D. Patients suffering from acute appendicitis are at risk of developing an ileus. Any gas in the body is subject to Boyle's law and is expected to expand at altitude; therefore, it is essential to decompress the gastrointestinal tract as much as possible before and during flight. Additionally, if the patient is prone to airsickness, a nasogastric tube and antiemetics will be helpful in reducing the chance of in-flight nausea and vomiting. The patient's pain intensity is likely to increase during flight due to vibration, gravitational forces, and the hypobaric environment. Subsequently, the U.S. Transportation Command Patient Movement Requirements Center recommends that patients' pain level be controlled to 3 or less on a 0–10 scale before they are validated for movement.[7] CAR may be helpful or necessary for patients with oxygenation difficulties, edema within a fixed space (i.e., cerebral edema or compartment syndrome), or trapped gas (i.e., pneumothorax or free air within the globe). In this case, despite the lack of imaging for confirmation, the diagnosis of acute appendicitis is fairly certain based upon the overall clinical picture. While the pathophysiology of acute appendicitis involves an ischemic process that does

not produce excessive gas within the appendix, the prevention of intraluminal gas expansion within the gastrointestinal tract may be beneficial in reducing pain and/or preventing perforation. The hypobaric cabin environment may also worsen the edema and resultant pain associated with the ischemic appendix. Likewise, if the appendix has already ruptured prior to aeromedical evacuation, the gas expansion could force additional gastrointestinal contents into the peritoneal space. In contrast, a patient presenting with nonspecific abdominal pain and a benign exam would not likely benefit from a CAR. While it is an essential tool used to mitigate the potential for certain conditions to deteriorate in the hypobaric environment, it is also important to use CAR judiciously, as it does impact aircraft performance and fuel consumption. For these reasons, the decision to use a CAR must be based on sound clinical judgment. Finally, if the origination air field or destination MTF elevation lies at or exceeds 8000 ft AMSL, a CAR would not apply because the typical aeromedical evacuation flight cabin altitude does not exceed 8000 ft AMSL.

A good mnemonic for recalling the stresses of flight is "GHOST BaN," which represents G-forces, decreased Humidity, decreased partial pressure of Oxygen, "Shakes" or vibration, decreased Temperature, decreased Barometric pressure, and Noise.[2] You have addressed the G, Ba, and N, as they have a direct impact on this patient's disease process. The flight environment also exposes aeromedical evacuation patients to low humidity, decreased oxygenation (hypoxic hypoxia), high sound levels, and low temperatures. All aeromedical evacuation patients should be provided with adequate fluids to account for insensible losses due to the relatively dry cabin air, supplemental oxygen to compensate for cabin altitude if necessary, hearing protection, and adequate warmth to avoid hypothermia.

Your patient arrives at the destination MTF and the surgeon on call determines that surgical intervention is indicated because he has clinically deteriorated 24 h after initiation of antibiotics. The patient undergoes laparoscopic appendectomy without complication and is recovering as expected.

4. What is the pilot's aeromedical disposition?

A. Return to flying status (RTFS) 6 wk after surgery (no waiver required).
B. RTFS when able to safely pilot and egress the aircraft (no waiver required).
C. RTFS 6 wk after surgery (pending waiver approval).
D. Permanently disqualified.

ANSWER/DISCUSSION

4. B. A history of acute appendicitis is not specifically disqualifying by Air Force,[8] Army,[9] Navy,[5] or Federal Aviation Administration[3] aeromedical standards as long as the aviator has fully recovered. The acute condition may cause "incapacitating abdominal pain of such nature to prevent the member from performing his/her duties," but these symptoms are disqualifying only if they are recurrent in nature.* Simply stated, once acute appendicitis has resolved (regardless of the treatment modality used), the aviator can be RTFS and no waiver submission is required. The length of time necessary to reach RTFS following appendectomy will vary; however, some general guidelines can be used to determine when the aviator is safe to resume flying. Postappendectomy instructions usually preclude lifting more than 25 lb for 2–4 wk. Full recovery is usually attained by 6 wk following an uncomplicated, laparoscopic appendectomy (longer for an open procedure), and the aviator must no longer require narcotic pain medication. This pilot drives a C-17 (heavy, transport aircraft), so as the flight surgeon, your main concern is the pilot's ability to safely egress the aircraft in an emergency. The pilot was RTFS about 5 wk following his laparoscopic appendectomy because the condition resolved and he no longer required postoperative activity restrictions, which would preclude safe flight operations. Aircrew assigned to high-performance/ejection seat airframes may require a lengthier period of nonflying duties until such time as they are capable of tolerating the physical demands related to G-excess maneuvers, including the sudden stress of potential ejection seat activation.

* U.S. Air Force. Section I: abdominal and gastrointestinal USAF medical standards, I11. In: Medical standards directory. 2016:26. [Accessed 1 Nov. 2016]. Available from https://kx2.afms.mil/kj/kx4/FlightMedicine/Documents/Medical%20Standards%20Directory%20(MSD)/MSD%2029%20November%202016.pdf to those with access.

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REFERENCES

1. Armstrong C. ACEP releases guidelines on evaluation of suspected acute appendicitis. Am Fam Physician. 2010; 81(8):1043–1044.
2. Dufour KM. Air medical evacuation in the military: how we deal with the stresses of flight. Air Med J. 2003; 22(4):24–25.
3. Federal Aviation Administration. Item 38. Abdomen and viscera. In: Guide for aviation medical examiners. Washington (DC): Federal Aviation Administration; 2016:90. [Accessed 1 Nov. 2016]. Available from https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/ame/guide/.
4. Hardin DM. Acute appendicitis: review and update. Am Fam Physician. 1999; 60(7):2027–2034.
5. Naval Aerospace Medical Institute. U.S. Navy aeromedical reference and waiver guide. Pensacola (FL): Naval Aerospace Medical Institute; 2016. [Accessed 1 Nov. 2016]. Available from http://www.med.navy.mil/sites/nmotc/nami/arwg/Documents/WaiverGuide/Complete_Waiver_Guide.pdf.
6. Salminen P, Paajanen H, Rautio T, Nordström P, Aarnio M, et al. Antibiotic therapy vs. appendectomy for treatment of uncomplicated acute appendicitis: the APPAC Randomized Clinical Trial. JAMA. 2015; 313(23):2340–2348.
7. U.S. Air Force. En route care and aeromedical evacuation medical operations. Washington (DC): Department of the Air Force; 2017. Air

Force Instruction 48-307. [Accessed 1 Feb. 2017]. Available from http://static.e-publishing.af.mil/production/1/af_sg/publication/afi48-307v1/afi48-307v1.pdf.
8. U.S. Air Force School of Aerospace Medicine. Air Force waiver guide. Wright-Patterson AFB (OH): U.S. Air Force School of Aerospace Medicine; 2016. [Accessed 1 Nov. 2016]. Available from http://www.wpafb.af.mil/afrl/711hpw/USAFSAM.
9. U.S. Army Aeromedical Activity. Flight surgeon's aeromedical checklists. Ft. Rucker (AL): U.S. Army Aeromedical Activity; 2014. [Accessed 1 Nov. 2016]. Available from http://glwach.amedd.army.mil/victoryclinic/documents/Army_APLs_28may2014.pdf.
10. Yeh B. Evidence-based emergency medicine/rational clinical examination abstract. Does this adult patient have appendicitis? Ann Emerg Med. 2008; 52(3):301–303.

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You are a flight surgeon at a geographically separated medical clinic. Your patient is a 40-yr-old pilot complaining of weakness for the past month during a routine appointment. He has not been into the clinic since his last annual flight physical. The patient states he has been working out and would suddenly lose his balance while walking. He states the symptom presents itself intermittently and has no predictive pattern; he denies the weakness is any different during the morning vs. the evening. He denies any intercurrent illness. He denies any change in diet or intake of supplements other than post-workout protein. He denies generalized fatigue, difficulty swallowing, difficulty breathing, and pain. He is very muscular and his examination is grossly normal with +2/4 reflexes symmetrically and 5/5 motor strength in upper and lower extremities. Upon examination, you notice he is unable to sit still and his extremities portray jerky, fidgety movements.

1. If you suspect myopathy as the pathology in this case, which of the following labs would be of LEAST use to you?

A. Creatine kinase (CK).
B. Lactate dehydrogenase.
C. Aspartate aminotransferase.
D. Erythrocyte sedimentation rate.

ANSWER/DISCUSSION

1. D. Erythrocyte sedimentation rate is indicative of inflammation but is not specific to muscle disease, as are all of the other labs. CK would be leaked into the blood stream when muscle fibers are damaged. Lactate dehydrogenase is also indicative of acute muscle/tissue damage. Aspartate aminotransferase is usually indicative of liver disease but can also be elevated in cases of muscle damage. These levels may be elevated when a person strenuously works out. It is advisable to tell the patient not to vigorously work out prior to the lab being drawn. This is especially true if the person is deconditioned.

These labs as well as a comprehensive metabolic panel and thyroid panel are drawn from the patient, and they are within normal limits. CK is in the high range of normal, but the patient is fairly muscular and had been working out prior to the lab being drawn.

2. What symptoms in his history would relatively exclude this patient from the diagnosis of myasthenia gravis?

A. Lack of fluctuating weakness.
B. Lack of ptosis.
C. Lack of difficulty swallowing.
D. Lack of difficulty breathing.
E. A and B.

ANSWER/DISCUSSION

2. E. Myasthenia gravis is a disease that affects the neuromuscular junction. Symptoms are fluctuating weakness, ptosis, diplopia, difficulty swallowing, and difficulty breathing. The fluctuating weakness would show that the patient is weaker at the end of the day compared to the morning. The patient doesn't portray ptosis nor does he portray fluctuating weakness, which would be more indicative of myasthenia gravis. He does not present with difficulty swallowing nor does he present with difficulty breathing, which may be signs of this disease. Aside from history, this would be diagnosed by finding antibodies against acetylcholine receptor or muscle-specific tyrosine kinase.[4] Although the pathology can show similar symptoms, the lab test for myasthenia gravis was negative.

On subsequent visits, you notice the spastic, jerky involuntary movement in his extremities has noticeably increased. You also notice on examination today that the patient's upper extremity has become hypotonic and then hyper-reflexive. His hands and fingers are also twisting in an unusual fashion. You order a magnetic resonance imaging (MRI) of the brain.

3. What do you expect to find?

A. Normal findings – unremarkable.
B. Basal ganglia abnormalities.
C. White matter lesions in the brain.
D. Overall decrease in brain size and mass.

ANSWER/DISCUSSION

3. B. MRI of the brain in a patient with movement disorder will show abnormalities in the basal ganglia. However, these findings are not very definitive. An unremarkable brain scan can be seen in many neurological disorders, notably those that do not involve the central nervous system. White matter lesions are often a nonspecific finding on brain MRI scans, but can be seen with conditions such as trauma,

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