

You're the Flight Surgeon

This article was prepared by Paul D. Vu, M.D., M.P.H.

You are the U.S. Air Force flight surgeon of a 200-member squadron deployed to the Mediterranean. Your operation is small with limited supplies, without a nurse or medical technician. The operations tempo is high, but everyone has a positive attitude. Morale is good, people are healthy, and the internet works. You cannot believe this is considered a deployment.

As you're snorkeling, the phone rings. Confusion pulls you down into the darkness and you awaken to the quiet of the room. The 2 a.m. stillness is pierced by your duty phone. You answer and the caller gasps, "Doc, I'm dying."

The caller's voice belongs to one of the pilots. You grab your medical bag and head to his room. Upon entering, you find your patient on his bed, appearing very uncomfortable. He looks at you with moist eyes, telling you that this is the worst pain he has ever felt. Your mind momentarily registers the strain this will be for the squadron. Flying operations are already taxing the pilots to the max. Another pilot on duty not involving flying (DNIF) is not going to go over well. You push this aside and focus on your patient.

Your patient is 34 yr old and otherwise healthy. When you ask him to rate his pain, he sarcastically tells you "5 stars!" He's never felt pain like this before. He ate chicken and rice for dinner and has been drinking bottled water. He denies sick contacts. He's been deployed here for over a month. He's fit, exercises daily, and consumes about three protein shakes a day. He has not had any injuries. The pain started soon after he went to sleep, about 4 h ago. It started as a vague and deep discomfort. He was able to defecate, thinking that it might help, but achieved no relief. There was no diarrhea or blood in his stool.

The abdominal pain gradually worsened. It does not change with position. Movement does not increase the pain, but he finds it difficult to keep still. You notice that he's gently rocking back and forth on the bed with his knees pulled into his chest. He feels anxious and fears another attack similar to the one that prompted his call to you. During the crescendo, the attack was a deep sharp pain with some radiation to his right flank. He feels the urge to urinate. He denies seeing any blood in his urine. He denies chest pain or shortness of breath. He endorses feeling a bit warm and is nauseated. He has not vomited. He has been passing gas. He has no past medical or surgical history, no family history of disease, takes no medications, and does not have any allergies. He does not drink alcohol or smoke.

Your exam reveals a temperature of 99.0°F, blood pressure of 120/80, pulse of 105, respiratory rate of 14 breaths/min, and oxygen saturation of 98%. He is slightly diaphoretic. Heart and lungs sound are normal. Abdominal exam is soft, nondistended, with normal bowel sounds. Deep palpation of the right side of the abdomen brings a slight increase in pain. There is no rebound tenderness. Murphy's sign is negative. There are no surgical scars or hernias. There is no costovertebral angle tenderness. He refuses your rectal exam.

1. He asks you what you think is going on.

- A. Renal colic.
- B. Cholecystitis.
- C. Pancreatitis.
- D. Diverticulitis.
- E. Appendicitis.

ANSWER/DISCUSSION

1. A. Kidney stones are common, with 19% of men and 9% of women eventually having this diagnosis by age 70.²² Most kidney stones are composed of calcium oxalate or calcium phosphate.²⁶ Other kinds of kidney stones include uric acid, struvite, and cystine stones.²⁹ Although variable in intensity, pain is the most common symptom. It is typically paroxysmal and is thought to result from ureteral spasm. Depending on the location of the stone, pain can involve the back, flank, abdomen, or groin with radiation to the groin.¹⁷ This patient's presentation most closely resembles the clinical picture of renal colic.

Gallstones can also cause pain, especially if they result in cholecystitis. Otherwise, uncomplicated gallstone pain is commonly known as biliary colic. A bit of a misnomer, biliary colic is often dull and constant, rather than colicky. It is classically localized to the right upper quadrant with possible radiation to the right shoulder. Other common symptoms involve diaphoresis, nausea, and vomiting.⁶ A negative Murphy's sign (no pain during inspiration with deep palpation inferior to the liver) can be helpful in ruling out acute cholecystitis, as the sensitivity for this test approaches 97%.²⁵ This patient did not have a Murphy's sign.

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Pancreatitis can cause severe abdominal pain and tenderness. Classically, it presents acutely as persistent epigastric pain that radiates to the back.²⁸ Nausea and vomiting are common symptoms, present in about 90% of patients.¹ Gallstones and chronic alcohol abuse account for most of the cases of acute pancreatitis.^{10,33} This patient does not have pain radiating to the back. He does not drink alcohol. This diagnosis is unlikely.

Diverticulitis results from inflammation of a colonic diverticulum and usually afflicts older people, with a mean age of 63.⁷ The classic presentation is constant, left lower quadrant pain, often for several days.²⁰ Of patients, 50% have associated constipation and 25–35% of patients have diarrhea.^{14,32} Urinary symptoms are present in 10–15% of patients as a result of bladder irritation from an adjacent inflamed colon.³² Although this patient has urinary symptoms, he's relatively young. His pain is not in the left lower quadrant, making this diagnosis less likely.

Appendicitis is one of the biggest causes for abdominal surgery worldwide.³¹ Classically, pain from appendicitis starts periumbilically and migrates to the right lower quadrant. It is associated with nausea, vomiting, and anorexia.¹⁵ Significant rebound tenderness can be from peritoneal irritation by an inflamed appendix. Of note, retrocecal appendicitis can manifest as a dull abdominal ache.¹¹ Although his abdominal pain is right sided, the constellation of findings makes this diagnosis less likely.

You inform him that he probably has kidney stones causing his symptoms. He's heard of this before and knows that it can be pretty painful. He is slightly relieved at having a diagnosis, but would like something for his pain.

2. What should you give him?

- Empirically treat him for pyelonephritis with a broad-spectrum antibiotic like ciprofloxacin.
- Treat his pain only with opiates, as kidney stones do not respond to nonsteroidal anti-inflammatory drugs (NSAIDs).
- Treat his pain only with NSAIDs, as you do not want to risk him becoming addicted.
- It is appropriate to use a combination of NSAIDs and opiates as needed.
- Dissuade him from medication; offer him battlefield acupuncture.

ANSWER/DISCUSSION

2. D. Although pyelonephritis can be a complication from kidney stones, common signs and symptoms of costovertebral angle tenderness and chills/fever are absent.⁸ Additionally, antibiotics would not address this patient's pain. Opiates and/or NSAIDs are appropriate to treat renal colic. There is evidence to show that NSAIDs are at least as effective as opiates, although opiates might have a slightly faster onset of action.⁵ Another randomized trial found that the combination of opiate and NSAID was superior to treating renal colic than either agent alone.²¹ It is necessary to use your clinical judgment to choose the best route. To protect the patient against addiction, you must have a thoughtful and honest discussion of opioid use with the patient upon prescription of this controlled medication. Limited

dispensation and close follow-up would be prudent. Battlefield acupuncture (also known as ear acupuncture) does have some evidence to support its effectiveness as a rapid pain reliever in emergency situations.¹⁸ More study would be needed to support its specific application to renal colic.

You decide to give him 800 mg of ibuprofen and 1 tablet of acetaminophen/hydrocodone 325/5 mg. Within half an hour, his pain is much improved. He falls asleep and you crash on his couch for a few hours. In the morning, after getting clearance from TriCare Overseas Program International SOS, you take your patient downtown for further workup.

3. What's the best study to confirm the diagnosis?

- Magnetic resonance imaging.
- Ultrasound.
- Computed tomography (CT) with intravenous (IV) contrast.
- CT without IV contrast.
- Abdominal radiography.

ANSWER/DISCUSSION

3. D. A noncontrast CT scan is the best study to diagnose renal stones, with sensitivity and specificity of 97% and 96%, respectively.²⁷ In addition to detecting renal stones, it can also evaluate hydronephrosis and other abdominal/pelvic pathology, which may influence your medical decisions and recommendations. Performing a CT with IV contrast is unnecessary and potentially harmful by exposing the patient to nephrotoxic contrast dye. Additionally, the presence of IV contrast may obscure radiopaque stones.

Magnetic resonance imaging poorly identifies renal stones and is rarely used for a kidney stone workup.²⁴ It may be a consideration in pregnant patients who need to avoid ionizing radiation. Abdominal radiography has the advantage of subjecting the patient to a much lower dose of ionizing radiation compared to a CT scan. Unfortunately, sensitivity and specificity are markedly reduced and other intra-abdominal pathology is difficult to detect.¹⁶ Renal ultrasound has the benefit of no radiation exposure, but suffers from reduced sensitivity. Other intra-abdominal pathology is also difficult to find, unless the ultrasound technologist specifically examines the suspected organ.

The CT scan reveals a 3-mm stone in the right ureterovesical junction, without hydronephrosis. No stones were seen on the contralateral side. Your patient is concerned about his future as an aviator.

4. What do you tell him?

- This stone will unlikely pass spontaneously; he will be disqualified from flying and will need to adjust to a new normal of pain.
- This stone will unlikely pass spontaneously, and he will need to be evaluated by a urologist.
- This stone has a good chance of passing spontaneously, but he does have an increased risk of recurrence.
- This stone has a good chance of passing spontaneously, and he is at no increased risk for recurrence.
- This stone is likely to pass, but he will likely suffer from chronic pain.

ANSWER/DISCUSSION

4. C. Given the stone's size, the ureteral stone has a 76% chance to pass spontaneously.⁴ Passage can be aided with adequate hydration and the prescription of tamsulosin, an alpha blocker.¹² Calcium channel blockers are another option for medical expulsive therapy.²³ Unfortunately, the development of this initial kidney stone does put him at increased risk for having recurrent stones in the future.² As such, he should be given a strainer to try to catch the stone for analysis and undergo workup to determine risk factors for stone formation. According to the Air Force Waiver Guide¹³ and Medical Standards Directory,* recovery from an initial uncomplicated attack of nephrolithiasis does not require a waiver. However, recurrent stones will need additional workup and require a waiver. Aeromedical dispositions from the Army³⁰ and Federal Aviation Administration⁹ are similar. The Navy requires a 2-wk DNIF period after spontaneous stone passage.¹⁹

He remains DNIF until a week later, when he reports that his pain has completely resolved. He has no stone to present, as he admits that he rarely (never) strained his urine. You tell him that he probably passed the stone. An abdominal plain film shows no stones. You and the pilot both agree that he's safe and is ready to resume flight duties, but before he leaves your office, you impress upon him the importance of preventing a recurrence. Staying well-hydrated and limiting sodium intake and protein consumption are important steps.³ Additionally, you discuss how flyers in the aviation environment often suffer from temperature extremes that can predispose to dehydration. Diets high in protein and sodium are an easy go-to (especially for busy aviators), but should be avoided. He responds with, "The best I can expect from you is to break even. Flight docs are always taking things away: DNIF, a favorite workout supplement, unapproved sunglasses, and in this case my beloved beef jerky!" He flashes you a big grin, shakes your hand, and says, "Thanks brother!"

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Erratum

Rodeheffer CD, Chabal S, Clarke JM, Fothergill DM. *Acute exposure to low-to-moderate carbon dioxide levels and submariner decision making.* *Aerosp Med Hum Perform.* 2018; 89(6):520–525; DOI: <https://doi.org/10.3357/AMHP5010.2018>.

There was an error in the references as printed. Three references were inadvertently omitted from the final version of the manuscript. In the fourth paragraph (bottom left col. of p. 521), the paragraph reads:

“In a recent review of cognitive and behavioral effects of increased CO₂ exposure...Earlier research, however, indicates that decrements in other measures of cognitive performance (e.g., longer time to complete reasoning tasks) do not emerge until CO₂ levels reach much higher levels (i.e., 6.5% and 7.5%), and are not present even at 4.5% and 5.5% CO₂.¹⁵ Furthermore, other studies have found null effects of CO₂ on neurobehavioral tests (i.e., redirection, grammatical reasoning, digit span, Stroop test) as well as cognitive tests simulating office work tasks with low CO₂ exposures (e.g., 3000 ppm, 5000 ppm)^{23,24} and moderate-to-high CO₂ exposures (e.g., 3–4%).^{20,21}”

Ref. 15, which is cited in the next to last sentence in the paragraph, should be added as Ref. 21; Refs. 23 and 24, which are cited in the last sentence, should be renumbered as Refs. 19 and 20, which are already in the Reference List; and Refs. 20 and 21, cited in the last line of the paragraph, should be added as Refs. 22 and 23.

21. Sayers JA, Smith RE, Holland RL, Keatinge WR. Effects of carbon dioxide on mental performance. *J Appl Physiol.* 1987; 63:25–30.
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By adding these references at the end of the reference list, we realize that they will not be in alphabetical order; however, this is the most efficient way to add the correct references to the article. We sincerely apologize for the error and any inconvenience this may cause.