

require Special Issuance as long as the pilot candidate/pilot is correctable to the minimum required visual acuities.<sup>2</sup>

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You're the flight surgeon at a busy fighter training base and have been called to respond to an in-flight physiological emergency. Your patient is a 28-yr-old student pilot who has just landed from a training flight. He had been flying solo in the aircraft and performing basic fighter maneuver "dog-fighting" engagements with his instructor pilot. He reports that he had some significant "light-loss" on one of his air-to-air engagements. As per emergency procedures, he selected 100% oxygen on his regulator, declared an emergency, and immediately returned to base. He denies complete vision loss or gravity-induced loss of consciousness during the event. He currently feels fine and denies any symptoms such as lightheadedness, dizziness, fatigue, headaches, or breathing difficulties. He denies any problems with the cabin pressurization system or life support equipment (mask, helmet, and G-suit). His vital signs and pulse oximetry are normal when checked in the ambulance.

### 1. What's the next step?

- A. No further work-up is required as he is asymptomatic and vital signs are normal.
- B. Further evaluation in the clinic, including detailed history and physical exam.
- C. Evaluation of pilot's life support equipment to check for malfunctions.
- D. Laboratory evaluation to include complete blood count and metabolic panel.
- E. B, C, and D above.

## ANSWER/DISCUSSION

**1. E.** After a suspected physiological incident, it is appropriate to bring the aviator back to the clinic and perform a thorough, but

focused, history and physical exam. This would include a 72-h history evaluating sleep, crew-rest hours, hydration, nutrition, and any current interpersonal or family stressors. The physical exam should include a full set of vital signs with focus on the cardiovascular, pulmonary, and ear, nose, and throat systems. Additional organ systems may receive a targeted exam based on any significant symptoms or findings elicited from the history.

Laboratory evaluation is indicated and should be routinely used after in-flight physiological events to assess the aviator's current metabolic state and evaluate for occult disease. Suggested initial laboratory evaluation for a physiological event includes a complete blood count (CBC), basic metabolic panel (Chem-7, etc.), and a urinalysis. The urinalysis may be helpful in evaluating the hydration status of the aviator and should also be used to screen for elevated glucose levels. Because the physiological event could result in a future safety investigation, getting additional labs as part of this initial screen should be considered. These tests could include a blood alcohol level and urine drug screen.<sup>5</sup> Other additional laboratory testing may be performed as indicated, such as when evaluating specific symptoms or following a patient's previously known medical condition. For example, a thyroid-stimulating hormone test would be indicated in a patient with a known thyroid disorder.

The patient in this case was brought to the clinic and evaluated. His vital signs, including pulse oximetry, were normal. His 72-h history was unremarkable and there were no indications of abnormal sleep or nutrition habits. The patient did report a 1- to 2-mo history of vague midabdominal pain, though. This pain was described as burning, intermittent, and not associated with food intake. He denied any prior history of gastrointestinal problems or prior abdominal surgery.

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Laboratory evaluation of the patient revealed a normal metabolic panel, normal urinalysis, and negative urine drug screen and blood alcohol level. His CBC was notable for hemoglobin of  $7.3 \text{ g} \cdot \text{dl}^{-1}$  (normal  $10.5\text{--}16.8 \text{ g} \cdot \text{dl}^{-1}$ ) and hematocrit of 20.8% (normal 32.0–50.5%). This anemia had been absent on his initial military entrance exam 3 yr prior, with hemoglobin of  $16.1 \text{ g} \cdot \text{dl}^{-1}$  and hematocrit of 47.1% recorded at that time. When questioned further, the patient did endorse some mild fatigue with exertion over the prior 2 mo. Specifically, he noted fatiguing more easily during his routine workouts, which included running and weight lifting. He again denied lightheadedness or dizziness, headaches, rash, cough, chest pains, easy bruising, significant bleeding events, or recent blood donation. He did endorse some intermittent nausea with his abdominal pain, but denied vomiting, diarrhea, or constipation. When asked about bloody stools or melena, the patient replied, “I don’t know. I don’t really look.” His physical exam was notable for a soft abdomen with normal bowel sounds and mild midabdominal tenderness. He was afebrile and without abdominal rebound tenderness or peritoneal signs. A rectal exam was negative for gross melena, obvious hemorrhoids, or active bleeding. Stool guaiac testing was unfortunately unavailable in the clinic at the time of the patient’s presentation. Slight pallor was noted to both his conjunctiva and oral mucus membranes. There were no oral ulcerations or pigmented lesions noted.

## 2. What’s the next step in evaluating this aviator’s anemia?

- Further laboratory evaluation, including reticulocyte count, iron studies, and basic clotting studies.
- Fecal occult blood testing.
- Place the aviator on duties not including flying until the cause of his anemia is determined and treated.
- A, B, and C above.
- No further work-up is required, as his event was clearly the result of his anemia.

## ANSWER/DISCUSSION

**2. D.** Additional evaluation is required in this case to further evaluate the cause of his anemia. Specifically, laboratory studies to evaluate and characterize his anemia should be completed. These studies would include a reticulocyte count, iron levels, total iron binding capacity studies, serum transferrin, and prothrombin time/international normalized ratio. Because of his abdominal pain, it would also be reasonable to obtain fecal occult blood testing to evaluate for gastrointestinal bleeding. He is not safe to fly in any aircraft with his anemia, as decreased oxygenation may compromise organ function and increase his risk for lightheadedness, chest pain, and decreased  $G_z$  tolerance.<sup>17</sup> He should thus be placed in duties not including flying until his symptoms and their source are properly evaluated and treated.

The pilot returns the next day for the results of his labs, feeling unchanged. He has not noted any new symptoms, although he has stopped exercising due to fatigue and your recommendations. The additional lab work you ordered now reveals a normocytic, normochromic anemia. His reticulocyte count is elevated, his iron levels are low normal, his total iron binding capacity is elevated, and his fecal occult blood testing is positive.

## 3. The next best step in the evaluation of this patient would include which of the following?

- Bone marrow biopsy.
- Computed tomography (CT) colonography.
- Gastroenterology specialty referral.
- Magnetic resonance imaging (MRI) of the adrenal glands.

## ANSWER/DISCUSSION

**3. C.** Gastrointestinal (GI) specialty referral would be appropriate at this time for further evaluation of his occult blood loss. A suspected GI source should be considered in young individuals who present with anemia and vague abdominal symptoms. While this patient currently has no symptoms of gastroesophageal reflux disease, he could have peptic ulcer disease or other gastrointestinal sources for his symptoms and anemia. A bone marrow biopsy is not specifically indicated at this time though, as his reticulocyte count and CBC suggest his bone marrow has adequate function and is producing new red blood cells. While a GI source of bleeding may be suspected here, current evidence suggests that CT colonography should not be viewed as a replacement for colonoscopy. Ideally it would be viewed as an additional modality for colorectal evaluation, particularly in cases unfit for traditional colonoscopy.<sup>13</sup> An MRI of the adrenal glands is also not indicated at this time, as his symptoms do not fit a pattern suggestive of pheochromocytoma or adrenal insufficiency.

A GI specialty evaluation is conducted, including an esophagogastroduodenoscopy and colonoscopy, which are both without any significant findings. The patient’s labs have remained stable, but he now reports dark stools and increased abdominal pain for the last 2 d. Despite the normal endoscopic studies, the gastroenterologist strongly suspects a GI source for his symptoms.

## 4. Your GI consultant and you generate a differential diagnosis list of potential conditions for your pilot. Which one of these is the most likely diagnosis at this time?

- Peptic ulcer disease.
- Irritable bowel syndrome.
- Inflammatory bowel disease.
- Meckel’s diverticulum.
- Peutz-Jeghers syndrome.

## ANSWER/DISCUSSION

**4. D.** Meckel’s diverticulum is reported to be the most common congenital abnormality of the GI tract.<sup>2</sup> It results from the improper closure and absorption of the omphalomesenteric duct,<sup>9</sup> contains all layers of the small intestine, and receives its own blood supply from a remnant of the vitelline artery.<sup>2</sup> It was first described in the late 1500s, but was formally named by Johann Friedrich Meckel in 1802 after a cadaver study of 22 children.<sup>1</sup> It is commonly taught in medicine that this condition follows the “rule of twos”: it is present in approximately 2% of the population, it occurs 2 ft from the ileocecal junction, and it is 2 in long.<sup>15</sup> It is also frequently described as occurring twice as often in males and containing two types of ectopic tissue (gastric and pancreatic).<sup>6</sup> Despite these simplistic common teachings, it can actually occur with many different anatomical variations and clinical, pathological, and radiographic features, making it quite difficult to detect at times.<sup>9</sup>

Most cases of Meckel's diverticulum are asymptomatic and are often diagnosed incidentally.<sup>4</sup> Occurrence is equally distributed between the sexes, but symptomatic complications are reportedly more common in males.<sup>9</sup> Symptoms occur less frequently with advancing age, with 60% of patients coming to medical attention before age 10.<sup>9</sup> Symptomatic presentations may mimic other GI conditions such as inflammatory bowel disease, ulcer disease, or appendicitis.<sup>8</sup> Gastrointestinal bleeding is a common presentation in otherwise asymptomatic patients.<sup>8</sup> Bowel obstruction is rare, but may occur from herniation or intussusception around a fibrous cord, which develops between the diverticulum and the abdominal wall.<sup>10</sup> The lifetime risk of developing complications from a Meckel's diverticulum is 4% up to the age of 20 and 2% up to the age of 40.<sup>9</sup> The mortality from the complications of Meckel's diverticulum is reportedly from 6 to 7.5%.<sup>10</sup>

In this specific case, the diagnosis of peptic ulcer disease would be unlikely in the setting of normal endoscopy.<sup>20</sup> The diagnosis of irritable bowel syndrome is not supported, as the patient does not have the typical presentation of abdominal pain with altered bowel habits for 3 d per month over the previous 3 mo in the absence of organic disease.<sup>19</sup> Inflammatory bowel disease is also unlikely, as the patient's colonoscopy is without mucosal surface irregularities and he is without weight loss, fevers, or other extraintestinal disease manifestations. Peutz-Jeghers syndrome is unlikely, as the patient is without the pigmented lip lesions or GI hamartomas noted with this condition.<sup>14</sup>

**5. Since you now strongly suspect a Meckel's diverticulum in this patient, which study might best assist you in confirming the diagnosis?**

- A. Abdominal CT scan.
- B. Abdominal MRI.
- C. Technetium-99m (<sup>99m</sup>Tc) pertechnetate scintigraphy study.
- D. Exploratory laparotomy.
- E. Video capsule endoscopy.

**ANSWER/DISCUSSION**

**5. C.** In this case a <sup>99m</sup>Tc pertechnetate scintigraphy study, commonly called a "Meckel's scan," would be the most appropriate. While a Meckel's is a true diverticulum consisting of all layers of the small intestine, it may also contain additional heterotopic tissue. The most frequent of these is gastric mucosa.<sup>6</sup> Meckel's diverticula containing gastric mucosa have been shown to have a higher chance of becoming symptomatic when compared to those without gastric mucosa.<sup>2</sup> Because the tracer in the <sup>99m</sup>Tc pertechnetate scintigraphy study may be concentrated in this ectopic gastric mucosa, the scan is commonly used as a noninvasive tool for investigating a suspected Meckel's diverticulum.<sup>15</sup> While the study can identify heterotopic gastric mucosa within the diverticuli, it may fail to identify a Meckel's diverticulum without this ectopic tissue present.<sup>8</sup> It is reported to have a sensitivity of 80–90% and a specificity of 95% in children, although this falls to a sensitivity of 62.5% and a specificity of only 9% in adults.<sup>15</sup> Abdominal radiographic imaging, including CT scans, may not assist in the diagnosis of Meckel's diverticulum unless the patient has intestinal obstruction or intussusception.<sup>7</sup> The patient's presentation and symptoms in this case are not suggestive of these acute conditions. It may often be difficult to distinguish between a diverticulum and

intestinal loops on CT scan, again making this test of limited value.<sup>8</sup> While abdominal MRI may be useful in providing improved anatomic definition when investigating pelvic masses such as a suspected mesenteric cyst, there is no evidence in the literature to support the use of abdominal MRI in the detection of Meckel's diverticulum.<sup>3</sup> As in many cases of Meckel's diverticulum, initial studies, including CT scan, esophagogastroduodenoscopy, and colonoscopy, may not reveal the acute source of GI bleeding. In these cases, a Meckel's diverticulum should strongly be considered and further studies may be indicated. Laparoscopy would be an additional diagnostic option in some cases, but would not be the recommended next step in this hemodynamically stable patient. Capsule endoscopy has also been previously reported as a method of evaluating patients with GI bleeding. Unfortunately, this method is considered to be relatively insensitive and with low diagnostic yield for the detection of Meckel's diverticulum.<sup>8</sup>

The patient in this case underwent a <sup>99m</sup>Tc pertechnetate scintigraphy study, which revealed a persistent focus of uptake in the right lower quadrant.

**6. Now that you have essentially confirmed your suspicion of a Meckel's diverticulum, what is the recommended treatment for this patient?**

- A. Watchful waiting.
- B. Treatment of symptoms with proton pump inhibitor and iron tablets until his anemia resolves.
- C. Surgical excision with segmental small bowel resection.
- D. Laparoscopic simple diverticulectomy.

**ANSWER/DISCUSSION**

**6. C.** Surgical excision with segmental small bowel resection is the recommended treatment in this case. For patients undergoing surgery due to a GI bleed, segmental small bowel resection is preferred over simple diverticulectomy.<sup>8</sup> This removes not only the diverticuli, but also any adjoining distal mucosal irritation. Watchful waiting is neither in the patient's best interest in this case nor does it represent sound aeromedical decision-making. Because of the patient's demonstrated anemia and his status as a single-seat aircraft pilot, his treatment should focus on restoring his health and reducing his risk for continued symptoms. While treatment with a proton pump inhibitor and iron replacement may be part of his postsurgical treatment, this would not be the recommended primary treatment at this time. Whether or not to resect an asymptomatic Meckel's diverticulum incidentally discovered is the source of some debate though. Some favor using established criteria favoring diverticulectomy, such as age > 40 yr, male gender, size greater than 2 cm, or presence of adhesions.<sup>1</sup> Resection of a small, asymptomatic Meckel's diverticulum could be performed using laparoscopic simple diverticulectomy, but in this specific case it would not conform to the recommended treatment for a GI bleed secondary to a Meckel's diverticulum.

Because of the symptomatic bleeding, the patient in this case underwent a surgical resection of the diverticulum with segmental small bowel resection. He did well postoperatively and suffered no surgical complications. He and his spouse now present to your office 6 wk after surgery, asking when he can be returned to flying status.

## 7. What is your recommended aeromedical decision regarding his suitability to return to flying fighter aircraft in the future?

- He can return to flying now, since his condition has been adequately treated.
- He can reasonably be returned with a waiver once his surgical incisions are healed and he is no longer anemic.
- He should not be recommended to return to single-seat fighter aircraft as his risk for future complications is high, although he may fly multipilot aircraft.
- He should be disqualified from all pilot duties in the future.

## ANSWER/DISCUSSION

**7. B.** This patient may reasonably be returned to flying duties in the future, with a waiver, once his surgical incisions are healed and he is no longer anemic. According to the Air Force Medical Standards Directory, symptomatic Meckel's diverticulum is disqualifying for all classes of flying.\* The Medical Standards Directory further references the Air Force Waiver Guide section regarding diverticular disease.<sup>18</sup> In this case, the patient is a trained asset and would require a waiver for his history of symptomatic diverticulosis. It would be reasonable to approve a waiver in this case, as the patient has undergone the definitive treatment (surgical resection). A practical consideration would be to ensure his anemia improved and that he was no longer fatigued with routine daily activities or vigorous exercise before submitting his waiver.

The U.S. Navy Aeromedical Reference and Waiver Guide states that waivers may be considered in aircrew with diverticular disease provided that symptoms are minimal and medications are not required.<sup>12</sup> U.S. Army regulations state that uncorrected GI bleeding does not meet medical standards. Meckel's diverticulum with a history of bleeding is therefore disqualifying, unless it has been greater than 6 mo since surgical correction.<sup>16</sup> The Federal Aviation Administration does not specifically address Meckel's diverticulum in Title 14 Part 67 of the Code of Federal Regulations, but it may fall under part 67.113, General Medical Conditions, making the condition disqualifying unless adequately treated.<sup>11</sup> The airman in this case would meet issuance criteria once adequately recovered from his surgical treatment.

The patient in this case was returned to full, single-seat, Air Force fighter aircraft duties after waiver submission and approval. By the time of waiver submission his anemia had resolved. His abdominal symptoms did not return and he successfully completed his student flying course. He transferred to another base and was reportedly doing well when last queried by the flight surgeon who submitted his waiver, approximately 18 mo after his initial diagnosis.

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