

Crossing the Diaphragm: Don't Let the Diaphragm Delay the Diagnosis

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Pneumococcal pneumonia has long been known to present as abdominal pain.^{1,2} Conversely, pulmonary infiltrates and pleural effusions are often the most salient signs of an abdominal pathologic process.^{3,4} In both cases, physicians must broaden their differential diagnosis to include illnesses occurring on the side of the diaphragm opposite from that of the presenting symptoms.

In this article, we present 4 cases that exemplify illnesses in which the site of the disease process does not lie on the side of the diaphragm one would expect based on the presenting signs and symptoms. The fourth of these cases is a reminder of how systemic illnesses can foil the clinician's search for pathology on either side of the diaphragm. We emphasize the importance of not allowing the diaphragm to be a mental barrier in differential diagnosis. Pathology should be sought on both sides of the diaphragm when faced with abdominal or thoracic symptoms.

CASE HISTORIES

Case 1

A 41-year-old woman with no history of medical problems except a prior hysterectomy presented to the emergency department (ED) complaining of diffuse abdominal pain of 12 hours' duration. She also reported fever, chills, nausea, vomiting, a nonproductive cough, mild dyspnea, and left-sided pleuritic chest pain. She was febrile to 101°F (38.3°C) and had left lower quadrant tenderness on palpation, with localized rebound and guarding. Laboratory tests were normal except for a leukocyte count of $26.0 \times 10^3/\text{mm}^3$. A chest radiograph showed a left lower lobe infiltrate.

Her leukocyte count continued to rise, and she underwent an exploratory laparotomy with appendectomy and lysis of adhesions. The leukocyte count fell postoperatively to $12.0 \times 10^3/\text{mm}^3$, although the appendix was normal. On postoperative day 3, the patient developed a fever of 102°F (38.9°C), and a repeat chest radiograph showed a persistent left lower lobe infiltrate. Sputum and blood cultures grew *Strepto-*

coccus pneumoniae. After appropriate antibiotic therapy, the patient became asymptomatic.

Case 2

A 40-year-old woman with asthma presented to the emergency room complaining of fever, pleuritic chest pain, shortness of breath, and cough with yellow phlegm for 7 days. She was treated presumptively for upper respiratory infection, but her symptoms worsened and she returned a few days later and was then admitted to the hospital. On admission, her oral temperature was 100°F (37.8°C), and she had diffuse abdominal tenderness that was most prominent in the right upper quadrant. The remainder of the physical examination was unremarkable. Laboratory results were normal except for a hemoglobin level of 9.2 g/dL (with microcytic indices) and a mildly elevated alkaline phosphatase. Chest radiograph showed cardiomegaly and clear lung fields. Abdominal ultrasound was negative.

Following surgical consultation, the patient underwent laparoscopic cholecystectomy for suspected acute cholecystitis. Pathologic examination showed a normal gallbladder. Several units of packed erythrocytes were transfused and the patient was discharged home on iron supplementation. However, she continued to have persistent chest pain, dyspnea, and fever. A chest radiograph performed on postoperative day 8 was unchanged from the previous study, but an echocardiogram showed a large pericardial effusion. A pericardiocentesis was performed, yielding 920 mL of fluid. The pericardial fluid had many leukocytes and erythrocytes, but cultures and cytology of the fluid were negative. The patient was placed on intravenous antibiotics for 7 days, and the pericardial fluid did not reaccumulate.

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Table 1. Chest Pathology Associated with Abdominal Pain

Lung and pleurae	Pneumonia, empyema, pleural inflammation, pulmonary infarction
Cardiac	Angina, myocardial infarction, pericarditis
Esophageal	Reflux, perforation

Table 2. Abdominal Pathology Associated with Chest Signs**Ascites**

Generalized peritonitis

Postoperatively following abdominal surgery

Gallbladder inflammation or empyema

Pancreatic disease

Pancreatitis (3%–17% may have pleural effusion)

Pancreatic pseudocyst (may develop a fistula creating a sinus tract into the chest cavity)

Pancreatic ascites (may enter chest cavity via inapparent diaphragmatic defects)

Pancreatic abscess (may cause pleural effusion in as many as 40% of cases)

Splenic abscess or infarction

Subdiaphragmatic abscess (subsequent irritation may lead to an exudative formation in the chest)

Subphrenic abscess (may lead to a pleural effusion in 30% of cases)

Intrahepatic or liver abscesses (may lead to a pleural effusion in 20% of cases)

Perinephric abscess

Renal disease

Renal failure

Nephrotic syndrome

Continuous ambulatory peritoneal dialysis

Carcinoma

Pelvic (Meig's syndrome)

Metastatic

Case 3

A 48-year-old man with a history of hypertension, diabetes mellitus, and end-stage renal disease presented with shortness of breath and right upper quadrant abdominal pain for 2 days. On physical examination, the patient appeared to be in mild-to-moderate respiratory distress. Oral temperature was 101.3°F (38.5°C). Significant clinical findings included generalized obesity, tachycardia, diminished breath sounds bilaterally (more prominent on the right side), and tenderness in the right upper quadrant of the abdomen on palpa-

tion. There were no abdominal masses, guarding, or rebound tenderness. Chest radiograph showed a right pleural effusion. Admission laboratory results showed an elevated leukocyte count of $17.9 \times 10^3/\text{mm}^3$ (65% neutrophils, 14% lymphocytes, 14% monocytes, 7% bands). A computed tomography scan of the chest showed a right pleural effusion and either a right lower lobe atelectasis or pneumonia. An abdominal ultrasound was remarkable for biliary sludge only. Computed tomography scans of the abdomen and pelvis were negative.

The patient was started on therapy for possible acute myocardial infarction, but further diagnostic studies did not support this diagnosis. Blood cultures drawn on admission grew *Bacteroides* and *Staphylococcus epidermidis*, and antibiotic therapy was begun. The fever, chills, and right upper quadrant abdominal pain persisted, however. Fiberoptic bronchoscopy was not helpful, but results of a nuclear medicine scan were consistent with chronic cholecystitis. Abdominal laparoscopy uncovered a right subdiaphragmatic abscess. After drainage of the abscess, the patient's clinical condition gradually improved.

Case 4

A 59-year-old woman presented with fever, nausea, vomiting, and diffuse crampy abdominal pain of 5 days' duration. On physical examination she had poor skin turgor and hypoactive bowel sounds. Laboratory results were normal except a low platelet count ($108 \times 10^3/\text{mm}^3$) and elevated liver enzymes. Abdominal ultrasound showed cholelithiasis and an enlarged common bile duct.

A laparoscopic cholecystectomy was performed. Pathologic examination showed moderate chronic cholecystitis. Intravenous antibiotics were started; however, the patient continued to have fever and mild/moderate abdominal pain. Repeated chest radiograph showed bilateral infiltrates consistent with atypical pneumonia. On further questioning, the patient reported being bitten by a tick in central Texas 3 weeks earlier. Intravenous tetracycline was initiated, and her abdominal pain and fever gradually resolved. Ehrlichia serology showed an IgM titer of greater than 1:320 and an IgG titer of greater than 1:1024. The patient was discharged home on a 14-day course of oral doxycycline.

DISCUSSION

Although physicians know theoretically that a diagnosis may be on the opposite side of the diaphragm than clinical signs would seem to indicate, these cases illustrate the importance of keeping in mind that the

Table 3. Nonsurgical or Systemic Illnesses Associated with Abdominal Pain

Pain originating in the abdomen	
Generalized peritonitis (tuberculosis and spontaneous bacterial peritonitis)	Pancreatitis
Vascular problems with embolism, thrombosis, or bleeding (hemophilia)	Diabetic ketoacidosis
Sickle cell disease	Hematologic disorders (eg, transfusion reactions, von Willebrand's disease)
Distention of a solid organ's visceral surfaces (eg, hepatic or renal capsule in hepatitis; ehrlichiosis; splenomegaly)	Porphyria
Visceral pain resulting from distention with gas, diarrhea, or fluid	Immunologic:
Inflamed lymph nodes (eg, lymphoma, Kawasaki disease)	Anaphylaxis
	CI-Esterase inhibitor deficiency
	Familial Mediterranean fever, systemic lupus erythematosus, rheumatic fever
Pain referred from an extra-abdominal source	
Thorax (see Table 2)	Neurologic causes
Spine (radiculitis)	Tabes dorsalis
Genitalia	Herpes zoster
	Causalgia
	Functional
Metabolic causes	Generalized infections
Toxins—black widow spider bites	Malaria
Vitamin deficiency—pellagra	Meningitis
Acute adrenocortical insufficiency	Bacteremia
Lead poisoning	Measles
Drugs	Kawasaki disease
Uremia and poststreptococcal glomerulonephritis	Typhoid fever
Hyperlipidemia (which may lead to pancreatitis)	

Adapted from Silen, W. Abdominal pain. In: Fauci, Braunwald, Isselbacher et al, editors. Harrison's principles of internal medicine. 14th ed. New York: McGraw-Hill; 1998.

diaphragm is an artificial boundary—not recognizing this crucial fact when evaluating a patient can delay the diagnosis.

Abdominal Pain Associated with Chest Pathology

The discrepancy between the location of abdominal findings and the location of a pathologic process in the chest can be explained by which nerves are irritated. The parietal pleura are richly supplied by fibers from the intercostal nerves. Irritation of the parietal pleura thus produces pain over the chest wall and upper back. In regions innervated by the phrenic nerve, such as the central portion of the diaphragmatic pleura, irritation can produce pain referred to the neck and central back. In contrast, irritation of the lateral aspect of the diaphragmatic pleura, which is innervated by intercostal nerves 7 through 11, will produce pain referred to the epigastrium or the abdomen. In this situation, the pain is usually experienced on the same side of the body as the focus of irritation. The patient may have marked pain in the lumbar region or in the lower

abdominal wall.^{5–7} Chest conditions that may result in abdominal pain are listed in **Table 1**.

In case 1, bacteremic pneumococcal pneumonia was the cause of the appendicitis symptomatology. Modern imaging technology has focused on findings below the diaphragm in the evaluation of possible appendicitis, and recent articles do not mention pneumonia as a cause of abdominal pain.^{8–11} Although most patients with signs and symptoms of abdominal or chest pathology have illnesses centered in that area, a broad differential diagnosis should be kept in mind. This principle is illustrated by case 2, in which a patient suspected of having acute cholecystitis was eventually found to have a pericardial effusion.

Chest Signs Associated with Abdominal Pathology

In case 3, dyspnea and a right-sided pleural effusion were caused by gallbladder disease. The pathogenesis of pleural effusions or empyemas associated with abdominal pathology is not known. It is theorized that inflammation of the diaphragm leads to fluid exudation into the chest from abnormally permeable

subpleural vessels of the diaphragm.^{12–14} Diaphragmatic irritation may also lead to transdiaphragmatic transfer of fluid via diaphragmatic lymphatic vessels or small inapparent defects in the diaphragm. This process may be the means through which amylase is transferred into a pleural effusion in pancreatitis.¹⁵ Abdominal conditions that may present with signs and symptoms in the chest are listed in **Table 2**.

Nonfocal Signs Associated with Focal Pathology (and Vice Versa)

Immunosuppressed patients and those at the extremes of age with focal disease may present with multiple nonfocal signs and symptoms, including nausea, anorexia, generalized malaise, headache, change in mental status, and diffuse myalgias.^{16–18} Such presentations make it difficult for the clinician to point to either side of the diaphragm for the etiology of the disease. This is illustrated by the patient with end-stage renal disease presented in case 3, who was eventually found to have a subdiaphragmatic abscess. Conversely, as in case 4, systemic illnesses may present with abdominal pain. Systemic illnesses that may manifest as abdominal pain are listed in **Table 3**.

CONCLUSION

The diaphragm should not limit the physician's differential diagnostic thoughts. The cases presented here serve to remind us that a disease process on either side of the diaphragm may cause signs and symptoms on the opposite side of the diaphragm. **HP**

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