Does This Patient Have a Pleural Effusion?

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PATIENT SCENARIO

Case 1

A 74-year-old man is admitted to the hospital with a 1-week history of dyspnea, fever, and cough. He has no history of respiratory disease but has a 40 pack-year smoking history. His respiratory examination reveals dullness to conventional percussion and crackles at the left base. Pneumonia seems likely, for which there is a 20% to 40% probability of an associated pleural effusion.[1] Do physical examination findings change the likelihood that this patient has a pleural effusion?

Case 2

A 57-year-old woman with a history of asthma, hypertension, and dyslipidemia presents to the emergency department with a 2-day history of new dyspnea. Her pretest probability of pleural effusion is estimated at 17% based on a prospective study of patients presenting to the emergency department with acute dyspnea.[2] The patient has reduced tactile vocal fremitus and dullness to conventional percussion bilaterally on respiratory examination. What is the most accurate physical examination maneuver for determining if this patient has a pleural effusion?

See also Patient Page.

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Context Pleural effusion is a common finding among patients presenting with respiratory symptoms. The value of the bedside examination to detect pleural effusion is unclear.

Objective To systematically review the evidence regarding the accuracy of the physical examination in assessing the probability of a pleural effusion.

Data Sources We searched MEDLINE (1950-October 2008) and EMBASE (1980-October 2008) using Ovid to identify English-language studies conducted in a clinical setting. Additional studies were identified by searching the bibliographies of retrieved articles and contacting experts in the field.

Study Selection We included prospective studies of diagnostic accuracy that compared at least 1 physical examination maneuver with radiographic confirmation of pleural effusion.

Data Extraction Three authors independently appraised study quality and extracted relevant data. Data regarding participant recruitment, reference standard, diagnostic test(s), and test accuracy were extracted. Disagreements were resolved by consensus.

Data Synthesis We identified 310 unique citations, but only 5 prospectively conducted studies met inclusion criteria (N=934 patients). A random-effects model was used for quantitative synthesis. Of the 8 physical examination maneuvers evaluated in the included studies (conventional percussion, auscultatory percussion, breath sounds, chest expansion, tactile vocal fremitus, vocal resonance, crackles, and pleural friction rub), dullness to conventional percussion was most accurate for diagnosing pleural effusion (summary positive likelihood ratio, 8.7; 95% confidence interval, 2.2-33.8), while the absence of reduced tactile vocal fremitus made pleural effusion less likely (negative likelihood ratio, 0.21; 95% confidence interval, 0.12-0.37).

Conclusions Based on the limited number of studies, dullness to percussion and tactile fremitus are the most useful findings for pleural effusion. Dull chest percussion makes the probability of a pleural effusion much more likely but requires a chest radiograph to confirm the diagnosis. When the pretest probability of pleural effusion is low, the absence of reduced tactile vocal fremitus makes pleural effusion less likely so that a chest radiograph might not be necessary depending on the overall clinical situation.

JAMA. 2009;301(3):309-317   www.jama.com

WHY IS THE PHYSICAL EXAMINATION IMPORTANT IN SUSPECTED PLEURAL EFFUSION?

Pleural effusion is a common finding among patients presenting with respiratory symptoms. It indicates the presence of a disease that may be pulmonary, pleural, or extrapulmonary in origin. The incidence of pleural effusion is estimated at 1 million cases in the United States per

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year.[3] In 1 series of medical intensive care unit patients, the incidence was 8.4% per year.[4] The incidence of parapneumonic effusions among individuals with pneumonia ranges from 20% to 57%,[5-8] and the incidence of pleural effusions in decompensated congestive heart failure (CHF) may be as high as 87%.[9]

Percussion, palpation, and auscultation of the chest should be performed in all patients suspected of having a pleural effusion. The most common symptoms of pleural effusion, chest pain and dyspnea, are nonspecific.[10]

While a pleural effusion can be confirmed by thoracentesis, this procedure can be harmful to patients if the diagnosis is incorrect. Physicians, therefore, confirm pleural effusion with chest radiographs, although other modalities such as ultrasound and chest computed tomography may also be used. Since not every patient with chest or respiratory symptoms requires a chest radiograph, we quantified the diagnostic accuracy of the routine physical examination to diagnose a pleural effusion. Thus, the clinical question of "Does this patient have a pleural effusion?" may in practice become "Does this patient need

Table 1. Distribution of Pleural Effusions in Congestive Heart Failure

Source	Patient Characteristics	No.	No.					Unilateral Right-Sided vs Unilateral Left-Sided		Asymmetric Right-Sided vs Asymmetric Left-Sided[a]	
			Unilateral		Bilateral						
			Right-Sided Only	Left-Sided Only	Right Side Larger Than Left Side	Bilaterally Symmetric or Not Specified	Left Side Larger Than Right Side	χ^2	P Value	χ^2	P Value
			Prospective Study of Consecutive Patients								
Kataoka,[9] 2000	Decompensated CHF, pleural effusion on chest CT	52	5	2	20	23	2	1.3	.26	15	<.01
			Retrospective Studies of Consecutive Patients								
Bedford and Lovibond,[19] 1941	CHF, pleural effusion	136 (89 on chest radiograph; 20 at autopsy; 27 clinically)	68	42	NA	26	NA	6.2	.01	NA	NA
McPeak and Levine,[20] 1946	CHF (bedside examination with or without chest radiograph), thoracentesis required	75	55	8	NA	12	NA	35	<.01	NA	NA
McPeak and Levine,[20] 1946	Clinical CHF, pleural effusion observed on chest radiograph	52	20	4	9	14	5	11	<.01	11	<.01
Leuallen and Carr,[21] 1955[b]	CHF with pleural effusion, available chest radiograph, thoracentesis performed	44	26	17	NA	1	NA	1.9	.17	NA	NA
Peterman and Brothers,[22] 1983	CHF, available chest radiograph, transudative pleural effusion on thoracentesis	54	2	3	16	19	14	0.20	.65	0.03	.87
Weiss and Spodick,[26] 1984	CHF, underlying heart disease, peripheral edema, dyspnea in the absence of other pulmonary and pleural disease, pleural effusion on chest radiograph	70	13	6	NA	51	NA	2.6	.11	NA	
Woodring,[23] 2005	CHF, pleural effusion on chest radiograph	120	18	15	25	36	26	0.27	.60	0.05	.83
Porcel and Vives,[24] 2006	CHF, pleural effusion on chest radiograph, thoracentesis performed	197	62	18	40	56	21	24	<.01	28	<.01
			Retrospective Studies of Autopsy Cases								
McPeak and Levine,[20] 1946	CHF with pleural effusion excluding effusions <300 mL	110	6	11	85	3	5	1.5	.23	53	<.01
White et al,[16] 1947	CHF with pleural effusion	100	15	13	30	34	8	0.14	.71	8.7	<.01
Race et al,[25] 1957	CHF with pleural effusion excluding effusions <250 mL	290	24	11	NA	255	NA	4.8	.03	NA	NA
Total		1300	314	150	225	530	81				

Abbreviations: CHF, congestive heart failure; CT, computed tomography; NA, not applicable.
[a] Either unilateral or right side larger than left vs unilateral or left side larger than right.
[b] Patients were consecutive but not described explicitly.

diagnostic imaging to rule out a pleural effusion?" The bedside physical examination may identify patients who require diagnostic imaging.

CAUSES OF PLEURAL EFFUSION

Pleural effusion occurs when there is disequilibrium between the quantity of fluid entering and leaving the pleural space. Mechanisms by which the rate of fluid formation exceeds the rate of fluid absorption include increased pulmonary capillary pressure or permeability of the endothelial barrier, decreased intrapleural pressure or plasma oncotic pressure, obstructed lymphatic flow, diaphragmatic defects, and thoracic duct rupture.[11] In the United States, the leading etiologies of pleural effusion in adults who undergo thoracentesis are CHF, pneumonia, malignancy, pulmonary embolus, viral disease, coronary artery bypass surgery, and cirrhosis with ascites.[12]

In CHF, pleural fluid formation comes from the alveolar capillaries.[13] Clinically, the accumulation of pleural fluid in CHF is more closely associated with left ventricular failure than right ventricular failure.[14] In 1966, Freidberg[15] noted, "Usually hydrothorax in the course of CHF appears predominantly or exclusively on the right side." This commonly taught concept is important in the clinical examination since it may create expectation bias in which the examiner performs the physical examination maneuvers with greater attention to the right side or interprets the findings with bias when heart failure is clinically suspected. Explanations for asymmetry in CHF-related pleural effusions include the greater extent of lung and pleural surfaces on the right side relative to the left side, and the greater frequency of right-sided vs left-sided decubitus positioning taken by patients with CHF.[16] It has been purported that isolated left-sided pleural effusion is unusual in uncomplicated CHF; and furthermore, that such a finding is suggestive of concurrent pulmonary infarction,[16] pericardial disease,[17] prior coronary artery bypass graft surgery,[18] left-sided pneumonia, or

neoplasm. However, studies that have assessed the lateralization of pleural effusions in the setting of CHF have found mixed results. Most of these studies[9,16,17,19-25] (1300 participants) show that bilateral effusions, symmetric and asymmetric, are the most common distribution in CHF (summary random-effects prevalence 60%, 95% confidence interval [CI], 39%-81%; **TABLE 1**). These data also suggest that when there is asymmetry in CHF-associated pleural effusions (either unilateral or one side larger than the other), the right side is more common with summary prevalence for unilateral or larger right-sided effusion at 47% (95% CI, 30%-65%) compared with left-sided prevalence of 19% (95% CI, 12%-26%).

In patients hospitalized for pneumonia, 20% to 40% will have a parapneumonic effusion.[1] Empyema is pus in the pleural space. Parapneumonic effusions develop due to increased pulmonary interstitial fluid traversing the pleura to enter the pleural space and also due to increased permeability of the capillaries in the pleural space. The mortality rate in patients with a parapneumonic effusion is higher than that in patients with pneumonia without a parapneumonic effusion. One study suggested that bilateral pleural effusions were an independent predictor of short-term mortality (relative risk, 2.8; 95% CI, 1.4-5.8).[27]

HOW TO ELICIT SIGNS OF PLEURAL EFFUSION ON PHYSICAL EXAMINATION

The physical examination for pleural effusion should include inspection, palpation, percussion, and auscultation. Chest examination should be performed with the patient seated and disrobed above the waist. A sheet or gown should be used to maintain patient comfort and privacy. The following are 8 specific physical examination maneuvers with data on diagnostic accuracy identified in the literature: chest expansion, tactile vocal fremitus, conventional percussion, auscultatory percussion, breath sounds, vocal resonance, crackles, and pleural friction rub (BOX).

Box. Physical Examination and Resultant Findings in Pleural Effusion

Inspection
Asymmetric chest expansion

Palpation
Decreased tactile fremitus

Conventional Percussion
Dullness to percussion

Auscultatory Percussion
Diminished resonance (original technique); sharp change to a loud percussion note at the superior edge of the pleural effusion (modified technique)

Auscultation
Reduced or absent intensity of breath sounds over the pleural effusion fluid, decreased vocal resonance or crackles, audible pleural rub

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Inspection

The chest should be inspected anteriorly and posteriorly for asymmetric chest expansion. This is defined as a visible difference in excursion between the 2 sides of the chest[28] and is best done by standing behind the patient and touching the lateral thorax. In addition, concavity of the intercostal spaces should be assessed. If the pleural pressure is increased on the side of the effusion, that hemithorax may be larger and the concavity of the intercostal spaces will be diminished; conversely, if the pleural pressure on the side of the effusion is decreased due to bronchus obstruction, that hemithorax may be smaller and the concavity of the intercostal spaces will be exaggerated.[3]

Palpation

Tactile vocal fremitus is the palpation of low-frequency vibrations transmitted by a patient's voice through the chest. The clinician should press firmly onto the patient's posterior chest using the palmar aspect of the hands and fingertips. The patient should be instructed to say the words "boy" or "toy." Early German physicians asked

Figure 1. Chest Radiograph of Right-Sided Pleural Effusion

patients to say *neun-und-neunzig* to evoke fremitus over the thorax and the English translation is *ninety-nine*. However, it is recommended that patients use the sound "oy" because it is believed to better transmit low-pitched vibrations than ninety-nine.[29] The intensity of the vibration bilaterally over all lung fields should be observed. In normal lung physiology, low-frequency sounds are easily transmitted but high-frequency sounds are filtered. Large pleural effusions, however, reduce the transmission of low-frequency sounds, resulting in decreased tactile fremitus. The differential diagnosis of decreased tactile fremitus includes bronchial obstruction, pneumothorax, and pleural thickening. Increased tactile fremitus is suggestive of consolidation.

Conventional Percussion

Chest percussion was first described in 1761 by Auenbrugger, and in 1892 Osler noted, "In a pleural effusion the percussion signs are very suggestive."[30]

The clinician should firmly place the second or third finger of the nondominant hand horizontally against the patient's posterior chest wall between the ribs. The second or third finger of the dominant hand should be slightly flexed and using the fingertips, the clinician should tap the distal interphalangeal joint of the firmly placed finger of the nondominant hand. Starting at the apices and progressing down to the bases,

the left and right hemithoraces should be compared at equal horizontal planes. A chest in normal condition should sound equally resonant on both sides.

Two theories have been proposed to explain the results of percussion. Under the topographic percussion theory, percussion causes vibrations in the underlying structures, and sound waves are reflected, refracted, and absorbed according to the density of the underlying structures.[31] In the cage resonance theory, the percussion sound reflects the ease with which the body wall vibrates.[31] In either case, both theories suggest pleural effusion will produce decreased resonance.[31] By the same physics of sound production, the differential diagnosis of dullness to percussion includes consolidation, pleural thickening, atelectasis, or elevated hemidiaphragm. An elevated hemidiaphragm can be distinguished from a pleural effusion by assessing for vertical movement of the interface between dullness and resonance; diaphragms normally move 3 to 5.5 cm by percussion from expiration to full inspiration.[32]

Auscultatory Percussion

This technique was originally described by Laennec[33] in 1821 and modified by Guarino[34] in 1974 to detect pulmonary lesions. The clinician should tap lightly over the manubrium with the distal phalanx of one finger while listening with the diaphragm of the stethoscope over the chest wall posteriorly—a pleural effusion will result in diminished resonance.[34]

The technique was modified again by Guarino in 1994.[35] In the modified technique, after the patient has been sitting upright for at least 5 minutes, the diaphragm of the stethoscope should be placed on the posterior chest wall in the midscapular line, approximately 3 cm below the level of the last rib. The stethoscope should rest lightly and be in complete contact with the patient's skin. Using the dominant hand, direct percussion should be applied by finger flicking along 3 or more parallel vertical lines from the apex down toward

the base. The same technique should be repeated on the other hemithorax. In a chest of normal condition, the percussion note remains dull until the last rib, where it changes sharply to a loud note. In the presence of pleural effusion, there will be a sharp change to a loud percussion note at the superior edge of the pleural effusion before the last rib is percussed. This reflects the auscultatory properties of the air-containing lung and pleural fluid interface above the level of the last rib.[35]

Auscultation

Auscultation should occur with the patient breathing through the mouth at normal tidal volumes. The assessment should note the intensity of breath sounds, the transmission of spoken words, and the presence of adventitious sounds. The clinician should proceed in a systematic fashion through all lung fields posteriorly and anteriorly, comparing one side with the other. The intensity of breath sounds is reduced or even absent over the pleural fluid; however, near the upper border of the fluid, the breath sounds may be accentuated due to increased conduction of breath sounds through the partially atelectatic lung compressed by the fluid.[36] Similar to the physiology underlying tactile fremitus, large pleural effusions reduce the transmission of low-frequency sounds, resulting in reduced vocal resonance. Discontinuous sounds or crackles may be heard in pleural effusion as distal airways collapsed from the previous exhalation abruptly open during inspiration. A pleural rub may be audible in inspiration and expiration, reflecting the presence of inflammation, such as rheumatic pleural effusion, adjacent to the area of the finding.

DETECTING PLEURAL EFFUSION BY CHEST RADIOGRAPH

Pleural fluid becomes visible on the upright lateral radiograph at a volume of approximately 50 mL as a meniscus in the posterior costophrenic sulcus. The meniscus becomes visible on the pos-

terior-anterior projection at a volume of about 200 mL.[37] A prediction rule, using lateral and posteroanterior chest radiographs, estimates pleural effusion volume by noting blunting of the costophrenic angle and obliteration of the hemidiaphragm (**FIGURE 1**). This retrospectively derived and validated rule has an accuracy of 85% when compared with computed tomography and an interobserver agreement of 88%.[37]

The first English-language description of the lateral decubitus film was by Rigler[38] in 1931, who used this technique to confirm the presence of pleural effusions in a small series of patients despite the absence of a visible effusion using the standard erect views. The prediction rule does not incorporate lateral decubitus views, which can detect effusions as small as 5 to 10 mL.[39] One expert, Light,[3] advocates ordering bilateral decubitus chest radiographs to document that the pleural fluid is free flowing.

METHODS

Literature Search Strategy

Searches of MEDLINE (1950-October 2008) and EMBASE (1980-October 2008) using Ovid were completed to identify English-language studies performed in a clinical setting. The search strategy for studies evaluating the diagnostic accuracy of the physical examination in pleural effusion used the terms *auscultation, clinical examination, clinical observation, diagnosis, diagnostic accuracy, diagnostic errors, diagnostic techniques and procedures, diagnostic test, diagnostic value, false-negative result, false-positive result, heart rate, likelihood functions, lung auscultation, mass screening, maximum likelihood method, measurement and analysis, medical examination, mouth breathing, palpation, percussion, physical examination, pleural effusion, predictive value of tests, receiver operating characteristic, reference standards, respiratory sounds, roc curve, screening, sensitivity and specificity, vital sign,* and *voice.* Additional articles were identified from searching the bibliographies of retrieved articles.

Study Selection

We retained prospective studies on diagnostic accuracy that described the use of an appropriate reference standard (a radiographic study), applied the same diagnostic and reference tests to all patients, and included participants with and without pleural effusion. Furthermore, primary data or appropriate summary statistics had to be available. Studies describing physical examination maneuvers that required special equipment or could not feasibly be done in a clinical setting were excluded. When necessary, additional data were obtained by contacting study authors.

Two reviewers (C.L.W. and J.H.-L.) independently reviewed the abstracts to select relevant publications that met the inclusion criteria. In cases of doubt, full-text articles were retrieved for review and discussion. Two reviewers (C.L.W. and S.E.S.) independently reviewed all full-text articles to confirm that inclusion criteria were met. Disagreements were

Figure 2. Selection Process for Studies of Physical Examination Accuracy and Radiographic Imaging in Detecting Pleural Effusion
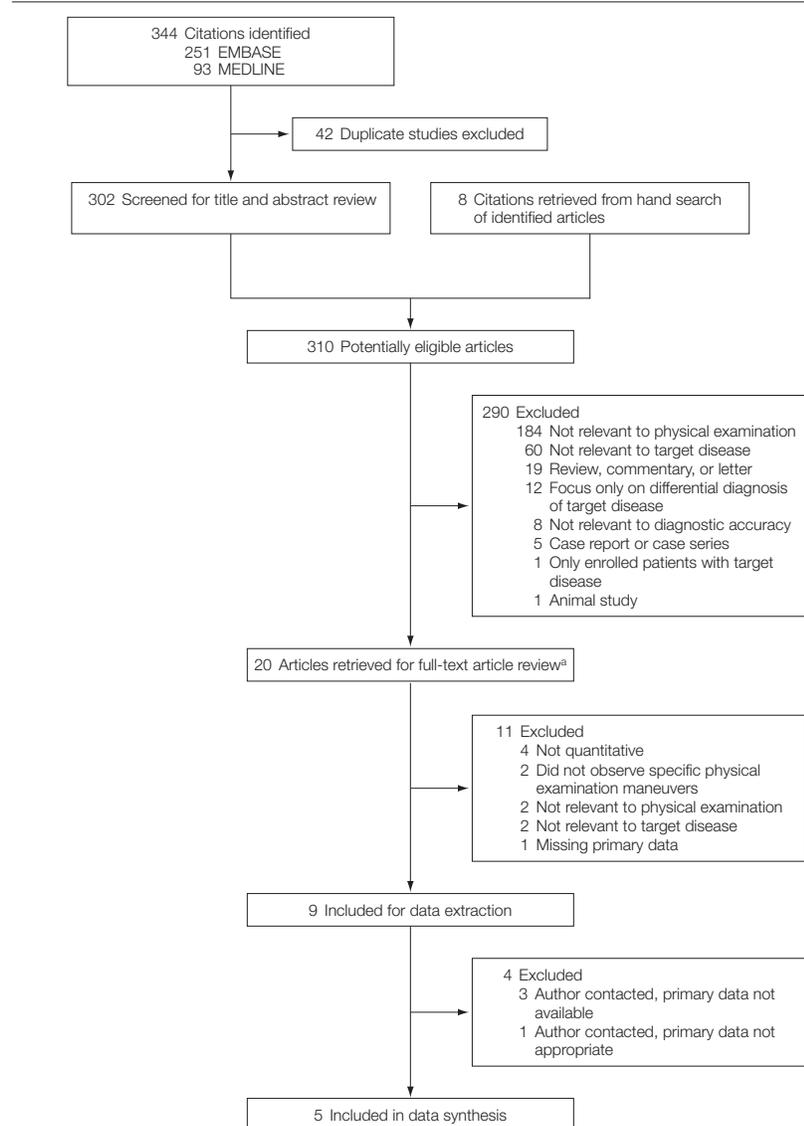
ᵃScreening based on exclusion/inclusion criteria κ=0.66 (95% confidence interval, 0.30-1.00).

resolved by discussion with the third reviewer (J.H.-L.).

Data Extraction

All 3 authors independently extracted data from the included studies. Disagreements were resolved by consensus. Information was extracted pertaining to study quality including study size, participant recruitment method, demographic characteristics of participants, application of reference standard, application of diagnostic test(s), presence of blinding, independence of tests, and participant attrition rates. Study quality was summarized using a qual-

ity checklist designed for the Rational Clinical Examination series.[40]

Statistical Methods

For studies of test accuracy, sensitivity, specificity, and likelihood ratios (LRs) were calculated. Summary LRs were derived using the random-effects model described by the DerSimonian-Laird method. For comparing accuracy between tests, we calculated the diagnostic odds ratio (OR [positive LR/ negative LR]). If one or more studies contained zeros in their 2×2 table, resulting in likelihood estimates of 0 or infinity, 0.5 was added to all the counts

for those studies. Heterogeneity was quantified using the I^2 index. Statistical analysis was conducted using Meta-DiSc version 1.4 (Unit of Clinical Biostatistics, Ramón y Cajal Hospital, Madrid, Spain).[41]

RESULTS

Study Characteristics

We identified 310 potential citations of which 20 were retrieved for full-text review. Fifteen studies were later excluded for a variety of reasons: 2 did not involve the target disease of interest[42,43]; 2 were not relevant to physical

Table 2. Study Characteristics[a]

Source	No. of Participants	Pleural Effusion Prevalence, % (No./Total)	Patient and Setting Characteristics	Recruitment Method	Test Administrator(s): Diagnostic Test(s)[b]	Test Interpreter: Reference Test[b]	Level of Evidence[40]
Bohadana et al,[54] 1986	281	8.2 (23/281)	Excluded patients with severe chest deformities, severe dyspnea, or age <12 y	No specific selection criteria mentioned	2 Trained medical students: (1) conventional percussion; (2) auscultatory percussion	Nonradiologist physician: chest radiograph	3
Bourke et al,[55] 1989	50 (100 lung fields)	4 (2/50)	Hospitalized patients	Random	2 Physicians: (1) conventional percussion; (2) auscultatory percussion	Radiologist: chest radiograph	3
Guarino and Guarino,[35] 1994	293	40 (118/293)	Tertiary hospital	Case participants consecutive, control participants random	Medical students, resident physicians, physicians: auscultatory percussion	Radiologist: chest radiograph	3
Lichtenstein et al,[57] 2004	32 (384 lung fields)[c]	26 of lung fields	Intensive care unit patients with adult respiratory distress syndrome in France	Consecutive	1 Physician: breath sounds	Radiologist: thoracic computed tomography	1
Kalantri et al,[56] 2007	278	21 (57/278)	Inpatients in a teaching hospital in rural India with at least 2 of (1) fever; (2) lower chest pain worsened by cough, sneeze, deep inspiration, or movement; (3) dyspnea; or (4) cough	Consecutive	2 Physicians: (1) chest expansion; (2) tactile vocal fremitus; (3) conventional percussion; (4) breath sounds; (5) vocal resonance; (6) crackles; (7) pleural friction rub; or (8) auscultatory percussion	Nonradiologist physician: chest radiograph	2

[a] Assessments were blinded and independent for all studies; attrition of participants was complete for all studies except Kalantri et al[56] in which 8 participants were excluded from final analysis (2, too ill for diagnostic test; 2, too ill for reference test; 4, discharged or died before test).
[b] Identical tests applied to all participants except diagnostic tests for Kalantri et al[56] in which data were missing for 1 participant for tactile vocal fremitus test and 2 participants for auscultatory percussion.
[c] There were also 10 healthy volunteers, but data were not provided.

examination[44,45]; 2 did not observe specific physical examination maneuvers[46,47]; 4 were not quantitative studies[31,34,48,49]; 1 did not include primary data[50]; 1 did not have the necessary primary data after contacting the author[51]; and 3 studies no longer had primary data available despite contact with the authors.[33,52,53] Five studies met inclusion criteria for data extraction and synthesis (**FIGURE 2**).[35,54-57]

The included studies ranged in size from 32 to 293 participants. Four studies provided details on participant recruitment.[35,55-57] All studies described the use of independent, blinded assessment of reference and diagnostic tests in a clinical setting. Application of the diagnostic tests was consistent and complete in 4 of the studies[35,54,55,57] and some data were missing for 3 patients in 1 study.[56] Application of the reference test was identical and complete within each study. For

the reference test, 2 studies used chest radiographs interpreted by a radiologist,[35,55] 2 used chest radiographs read by a physician who was not a radiologist,[54,56] and 1 used thoracic computed tomography scans interpreted by a radiologist[57] (**TABLE 2**). Although the focus of the review was on physical examination maneuvers, these articles contained no information on the accuracy of symptoms for detecting a pleural effusion.

ACCURACY OF PHYSICAL EXAMINATION FINDINGS IN THE DIAGNOSIS OF PLEURAL EFFUSION

Three studies[54-56] reported on conventional percussion (609 participants), 4 studies[35,54-57] on auscultatory percussion (902 participants), 2 studies[56,57] on breath sounds (310 participants), and 1 study[56] on chest expansion, crackles, pleural friction rub, tactile vocal

fremitus, and vocal resonance (278 participants). There was statistically significant heterogeneity among the studies likely owing to differences in disease severity, patient recruitment method, and experience level of the examiner.

Of the 8 physical examination maneuvers, the presence of dullness to conventional percussion (summary positive LR, 8.7; 95% CI, 2.2-33.8)[54,56] and asymmetric chest expansion (positive LR, 8.1; 95% CI, 5.2-12.7)[56] were most accurate in diagnosing pleural effusion (**TABLE 3**). The diagnostic OR of the 2 studies that compared conventional percussion (summary diagnostic OR, 34; 95% CI, 16-72) with auscultatory percussion (summary diagnostic OR, 8.1; 95% CI, 4.7-14.0) favored conventional percussion.[54,56] The extremely low negative LR for auscultatory percussion popularized by Guarino[35] (negative LR, 0.05; 95% CI, 0.02-0.11) has not

Table 3. Accuracy of Physical Examination Maneuvers in Diagnosing Pleural Effusion

Source	Sensitivity,% (95% CI)	Specificity, % (95% CI)	Positive LR (95% CI)	Negative LR (95% CI)
Asymmetric chest expansion				
Kalantri et al,[56] 2007	74 (60-85)	91 (86-94)	8.1 (5.2-12.7)	0.29 (0.19-0.45)
Auscultatory percussion				
Bohadana et al,[54] 1986	30 (13-53)	95 (92-98)	6.5 (2.9-15.0)	0.73 (0.56-0.96)
Guarino and Guarino,[35] 1994	96 (90-99)	95 (91-98)	19 (9.8-35.2)	0.05 (0.02-0.11)
Kalantri et al,[56] 2007	58 (44-71)	85 (80-90)	3.9 (2.6-5.7)	0.50 (0.36-0.67)
Bourke et al,[55] 1989[a]	0 (0-84)	84 (75-90)	1.0 (0.08-13.0)	1.0 (0.60-1.7)
Pooled	77 (71-83)	92 (89-94)	7.7 (2.4-25.1)	0.27 (0.07-1.0)
P value			<.001	<.001
I² index			91%	97%
Crackles				
Kalantri et al,[56] 2007	56 (42-69)	62 (55-68)	1.5 (1.1-2.0)	0.71 (0.52-0.97)
Diminished breath sounds				
Lichtenstein et al,[57] 2004[b]	42 (33-53)	90 (86-93)	4.3 (2.8-6.6)	0.64 (0.54-0.76)
Kalantri et al,[56] 2007	88 (76-95)	83 (77-88)	5.2 (3.8-7.1)	0.15 (0.07-0.30)
Dullness to conventional percussion				
Bohadana et al,[54] 1986	30 (13-53)	98 (96-100)	19 (6.2-62.1)	0.71 (0.54-0.93)
Kalantri et al,[56] 2007	90 (79-96)	81 (76-86)	4.8 (3.6-6.4)	0.13 (0.06-0.28)
Bourke et al,[55] 1989[a]	50 (1.3-98.7)	95 (89-98)	9.8 (1.9-49.9)	0.53 (0.13-2.1)
Pooled	73 (61-82)	91 (88-93)	8.7 (2.2-33.8)	0.31 (0.03-3.3)
P Value			.02	<.001
I² index			82%	97%
Pleural friction rub				
Kalantri et al,[56] 2007	5.3 (1.1-14.6)	99 (96-100)	3.9 (0.80-18.7)	0.96 (0.90-1.0)
Reduced tactile vocal fremitus				
Kalantri et al,[56] 2007	82 (70-91)	86 (80-90)	5.7 (4.0-8.0)	0.21 (0.12-0.37)
Reduced vocal resonance				
Kalantri et al,[56] 2007	76 (63-87)	88 (83-92)	6.5 (4.4-9.6)	0.27 (0.17-0.43)

Abbreviations: CI, confidence interval; LR, likelihood ratio.
[a] Not included in pooled analyses because data were per hemithorax, not per patient.
[b] Not included in pooled analyses because data were per lung region, not per patient.

been replicated in other studies (negative LR range, 0.50-1.0).[54-56]

Of the 8 physical examination maneuvers, the absence of reduced tactile vocal fremitus makes pleural effusion less likely (negative LR, 0.21; 95% CI, 0.12-0.37).[56]

Limitations

The results of this systematic review should be interpreted within the context of the included studies, of which only 1 examined more than 2 physical examination maneuvers.[56] First, radiographic interpretation, the reference standard for pleural effusion, is prone to variability in accuracy. For example, 1 study noted the sensitivity and specificity of emergency physicians' interpretation of pleural effusion on chest radiograph compared with senior radiologists' interpretation to be 26% and 99%, respectively.[58] Second, the data represented heterogeneous patient populations ranging from patients in rural India[56] to intensive care patients in France with acute respiratory distress syndrome.[57] Third, the level of experience of the examiners in the studies ranged from medical students to experienced physicians, adding further to the source of heterogeneity. Fourth, it is postulated that body habitus may affect the accuracy of chest percussion, for example, in cases of extreme obesity in which percussion sound may be of limited value because it is generally muffled or even inaudible.[30,43] Fifth, the size of the effusion may limit diagnostic accuracy. Last, like other types of systematic reviews, evaluations of diagnostic tests are subject to publication bias and may exaggerate the summary estimate of test accuracy if publication is related to the positivity of results.

BOTTOM LINE

The physical examination should be used for incremental gain in diagnostic certainty. In a population of patients at risk for pleural effusion, dullness to percussion makes a pleural effusion much more likely. A chest radiograph should be obtained to con-

firm the diagnosis. However, the absence of dullness to percussion cannot be similarly used to avoid chest radiographs if the pretest probability for pleural effusion is moderate or high. Mastering the skill of conventional percussion may be particularly useful for localizing an effusion for a thoracentesis or monitoring patients who develop recurrent effusions.

The test characteristics of auscultatory percussion have not been sufficiently validated to recommend its use in the bedside evaluation of pleural effusion. In a population in which the pretest probability of pleural effusion is low, the absence of reduced tactile vocal fremitus makes pleural effusion less likely and a chest radiograph may not be necessary depending on the overall clinical situation.

SCENARIO RESOLUTION

Case 1

Based on the literature, we identified that the pretest probability of a pleural effusion in this patient was 20% to 40%.[1] Clinical features suggestive for pleural effusion were dullness to conventional percussion (summary positive LR, 8.7; 95% CI, 2.2-33.8) and crackles (positive LR, 1.5; 95% CI, 1.1-2.0). Using the single best finding[59] of dullness to conventional percussion, the posttest probability of a pleural effusion is 69% to 85% (pretest odds × positive LR = posttest odds).

The patient subsequently underwent a chest radiograph, including decubitus views, prior to a diagnostic thoracentesis. A computed tomography image of the thorax confirmed a parapneumonic effusion with no evidence of a central obstructing airway mass with postobstructive pneumonia. Pleural fluid (200 mL) was subsequently drained from the left hemithorax.

Case 2

Based on the literature, we identified the pretest probability of a pleural effusion in this patient to be 17%.[2] This patient had some features suspicious for pleural effusion, such as reduced tactile vocal fremitus (positive LR, 5.7; 95% CI,

4.0-8.0) and dullness to conventional percussion (summary positive LR, 8.7; 95% CI, 2.2-33.8). Using the single best finding as in case 1, the presence of dullness to conventional percussion increases the probability of a pleural effusion to 64%. The patient proceeded to have a chest radiograph, which confirmed cardiomegaly, interstitial edema, and bilateral pleural effusions. The patient then underwent further diagnostic evaluation to determine the etiology of the pleural effusions.

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