The Usefulness of Diagnostic Tests on Pericardial Fluid*

David G. Meyers, MD, FCCP; Rayma E. Meyers, BA; and Thomas W. Prendergast, MD

**Study objectives:** To determine the physical, chemical, and cellular characteristics of pericardial fluid in various disease states and to assess their diagnostic accuracies.

**Setting:** A metropolitan university hospital.

**Design:** Consecutive case series.

**Patients:** One hundred seventy-five hospital patients, aged 1 month to 87 years, who had undergone pericardiocentesis (n=165) or control subjects who had undergone open heart surgery (n=10) between 1984 and 1996.

**Measurements:** The appearance of pericardial fluid and results of chemistry tests, cell counts, cytologic studies, Gram’s stain, and microbial cultures were obtained by chart review. The etiology of each pericardial fluid sample was determined using prospective diagnostic criteria.

**Results:** Exudates differed from transudates by higher leukocyte counts and ratios of fluid to serum lactate dehydrogenase levels. Fluid glucose levels were significantly less in exudates. Sensitivity for detecting exudates was high for specific gravity >1.015 (90%), fluid total protein >3.0 g/dL (97%), fluid to serum protein ratio >0.5 (96%), fluid lactate dehydrogenase ratio >0.6 (94%), and fluid to serum glucose ratio <1.0 (85%). None of these indicators were specific. Fluid total protein and specific gravity were moderately correlated (r=0.56). Fluid cytologic study had a sensitivity of 92% and specificity of 100% for malignant effusion. No other test was diagnostic for a specific etiology. Among infection-associated effusions, culture-positive fluid had more neutrophils, higher lactate dehydrogenase levels, and lower ratios of fluid to serum glucose than culture-negative (parainfective) fluid.

**Conclusions:** Evaluation of pericardial fluid might be limited to cell count, glucose, protein, and lactate dehydrogenase determinations plus bacterial culture and cytology. While not used routinely, other tests that may be highly specific for particular diseases should be ordered only to confirm a high clinical suspicion.

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**Key words:** culture; cytology; diagnosis; glucose; lactate dehydrogenase; protein

Pericardial effusion is present in a variety of pathologic conditions. Often the etiology of the effusion is uncertain and cannot be clearly defined on the basis of clinical assessment or even autopsy. With few validated tests available, investigators have successfully made correct diagnoses based on pericardial fluid analysis in 24 to 93% of cases in reported series.1,2

The laboratory analysis of pleural fluid is well established. For instance, exudative pleural effusions have protein levels >3.0 g/dL, specific gravity >1.015, a pleural fluid to serum protein ratio >0.5, and a pleural fluid to serum lactate dehydrogenase ratio >0.6.3-5 If the pleural fluid has none of these characteristics, it is a transudate. Grossly bloody fluid with an RBC count >100,000/mm³ is suggestive of trauma, malignancy, or pulmonary embolism. Pleural fluid leukocyte counts >10,000/mm³ are most common with empyema, parapneumonic effusions, pancreatitis, pulmonary infarction, collagen vascular diseases, malignancy, and tuberculosis. Pleural fluid protein level >6.0 g/dL often indicates tuberculosis or parapneumonic effusion. An elevated fluid lactate dehydrogenase with normal fluid protein is most likely due to malignancy. Low pleural fluid glucose level (<60 to 80 mg/dL) may be due to parapneumonic, rheumatoid, tuberculous, or malignant effusion.

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In contrast to the well-documented ability of tests on pleural fluid to identify the cause of pleural effusion, to our knowledge there has been no comparable systematic evaluation of diagnostic test usefulness when applied to pericardial fluid. This report examines the diagnostic and discriminant power of several chemistry, cellular, and microbiological tests on pericardial fluid.

**Materials and Methods**

The charts of patients admitted to Kansas University Medical Center who underwent pericardiocentesis between January 1, 1984 and January 30, 1992 were identified by a computer search of medical records for pericardiocentesis (International Classification of Diseases code 37.0). One hundred sixty-seven cases were identified. Two were excluded because no laboratory studies had been obtained.

Each hospital discharge summary was reviewed for the cause of the pericardial effusion as originally determined by the patient's attending physician. An investigator (D.G.M.) then reviewed the entire hospital record to confirm the cause of the effusion using the following prospectively defined criteria: malignant—a histologically confirmed diagnosis of any type of cancer, known to metastasize or extend to the pericardium, made within 1 year preceding the pericardiocentesis; bacterial—culture-proved bacterial infection of blood, lung, or pericardium; viral—clinical presentation suggesting a viral syndrome; radiation—prior mediastinal irradiation; uremic—current renal dialysis or serum creatinine value >2.0 mg/dL; rheumatologic—American Rheumatologic Association criteria for rheumatoid arthritis, systemic lupus erythematosus, or scleroderma, or current exposure to hydralazine or procainamide; postpericardiotomy—pericardiotomy within the previous 3 months; traumatic—chest trauma within the 7 days preceding pericardiocentesis; and hypothyroid—serum thyroxine value <5 mg/dL and thyroid stimulating hormone value >5 μU/mL.

If more than one of the above causes of pericardial effusion were present or if the attending physician and the reviewer did not identify the same cause, then the etiology for that patient was classified as undetermined. Diagnoses were confirmed by autopsy in eight cases.

Control patients were evaluated by obtaining pericardial fluid during routine open heart surgery (nine coronary artery bypass procedures and one aortic valve replacement) between February and March 1996 by open pericardial aspiration. None of these patients had diseases or were receiving medications known to cause pericardial effusion.

Between 1984 and 1992, virtually all pericardial fluid samples were submitted for the same battery of laboratory tests, including the following: appearance; volume; cell count; specific gravity; protein; lactate dehydrogenase; glucose; Gram's stain; culture for bacteria mycobacteria, virus, and fungus; and cytology.

Data were abstracted from medical records, entered into a computer database, and analyzed using software (STATA version 4.0 statistical software package; STATA Corporation; College Station, Tex). Because of unequal variance, comparisons of discrete data used the χ² tests, while comparisons of continuous variables used either the Wilcoxon rank-sum test or the Kruskal-Wallis test with Bonferroni post hoc testing. Significance was defined as a two-tailed alpha level <0.10. Sensitivity was defined as true-positives/true-positives + false-negatives. Specificity was defined as true-negatives/true-negatives + false-positives.

**Results**

The results from 82 male and 93 female subjects aged 46.0±21.6 years (range, 1 month to 87 years) are included. Exudative effusions included those diagnosed as malignant (n=37), viral (n=19), bacterial (n=9) or associated with infection but with no growth on cultures (parainfective) (n=6), rheumatologic (n=8), or postpericardiotomy (n=8) based on the degree of inflammation inherent in each disease process. Transudates included those effusions due to radiation (n=15), uremia (n=15), trauma (n=4), hypothyroidism (n=3), and normal controls (n=10). The 41 unclassified cases were analyzed separately.

The initial analysis compared exudates with transudates (Table 1). Neither the volume nor the appearance of the pericardial fluid differed between exudates and transudates. While RBC counts were similar, exudates had significantly higher fluid leukocyte counts (14,116±37,446 vs 2,210±1,916 cells per milliliter; p=0.0123). The proportions of neutrophils and monocytes did not differ. Few differences between exudates and transudates occurred among the chemistry tests evaluated. The ratio of fluid lactate dehydrogenase to serum lactate dehydrogenase was greater with exudates (11.6±16.4 vs 2.6±2.8; p=0.0668). Fluid glucose level was lower with exudates (77.9±41.9 vs 96.1±50.7 mg/dL; p=0.0218).

Specific gravity and total protein of pericardial fluid are moderately correlated, with specific gravity changing by 0.0025 for each 1.0 g change in total protein (r=0.56, p<0.001) (Fig 1).

The ability of each test to correctly classify fluid as exudate or transudate was evaluated using the cut points generally used for pleural fluid. Figure 2 shows the individual data points with the horizontal line denoting the cut point and open symbols marking correct classifications. Exudate was correctly detected (sensitivity) by specific gravity >1.015 in 90% of cases. Similarly, a fluid total protein level >3.0 g/dL had a sensitivity of 97%, and a fluid to serum protein ratio >0.5 had a sensitivity of 96%. The most sensitive marker of exudate was fluid lactate dehydrogenase >200 mg/dL, giving a sensitivity of 98%. The ratio of fluid to serum lactate dehydrogenase >0.6 had a sensitivity of 94%. Specificity was low for these tests. Conversely, the most specific tests (those best identifying transudate) were fluid leukocyte count <10,000 cells per milliliter (89%) and fluid glucose level >60 mg/dL (76%). Other cut points did not materially improve diagnostic accuracy for any test. The test that most correctly classified fluids as exudate or transudate was a fluid to serum lactate dehydrogenase ratio >0.6 (diagnostic accuracy of 87%). While results of fluid-specific
gravity and total protein are correlated, fluid total protein has a superior diagnostic accuracy (77% vs 82%).

Fluid characteristics were compared among the nine disease groups plus the unclassified effusions and controls (Table 2); unclassified effusions had the largest volume, significantly greater than hypothyroid effusions (666 ± 421 vs 200 ± 199 mL; p = 0.02). Among the nine specific disease groups, however, the wide range in volumes was not significantly different. The variation in fluid volumes prohibits any usefulness of fluid volume to discriminate among specific diagnoses. Except for hypothyroid-associated effusions, most effusions (72.6%) were serousanguineous or hemorrhagic. All cases of postpericardiotomy, rheumatologic, and traumatic effusions had bloody fluid. Purulent-appearing fluid was seen only with infective (or parainfective) fluid, but then only in 29% of those cases.

RBC counts did not significantly differ among the

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**Table 1—Pericardial Fluid Appearance, Cell Counts, and Chemistry**

<table>
<thead>
<tr>
<th></th>
<th>Appearance, %</th>
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<tbody>
<tr>
<td></td>
<td>Volume</td>
<td>Serous</td>
<td>Hemorrhagic</td>
<td>Purulent</td>
</tr>
<tr>
<td>Exudate</td>
<td>509 ± 410</td>
<td>17</td>
<td>77</td>
<td>6</td>
</tr>
<tr>
<td>Transudate</td>
<td>495 ± 510</td>
<td>28</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>p Value</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>RBC</th>
<th>WBC</th>
<th>Neutrophil, %</th>
<th>Monocyte Proportion, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exudate</td>
<td>546,415 ± 813,747</td>
<td>14,116 ± 37,446</td>
<td>43.1 ± 33.5</td>
<td>53.9 ± 340</td>
</tr>
<tr>
<td>Transudate</td>
<td>875,652 ± 1,368,490</td>
<td>2,210 ± 1,916</td>
<td>47.8 ± 29.4</td>
<td>50.9 ± 31.0</td>
</tr>
<tr>
<td>p Value</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sp Gr, g/dL</th>
<th>pTP/TP</th>
<th>pFLDH, mg/dL</th>
<th>pFLDH/LDH</th>
<th>pf Gluc, mg/dL</th>
<th>pf Gluc/Gluc</th>
<th>pfpH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exudates</td>
<td>1.021 ± 0.010</td>
<td>4.8 ± 0.8</td>
<td>0.76 ± 0.15</td>
<td>4510 ± 9839</td>
<td>11.6 ± 16.4</td>
<td>77.9 ± 41.9</td>
<td>1.15 ± 2.83</td>
</tr>
<tr>
<td>Transudate</td>
<td>1.024 ± 0.004</td>
<td>4.7 ± 1.3</td>
<td>0.75 ± 0.18</td>
<td>2192 ± 2242</td>
<td>2.6 ± 2.8</td>
<td>96.1 ± 50.7</td>
<td>0.77 ± 0.33</td>
</tr>
<tr>
<td>p Value</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.0668</td>
<td>0.0215</td>
<td>NS</td>
</tr>
</tbody>
</table>

*NS = not significant; Sp Gr = specific gravity; pTP = pericardial fluid total protein; pTP/TP = ratio of pericardial fluid total protein to serum total protein; pFLDH = pericardial fluid lactate dehydrogenase; pFLDH/LDH = ratio of pericardial fluid lactate dehydrogenase to serum lactate dehydrogenase; pf Gluc = pericardial fluid glucose; pf Gluc/Gluc = ratio of pericardial fluid glucose to serum glucose; pfpH = pericardial fluid pH.

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**Figure 1.** Relationship between specific gravity and total protein.

\[ r = 0.56, \ p < 0.001 \]

\[ \text{Sp.Gr.} = 1.0088 + 0.0025 \ \text{(total protein)} \]

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diagnostic groups (Table 3). WBC counts were highest among inflammatory diseases, particularly those with bacterial (41,410±77,122 cells per milliliter) and rheumatologic (12,100±21,636 cells per milliliter) etiologies. Very low WBC counts were seen in hypothyroid effusions (625±247 cells per milliliter). Hypothyroid and malignant effusions had the highest proportions of monocytes (79±27% and 74±26%, respectively). Rheumatoid and bacterial effusions had the highest proportions of neutrophils (78±20% and 69±32%, respectively).

Two chemistry tests differed among the 11 diagnostic groups (Table 4). The ratio of fluid to serum total protein significantly differed between the 10 control subjects and the 10 patients with bacterial or parainfective cases (0.55±0.07 vs 0.85±0.10, respectively; p<0.001). As expected, traumatic effusion had a pericardial fluid to serum protein ratio approaching 1.0. Pericardial fluid cholesterol levels significantly differed between control subjects and subjects with both bacterial-parainfective and malignant fluids (49±18 vs 121±20 and 117±33 mg/dL, respectively; p=0.09). Lowest pH measurements were noted with infected fluids but this did not statistically differ from other causes. The overlap between most diagnostic groups is so large with all chemistry tests that discriminating ability is lost.

Among the 15 cases clinically classified as having bacterial infection-associated pericardial effusion, nine had positive bacterial cultures of pericardial fluid and six had no growth on aerobic bacterial culture. There were no positive viral, fungal, or mycobacterial cultures in the entire cohort. Based on our clinical definition of bacterial infection-associ-
ated effusion, which would include septicemia and pneumonitis, the six culture-negative cases could have parainfective pericardial effusions, (similar to parapneumonic effusion). As shown in Table 5, those with infective cases (positive cultures) were significantly younger, trended toward higher fluid WBC counts, had significantly more neutrophils, and higher lactate dehydrogenase levels. They also had significantly lower fluid glucose levels and fluid to serum glucose ratios than those with parainfective cases.

The diagnostic accuracy of Gram’s stains was evaluated using growth on bacterial cultures of pericardial fluid as the reference standard. Stained bacteria were noted in three of the eight culture-positive fluid samples and in 1 of 83 culture-negative samples.
Table 5—Comparison of Infective and Parainfective Pericardial Effusion

<table>
<thead>
<tr>
<th></th>
<th>Infective</th>
<th>Parainfective</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Male/female</td>
<td>7/2</td>
<td>6/0</td>
<td>NS</td>
</tr>
<tr>
<td>Age, yr</td>
<td>28.8±20.0</td>
<td>45.2±24.3</td>
<td>0.05</td>
</tr>
<tr>
<td>Volume, mL</td>
<td>293±135.88</td>
<td>571.67±560.91</td>
<td>NS</td>
</tr>
<tr>
<td>Appearance (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pusulent</td>
<td>2 (22)</td>
<td>2 (33)</td>
<td>0.066</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>4 (45)</td>
<td>3 (50)</td>
<td></td>
</tr>
<tr>
<td>Clear</td>
<td>3 (33)</td>
<td>1 (17)</td>
<td></td>
</tr>
<tr>
<td>RBC</td>
<td>345,400±429,645</td>
<td>700,237±943,171</td>
<td>NS</td>
</tr>
<tr>
<td>WBC</td>
<td>31,775±36,092</td>
<td>8,192±11,216</td>
<td>NS</td>
</tr>
<tr>
<td>Neutrophils, %</td>
<td>89±5</td>
<td>52±37</td>
<td>0.015</td>
</tr>
<tr>
<td>Monocytes, %</td>
<td>11±5</td>
<td>48±37</td>
<td>0.015</td>
</tr>
<tr>
<td>LDH, mg/dL</td>
<td>7,1(101±3,675</td>
<td>1,704±706</td>
<td>0.032</td>
</tr>
<tr>
<td>Total protein, g/dL</td>
<td>4.15±1.44</td>
<td>4.66±0.63</td>
<td>NS</td>
</tr>
<tr>
<td>pTP/serum TP</td>
<td>0.7±0.28</td>
<td>0.8±0.12</td>
<td>NS</td>
</tr>
<tr>
<td>Glucose, mg/dL</td>
<td>47.2±25.3</td>
<td>102.5±35.6</td>
<td>0.014</td>
</tr>
<tr>
<td>pGlu/s serum Glucose</td>
<td>0.28±0.14</td>
<td>0.84±0.23</td>
<td>0.005</td>
</tr>
<tr>
<td>pH</td>
<td>7.035±0.445</td>
<td>7.082±0.732</td>
<td>NS</td>
</tr>
<tr>
<td>Gram stain (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>2 (25)</td>
<td>2 (33)</td>
<td></td>
</tr>
<tr>
<td>WBCs</td>
<td>3 (375)</td>
<td>3 (50)</td>
<td>NS</td>
</tr>
<tr>
<td>Bacteria</td>
<td>3 (375)</td>
<td>1 (17)</td>
<td></td>
</tr>
</tbody>
</table>

*LDH = lactate dehydrogenase; pTP = pericardial fluid total protein; TP = total protein; pGlu/serum Gluc = ratio of pericardial fluid glucose to serum glucose; NS = not significant.

(Table 6). Presence of stained bacteria had a sensitivity of 38% and absence of bacteria had a specificity of 99%. Leukocytes without bacteria were present in the stained pericardial fluid of three culture-positive cases and 42 culture-negative cases. Either bacteria or leukocytes were present in 64% of exudates while no abnormalities on Gram’s stain were seen in 58% of samples. Presence of leukocytes on Gram’s stains (false-positive) occurred in five transudates; four with uremia and one case with hypothyroidism.

Among 110 mycobacterial, 62 viral, and 120 fungal cultures of pericardial fluid, there were no positive results. Viral syndromes had been diagnosed by clinical presentation in 19 of these patients. No mycobacterial or fungal diseases had been suspected clinically.

Cytologic tests were obtained in 36 cases with malignancy and 101 cases with no clinical evidence of malignancy at the time of pericardiocentesis. Malignant cells were noted in 33 of 36 cases with malignancy (sensitivity of 92%) and in none of 101 nonmalignant cases (specificity of 100%).

Discussion

We are unaware of any other studies that have systematically evaluated the usefulness of laboratory tests performed on pericardial fluid. In the era of outcomes analysis, such critical evaluation is important. Since a battery of tests including microbial cultures, cytology, and chemical tests were obtained almost routinely, selection bias is minimal. The clinical diagnosis was generally not confirmed historically, thus allowing some risk of misclassification of diagnoses.

To our knowledge, no available literature discriminates pericardial fluids into transudate, exudate, or complicated exudate, as is done with pleural fluid. An article reporting three ill-defined cases with purported transudative pericardial fluid noted specific gravities of 1.018 to 1.022, protein level of 4.4 to 5.0 mg/dL, and glucose level of 70 to 90 mg/dL. One case series noted that inflammatory pericardial fluid had a pH of 7.06±0.07 compared with noninflammatory fluid pH of 7.42±0.06. The current series shows that exudate and transudate can be best discriminated by specific gravity > 1.015, fluid protein level > 3.0 mg/dL, fluid to serum protein ratio > 0.5, fluid lactate dehydrogenase value > 300 U/dL, and fluid to serum lactate dehydrogenase ratio > 0.6.

Case reports have described fluid characteristics in several specific diseases. In rheumatoid arthritis, pericardial fluid has been described in 41 cases. The fluid is always serosanguineous and sometimes viscous. A single report noted an RBC count of 30,100 cells per milliliter. Leukocyte counts have ranged from 300 to 88,100 cells per milliliter. Neutrophils were the predominant cell type (72 to 80%). Total protein level was 4.2 to 6.4 mg/dL. Fluid glucose level has ranged from 0 to 66 mg/dL, with most reported cases having glucose levels < 30 mg/dL. Our series observed similar fluid appearance, cell counts, and protein levels. But none of our seven cases had fluid glucose levels < 75 mg/dL. With pleural fluid, it is believed that a diffusion block of glucose occurs in the inflamed pleura. Our cases may have had lower intensities of pericardial inflammation than those other reported cases that had...
lower glucose levels. Fluid characteristics have been reported in four patients with systemic lupus erythematosus and three patients with drug-induced lupus.19-25 Three fluid samples were straw colored and two were serosanguineous.20-23 RBC counts have ranged from 33,750 to 229,000 cells per milliliter.20-22,24 Leukocyte counts of 544 to 199,600 cells per milliliter have been reported, with 76 to 96% neutrophils.20-22,24 With specific gravity of 1.02521 and protein of 4.9 to 7.5 mg/dL,20-25 this fluid is an exudate. Lactate dehydrogenase levels were 2,085 and 4,688 U/dL, in two cases, while glucose level has ranged from 20 to 100 mg/dL.21-24 For rheumatoid arthritis, the most specific tests on pericardial fluid appear to be latex agglutination of rheumatoid antigen,15 immunoglobulin complexes,17 diminished fluid complement,14,26 and cytologic identification of characteristic ‘RA cells.”13 High pericardial fluid titers of antinuclear antibody have been reported in systemic lupus erythematosus24,25 as have “LE cells.”19-21,23-25 Our series utilized none of these latter highly specific tests.

In one of the only case series published on purulent pericarditis, detailed analysis was performed on pericardial fluid from five patients.27 Fluid leukocyte counts ranged from 6,100 to 241,000 cells per milliliter and were >50,000 cells per milliliter in four of the five cases with infected fluid. There were >90% neutrophils in all cases. Fluid glucose level was <35 mg/dL in four patients. Protein level ranged from 3.3 to 6.2 g/dL. Lactate dehydrogenase levels were 4,800 and 6,700 U/mL in two patients. Among the currently reported culture-positive patients, nearly all test results were similar to these reports. Our observed fluid glucose levels were not as low (mean of 47.3 mg/dL) as the prior report and two of the five determinations were >60 mg/dL. Similar to rheumatoid diseases, infective pleuritis is believed to produce a diffusion block to glucose.3-5 To our knowledge, the accuracy of Gram’s stains of pericardial fluid has not been evaluated previously. Limited by the fact that only five culture-positive samples in the current series had Gram’s stains, we found a sensitivity of 38% and a specificity of 99% for presence of bacteria on the stain. Using either leukocytes or bacteria on Gram’s stain as indicators was prohibitively nonspecific for identifying infective pericardial fluid, but was more useful for discriminating exudate from transudate. Thus, a fluid to serum glucose ratio <1.0 may be useful in differentiating exudate from transudate and infective from parainfective effusions. Bacterial culture, but not Gram’s stain, is accurate for defining infective effusions and identifying causative agents.

With tuberculous pericarditis, others have reported a low yield from fluid culture or pericardial biopsy and culture.28,29 Fluid cell counts and chemistry have not been described. Recently, adenosine deaminase levels >40 U/L have demonstrated a sensitivity of 93% and a specificity of 97% for tuberculous pericarditis.30,31 Nested polymerase chain reaction from as little as 1 µL of pericardial fluid can establish the diagnosis.32

Little has been published regarding viral pericarditis. To our knowledge, no cell counts or chemistry results have been reported. Intranuclear inclusions, multinucleated giant cells, and atypical mesothelial cells have been observed with Papanicolaou-stained pericardial fluid in one case each of cytomegalic and herpes simplex pericarditis.33 We found no distinguishing results of any tests.

To our knowledge, no prior reports have described parainfective pericardial effusion. In the cases believed associated with bacterial infection, but with negative pericardial fluid cultures, it is likely that the pericardial fluid was an inflammatory response to adjacent infection, eg, parainfective pericarditis. We noted low fluid leukocyte counts (four of six cases had <10,000 cells per milliliter), a high proportion of monocytes (mean = 48%), lactate dehydrogenase levels <1,550 U/dL in four of five cases, and glucose levels always >50 mg/dL. These observations are very similar to those in parapneumonic pleural effusions.3-5

The fluid characteristics of one patient with postmyocardial infarction pericarditis34 and nine patients with postpericardiotomy syndrome35 have been reported. The fluid appears serous or serosanguineous with a mean of 5,628 leukocytes per milliliter, predominantly monocytes and lymphocytes, and a mean protein level of 6.1 mg/dL (range, 4.3 to 7.2). Our results closely resemble the results of these reports.34,35

In 15 cases of uremic pericarditis, all had serosanguineous fluid with hematocrits of 1 to 24%.36,37 The mean leukocyte count was 2,580 cells per milliliter, primarily consisting of neutrophils.

Mean total protein value has been reported at 4.08 g/dL (80% that of serum levels) and a cholesterol level of 94 mg/dL (50% that of serum levels). In three patients, the mean pericardial fluid pH was 7.08 ± 0.1.37 Our results are quite similar for each parameter.

In one previously described patient with myocardial infarction, the fluid was amber color with a leukocyte count of 1,800 cells per milliliter, total protein level of 6.0 g/dL (similar to serum), and a cholesterol level of 76 mg/dL.38 The protein levels we observed in two patients were much lower and only half that of serum. Our observed cholesterol levels were higher.
and similar to serum. These differences are unexplained. Caution is warranted given the few cases examined.

To our knowledge, the fluid characteristics of radiation-induced pericardial fluid have not been described previously. We failed to identify any distinctive characteristics.

Meta-analysis of 113 cases of malignant pericardial effusion demonstrates a sensitivity of 95% for pericardial fluid cytologic study and a specificity of 100% in 82 samples from patients not having cancer. Our sensitivity of 92% and specificity of 100% in 36 cancer cases and 101 noncancer cases agree with previous reports. Since our cases, as with many other reports, did not always have histologic confirmation of malignant pericardial involvement, a sensitivity <100% would be expected. Additionally, single-sample cytologic study is known to allow false-negative results.

One report has examined normal pericardial fluid, obtained at open heart surgery in 11 patients. These samples resembled serum: sodium, 138±4 mEq/L; potassium, 4.5±1 mEq/L; chloride, 109±5 mEq/L; and bicarbonate, 25±6 mEq/L. Total protein level was 3.1±0.6 g/dL. Fluid pH was 7.57±0.11. We noted a slightly higher protein level in our 10 control patients. The other parameters were not measured.

CONCLUSIONS

Diagnostic evaluation of pericardial fluid should begin with differentiation between exudate and transudate. The identification of an exudate is best done with one or more of four tests using the following cut points: fluid total protein level >3.0 g/dL; fluid to serum total protein ratio >0.5; fluid to serum lactate dehydrogenase ratio >0.6; and fluid lactate dehydrogenase <300 U/dL.

Two other tests should also be ordered routinely based on their high specificity and the crucial importance of detecting a specific disease: bacterial culture and fluid cytology.

Other tests either do not have significant discriminating power, do not identify a prevalent disease, or closely parallel results of another test. Thus, routine testing should be limited to the above six tests.

Other tests should be ordered only when a high level of clinical suspicion of a specific disease warrants confirmation. These tests might include the following: fluid latex fixation for rheumatoid antigen, γ-globulin complexes, and fluid complement levels for rheumatoid arthritis; fluid antinuclear antibody titers for systemic lupus erythematosus; and fluid adenosine deaminase and nested polymerase chain reaction for tuberculosis.

To our knowledge, no diagnostic tests of pericardial fluid exist that are specific for effusion associated with postpericardiotomy syndrome, radiation or uremic pericarditis, hypothyroidism, or trauma.

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