The Use of Paracentesis in the Assessment of the Patient With Ascites

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RATIONAL CLINICAL EXAMINATION REVIEW SOURCE

This is a rational clinical examination abstract, a regular feature of the *Annals*' Evidence-Based Emergency Medicine (EBEM) series. Each features an abstract of a rational clinical examination review from the *Journal of the American Medical Association* and a commentary by an emergency physician knowledgeable in the subject area.

The source for this rational clinical examination review abstract is: Wong CL, Holroyd-Leduc J, Thorpe KE, et al. Does this patient have bacterial peritonitis or portal hypertension? how do I perform a paracentesis and analyze the results? *JAMA*. 2008;299:1166-1178.[1] The *Annals*' EBEM editors assisted in the preparation of the abstract of this rational clinical examination review, as well as selection of the Evidence-Based Medicine Teaching Points.

OBJECTIVE

This article reviews the evidence for methods of performing paracentesis to decrease risk of adverse events and improve diagnostic yield. It also determines the accuracy of ascitic fluid analysis for spontaneous bacterial peritonitis or portal hypertension.

DATA SOURCES

The authors report a search of relevant English-language studies from MEDLINE from 1966 to April 2007 and from EMBASE from 1980 to April 2007. The authors described detailed searches for studies evaluating interventions to optimize success of paracentesis, using all relevant terms. The authors then performed detailed searches for studies of accuracy test parameters. Finally, they performed searches of the bibliographies of retrieved articles to locate additional sources.

STUDY SELECTION

Studies were included if they were randomized trials of a predominantly adult population undergoing intervention to reduce adverse events from paracentesis and optimize success. If no randomized studies were found, studies of lower quality were retrieved. There were 6 interventions of interest to the authors' study: measurement of coagulation status, use of ultrasonographic guidance, location of needle insertion, needle design, bedside versus delayed inoculation in culture bottles, and use of plasma expanders. There were 3 outcomes of interest to the authors' study: amount of ascitic fluid, number of attempts, and adverse events. There were 5 diagnostic tests of ascitic fluid of interest: WBC count, polymorphonuclear cell count, pH, blood–ascitic fluid pH gradient, and serum-ascites albumin gradient.

DATA EXTRACTION AND ANALYSIS

Two investigators independently reviewed potentially eligible articles. Disagreements were resolved by discussion with a third investigator. For studies of interventions, a 2-tailed Fisher exact test was used to examine the significance of association between 2 categorical variables. Studies on the use of plasma expanders were assessed using the Q test for statistical heterogeneity. Summary likelihood ratios (LRs) were calculated with the random-effects method of DerSimonian and Laird for meta-analysis.

MAIN RESULTS

Preprocedure Coagulation Studies

From 73 articles identified using the search strategy, 2 prospective studies were found that obtained prothrombin times and platelet counts before paracentesis. There were no instances of significant bleeding in either study for diagnostic procedures, even though some patients had platelet counts less than 50,000/μL or had international normalized ratios greater than 1.5. There were 2 instances of minor bleeding among the therapeutic procedures (0.64%; 95% confidence interval [CI] 0.08% to 2.3%). Both occurred in patients with an international normalized ratio between 2.5 and 2.9 and platelet count between 50,000 and 99,000/μL.

Location of Paracentesis and Ultrasonographic Guidance

There were 3 articles from 148 possible citations that met inclusion criteria for studies investigating the location of paracentesis. Two of the 3 studies evaluated potential locations for paracentesis by ultrasonography but neither objectively confirmed the location by actually performing the procedure. The final study prospectively compared the traditional method to bedside ultrasonographically guided technique. The randomization was performed by coin toss. With intention-to-treat analysis, there was no significant difference in the rate of successful aspiration of ascites: 71% for ultrasonographically guided and 61% for traditional technique ($P=.39$). In the 17 patients who failed traditional technique, 15 underwent ultrasonographic evaluation. In 13 of these, there was ascitic fluid visible, and all 13 underwent successful aspiration. This study also examined the number of attempts between the 2 groups and found no difference in the proportion of patients requiring more than 1 attempt ($P=1.00$).

Needle Design

There were 116 possible citations found about needle design. There were no randomized studies about needle gauge or length. One prospective study used 22-gauge needles. First attempts were made with a 1.5-inch needle, and second attempts, when necessary, were made with a 3.5-inch needle. Ninety-four percent of attempts with the shorter needle were successful, and the remaining 6% were successfully accomplished with the longer needle.

Another study assessed 14-gauge, 3.25-inch Angiocath needles with the plastic sheath discarded compared with the use of a 15-gauge, 3.25-inch Caldwell needle/cannula for the performance of paracentesis. There were fewer patients in the Caldwell group who required multiple punctures (1 versus 6; $P<.05$), and fewer procedures were terminated because of poor fluid return (1 versus 8; $P<.02$). There were no significant differences in complications or volume removed.

Bedside Inoculation

A single study examined the inoculation of blood culture vials with 10 mL of ascitic fluid versus a 4-hour delayed inoculation in the laboratory. Of 53 paracenteses performed, 29 blood cultures grew pathogenic bacteria. There were no sets in which the delayed laboratory-inoculated bottles grew bacteria and the bedside-inoculated bottles did not. With a composite reference standard of any set growing pathogenic bacteria, the bedside inoculation had a sensitivity of 100% compared with a sensitivity of 77% for delayed inoculation. The absolute difference was 23% (95% CI 5.3% to 40%).

Plasma Expanders in Therapeutic Paracentesis

The search strategy identified 1,264 potential citations, of which 9 were prospective randomized studies. All 9 reported hyponatremia and renal impairment as outcomes of interest. Of the pooled 806 procedures, there was no significant difference for either outcome with the use of plasma expansion with albumin. Seven of the 9 studies reported encephalopathy as an outcome of interest, and 7 of 9 reported risk of death. Again, there was no significant difference.

Interpreting the Results

The authors focused on the analysis of ascitic fluid for the diagnosis of spontaneous bacterial peritonitis or portal hypertension. The diagnostic accuracies of the various tests were reported as LRs. The reference standard for the diagnosis of spontaneous bacterial peritonitis was a positive ascitic culture result.

Ascitic Fluid WBC and Polymorphonuclear Cell Counts

There were 14 studies identified of a possible 764 citations that fulfilled the search criteria and were not rejected because of study design, study characteristics, or data inaccessibility. All studies used a positive culture result from the ascitic fluid as their reference standard. Four studies reviewed used a cutoff of ascitic fluid WBC greater than 1,000 cells/μL. The summary positive LR was 9.1 (95% CI 5.5 to 15.1) and negative LR was 0.25 (95% CI 0.13 to 0.48). There were 7 studies that examined a cutoff of greater than 500 cells/μL. The summary positive LR was 5.9 (95% CI 2.3 to 15.5) and the negative LR was 0.21 (95% CI 0.12 to 0.38). There was only 1 study that examined a cutoff of 250 cells/μL. In this study of 64 patients, the positive LR was 0.9 (95% CI 0.3 to 2.7) and the negative LR was 1.1 (95% CI 0.52 to 2.4).

Of the 14 studies, 5 examined an ascitic fluid polymorphonuclear greater than 500 cells/μL as a cutoff for diagnosis of spontaneous bacterial peritonitis. The summary positive LR was 10.6 (95% CI 6.1 to 18.3) and the negative LR was 0.16 (95% CI 0.08 to 0.33). Seven articles used a cutoff of 250 cells/μL. The summary positive LR was 6.4 (95% CI 4.6 to 8.8) and the negative LR was 0.20 (95% CI 0.11 to 0.37).

Table 1 summarizes the various cutoffs used for ascitic WBC count and polymorphonuclear cell count for the diagnosis of spontaneous bacterial peritonitis.

Ascitic Fluid pH and Blood–Ascitic Fluid pH Gradient

The authors' search strategy produced 192 citations. Of these, 9 were appropriate for data extraction. The most accurate cutoff found was an ascitic pH less than 7.35. There were 3 studies that examined this cutoff. The summary positive LR was 9.0 (95% CI 2.0 to 40.6) and the negative LR was 0.31 (95% CI 0.11 to 0.84).

A blood-to-ascitic fluid pH gradient greater than 0.10 was used as a cutoff in 2 studies. The summary positive LR was 7.1 (95% CI 3.5 to 14.6) and the negative LR was 0.30 (95% CI 0.06 to 1.5).

Table 2 summarizes the studies used that examined ascitic fluid pH and blood–ascitic fluid pH gradient.

The Serum-Ascites Albumin Gradient

The serum-ascites albumin gradient is used for the diagnosis of portal hypertension as the cause of ascites in patients. This

Table 1. Studies assessing ascitic fluid WBC and polymorphonuclear cell counts for spontaneous bacterial peritonitis.

Source	No. Patients	Positive LR (95% CI)	Negative LR (95% CI)
Ascitic fluid WBC >1,000 cells/μL			
Summary	508	9.1 (5.5–15.1)	0.25 (0.13–0.48)
Ascitic fluid WBC >500 cells/μL			
Summary	717	5.9 (2.3–15.5)	0.21 (0.12–0.38)
Ascitic fluid WBC >250 cells/μL			
Storgaard et al, 1991	64	0.9 (0.3–2.7)	1.1 (0.52–2.4)
Ascitic fluid polymorphonuclear >500 cells/μL			
Summary	1,074	10.6 (6.1–18.3)	0.16 (0.08–0.33)
Ascitic fluid polymorphonuclear >250 cells/μL			
Summary	1,058	6.4 (4.6–8.8)	0.20 (0.11–0.37)

Table 2. Studies assessing ascitic fluid pH and blood–ascitic fluid pH gradient for spontaneous bacterial peritonitis.

Source	No. Patients	Positive LR (95% CI)	Negative LR (95% CI)
Ascitic fluid pH <7.35			
Summary	129	9.0 (2.0–40.6)	0.31 (0.11–0.84)
Blood–ascitic fluid pH gradient >0.10			
Summary	277	7.1 (3.5–14.6)	0.30 (0.06–1.5)

review found 4 of a possible 116 citations that meet the search criteria and were not excluded for various reasons. With the pooled data from these 4 studies examining a gradient of greater than or equal to 1.1 g/dL, the positive LR was 4.6 (95% CI 1.6 to 12.9) and the negative LR was 0.06 (95% CI 0.02 to 0.20).

CONCLUSIONS

In a patient in whom spontaneous bacterial peritonitis is suspected, paracentesis should be performed. Coagulation studies are likely not required before performance of the procedure. There may be a role for ultrasonographic guidance after initial attempts at paracentesis are unsuccessful. The ascitic fluid should be directly inoculated into blood culture bottles at the bedside, rather than sending to the laboratory, where inoculation might be performed at a later time. Plasma expansion with albumin is likely not necessary in therapeutic paracentesis, but evidence is lacking to completely rule out benefit.

For diagnosis of spontaneous bacterial peritonitis, ascitic WBC count of greater than 1,000 cells/μL and a polymorphonuclear cell count greater than 500 cells/μL provide the greatest accuracy. The lower threshold of polymorphonuclear greater than 250 cells/μL is acceptable to increase sensitivity for this entity with a high mortality and morbidity rate. The most accurate cutoff for ascitic pH in the diagnosis of spontaneous bacterial peritonitis is less than 7.35, and for the blood–ascitic fluid pH gradient the most accurate cutoff is greater than 0.10.

For diagnosis of portal hypertension in a patient with ascites, the most accurate serum-ascites albumin gradient is 1.1 g/dL or greater. If the gradient is less than 1.1 g/dL, the diagnosis is likely ruled out.

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COMMENTARY: CLINICAL IMPLICATIONS

Chronic liver diseases and cirrhosis are on the increase worldwide. This trend has been linked to increases in hepatitis (especially C) and alcoholism. It has been estimated that 400,000 Americans[2] have chronic liver disease and cirrhosis, resulting in 421,000 annual hospitalizations[3] and 1,000,000 yearly office visits.[2] Cirrhosis as a result of chronic liver disease is the 12th leading cause of death in the United States, accounting for more than 27,000 deaths per year.[4]

Approximately 50% of cirrhotic patients will develop ascites during the first 10 years after their initial diagnosis.[5] Spontaneous bacterial peritonitis will occur in 10% to 30% of ascitic patients[6] and carries an inhospital mortality rate of 20% to 40%.[7] The emergency physician therefore needs a high index of suspicion to identify and prevent morbidity caused by spontaneous bacterial peritonitis. The classic physical signs of peritonitis such as abdominal rebound tenderness and guarding are often not present as a result of ascitic fluid causing separation of visceral and parietal peritoneal membranes.[8] Cirrhotic patients with spontaneous bacterial peritonitis commonly present with only an isolated fever (69%), abdominal pain (59%), hepatic encephalopathy, diarrhea, ileus, shock, or hypothermia.[9]

Diagnosis of spontaneous bacterial peritonitis requires sampling of ascitic fluid by paracentesis. The procedure of paracentesis has been considered by some to be a potential barrier for the emergency physician's rapid diagnosis of spontaneous bacterial peritonitis. Concerns over the patient's

coagulopathy, uncertainties about which needle to use, ultrasonographic versus anatomic landmarks, the proper technique to culture the fluid, and the cell counts sufficient to make an empiric diagnosis all may have encumbered emergency department performance of paracentesis. These issues should now be considered assuaged by this evidence-based review, allowing emergency physician to comfortably and expeditiously use paracentesis to investigate spontaneous bacterial peritonitis in any decompensated patient with ascites.

In this rational clinical examination review, the authors found no evidence to support preprocedural coagulation studies, the use of one needle design over another, the use of plasma expanders in therapeutic paracentesis, or the initial use of ultrasonography over the traditional landmark approach. There is only a demonstrable benefit to ultrasonography if the landmark approach initially fails, although the adverse effect profile of sonography and the advantage of anatomic knowledge may make its use reasonable despite lack of demonstrated benefit in these small trials. Bedside inoculation of blood culture bottles increases the sensitivity in diagnosis of spontaneous bacterial peritonitis. The diagnosis of spontaneous bacterial peritonitis can be made with appropriate certainty with cutoffs of 500 WBCs/μL of ascitic fluid or 250 polymorphonuclear cells/μL, ascitic pH of 7.35, or an ascitic to blood pH gradient of 0.10.

TAKE-HOME MESSAGE

Bedside culture inoculation is recommended, and ultrasonography appears safe and potentially helpful during paracentesis procedures. Diagnostic cutoffs for spontaneous bacterial peritonitis are maximized, though often nondiagnostic, when ascetic fluid yields greater than 500 WBCs/μL, greater than 250 polymorphonuclear cells/μL, a pH of less than 7.35, or a fluid-blood gradient of greater than 0.1.

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