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Ultrasound-Guided Paracentesis

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PARACENTESIS

Hospitalist Procedure Service Best Practice Guidelines: Paracentesis

DIAGNOSING ASCITES AND SBP BY EXAM

Recommendation: Diagnosing Ascites- Sensitivity of physical exam maneuvers to diagnose ascites range from 20-66% with auscultatory percussion being the most sensitive, but fluid wave being the most specific.

Evidence: Chongtham et al. performed a study of 66 patients comparing the accuracy of physical examination to that of ultrasonography as a gold standard in the detection of ascites. Those with a history of ascites or undergoing therapeutic paracentesis, or in whom ascites was detected by shifting dullness or fluid wave, were excluded. They found that auscultatory percussion was the most sensitive maneuver (66%), followed by flank dullness (57%). The fluid wave sign was found to not be very sensitive (20%), however it was notably specific (100%). [1]

Recommendation: Clinical suspicion of SBP- Clinicians have a poor ability to determine the likelihood of SBP by clinical exam and presentation alone.

Evidence: There were 285 separate physician assessments in 144 patients enrolled with complete data. Spontaneous bacterial peritonitis was diagnosed in 17 (11.8%) patients. Physician clinical impression had a sensitivity of 76% (95% confidence interval [CI] 62% to 91%) and specificity of 34% (95% CI 28% to 40%) for the detection of spontaneous bacterial peritonitis. The lowest negative LR was associated with the presence of any abdominal pain or tenderness (negative LR=0.4); however, the presence of pain/tenderness was also observed in 85% of patients without spontaneous bacterial peritonitis. Six patients (4.2%) with spontaneous bacterial peritonitis had at least 1 physician assessment of little to no risk for spontaneous bacterial peritonitis, and 3 of the 6 subsequently died during their hospitalization. [2]

Table 1 Patients who should undergo diagnostic paracentesis

- Patients with new-onset ascites
- Hospitalized patients with ascites, especially those with GI bleeding
- Patients with known ascites and at least one of the following:
  - Fever
  - Leukocytosis
  - Abdominal pain
  - Peritoneal findings
  - Increasing ascites volume
  - Unexplained encephalopathy
  - Deteriorating liver function
  - Renal failure

1 Modified by Kierstin Kennedy, UAB, 2020, Joshua Lenchus, Univ of Miami, 2014, from Diane Sliwka and Michelle Mourad, UCSF, 2008

Indications/Contraindications

Recommendation- Relative Contraindications: uncooperative patient, skin infection at the proposed puncture site, pregnancy, and severe bowel distension.

Absolute Contraindication: One expert suggests that coagulopathy precludes paracentesis only if there is clinically evident fibrinolysis or disseminated intravascular coagulation.[3] Caveat - we have data that supports the performance of a paracentesis in patients despite coagulopathy and/or thrombocytopenia, without an increased risk of hemorrhagic complications. See below.

Evidence: Expert consensus rather than evidence now guides these recommendations

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Paracentesis in Coagulopathic Patients

Recommendation: No strict guidelines exist. Most studies indicate safety of paracentesis below an INR of 2.0, platelets >50. Caveat as noted above.

Evidence:
<u>One study:</u> 314 procedures, only 2 episodes of minor bleeding occurred (0.0064%; 95% CI, 0.0008%-0.023%). Both occurred with an INR of 2.5 to 2.9 and platelet count of 50,000 to 99,000/μL. Neither resulted in hospitalization or transfusion.[4]

<u>Second study:</u> 1100 large-volume paracenteses performed by trained endoscopy assistants in an outpatient setting. There was no significant bleeding in any patient (95% CI, 0%-0.33%) despite 598 procedures that were performed with a platelet count of less than 50,000/μL and 292 with an INR of greater than 2.0.[5]

<u>Larger studies:</u> Two larger retrospective studies, of 608 and 4729 paracenteses, showed a very low risk of bleeding complications in patients with coagulopathy and/or thrombocytopenia of varying severities. The results between the studies are consistent with a significant bleeding rate of about 0.2%. The amount of blood loss was also similar among those with mild to moderate coagulopathy compared with no coagulopathy. In both studies, significant renal impairment was associated with an increased bleeding rate, likely related to a qualitative platelet defect from uremia.[6, 7]

Informed Consent/Time Out

Recommendations: All patients must undergo informed decision-making process. This must be done prior to every procedure, regardless of the number of times the patient has undergone such. Finally, a "time out" must occur prior to the initiation of the procedure.

Patient positioning

Recommendation: Supine with the head of the bed elevated at 15 – 30 degrees. Caveat - for smaller pockets of fluid, or to facilitate drainage once access has been established, the patient may

rotate slightly to the side of the insertion. A rolled towel or pillow can be inserted under the contralateral hip to assist the patient in maintaining such a position.

Evidence: Expert consensus, no studies.

Sterile Technique/Gowning

Recommendation: Surgical cap, mask and face shield, sterile gloves, sterile drape, and sterile skin prep is required. A sterile gown can be worn, but is optional. Caveat - since we do not believe that excess sterility is possible, we recommend the use of a sterile gown.

Evidence: No evidence exists to support this recommendation.

Ultrasound Guidance

Recommendation: Relative contraindications to blind paracentesis (performed without the aid of ultrasound) include pregnancy, severe bowel distension, previous extensive abdominal/pelvic surgery, or low fluid volume. If a relative contraindication is present, the use of ultrasonography should be considered.

Evidence:
A study of 27 patients requiring paracentesis showed that the success of blind paracentesis is directly related to the amount of ascitic fluid present (44% with 300 ml and 78% with 500 ml).[8]

Randomized trial of 100 ED patients compared bedside ultrasound-guided paracentesis vs the traditional technique. Of the 56 patients assigned to the ultrasound group, 42 showed identifiable ascites on diagnostic imaging, of whom 40 underwent successful aspiration. In the 44 patients randomized to paracentesis without ultrasound evaluation, 27 underwent successful aspiration. The ultrasound-guided approach yielded a successful aspiration rate of 71% vs 61% without ultrasound ($P = .39$, using an intention-to-treat analysis). For 15 of the 17 patients in whom the traditional technique failed, the ultrasound technique was later used. In 13 patients, fluid was visualized on ultrasound and all underwent successful aspiration. Therefore, a role may exist for ultrasound guidance when the traditional technique fails. In the same study, the number of passes was recorded in 80 patients. Of these patients, there was no difference in the proportion of patients who required more than 1 attempt between the ultrasound group vs the traditional group ($P = 1.00$).[9]

Z technique

Recommendation: Personal physician preference, risk of decreased ascites leak is theoretical only, and seems to depend more on presence of tense ascites rather than the technique used.

Evidence: In a randomized, single blind study, of 72 patients with cirrhosis undergoing outpatient therapeutic paracentesis randomized to the z-tract or the modified angular (coaxial) needle insertion technique, researchers found a statistically significant increase in subject reported pain and physician rated procedure difficulty with the z-tract technique compared to the coaxial technique.[14]

Site of Needle Insertion

Recommendation: Slight preference for the left and right lower quadrants.

Evidence: There have been case reports of significant bleeding from paracentesis performed in the midline related to puncture of intra-abdominal varices and a recanalized umbilical vein.[10, 11]

In a study of 52 patients, the investigators compared the abdominal wall thickness and depth of ascites between the infraumbilical midline and the left lower quadrant using ultrasonography. The abdominal wall was thicker ($P < .0001$) and the depth of the ascites more shallow ($P < .02$) at the midline than at the left lower quadrant in the supine position.[12]

In another study of 27 patients, ascites detected by ultrasonography found the location of the distribution too variable to identify the ideal site for blind puncture, particularly in small or moderate ascites.[8]

Needle/Catheter Type

Recommendation: For diagnostic studies, a 1.5 inch 22 gauge needle is generally sufficient. For more obese patients, a 3.5 inch or a spinal needle may be needed. Caveat – the use of a needle may increase the potential for bowel perforation. Catheter over the needle kits can decrease the risk of bowel perforation. Limited accounts of retained plastic when using plastic sheathed needles have been noted in recent literature[16] however this is related to attempts to reinsert the sharp component of the needle without fully withdrawing the catheter, and should not preclude the use of a catheter over needle kits.

Evidence: 1 prospective study of 229 paracenteses in which the procedure was first attempted with a 1.5-inch, 22-gauge metal needle, and if unsuccessful, it was reattempted with a 3.5-inch, 22-gauge replacement. Seven procedures required ultrasound for localization. Successful aspiration was achieved in 94% of attempts with the shorter needle, and the remaining 6% of attempts with the 3.5-inch needle.[3]

Post Procedure Studies

Recommendation: Ascitic fluid albumin, total protein, cell count and differential as well as bacterial culture are standard tests that should be routinely ordered when the procedure is performed for diagnostic purposes. Further, serum albumin and total protein should be obtained on the same day in order to differentiate the underlying etiology. When considering spontaneous bacterial peritonitis (SBP), the diagnosis is confirmed with > 250 polymorphonuclear cells (PMNs) in the presence of a positive culture. This is especially important in patients with ascites in the face of a GI bleed due to the high mortality risk. Further, direct inoculation of culture bottles at the time of procedure leads to a significantly higher culture yield than sending a sample to the lab for inoculation.

Caveat – absent the culture, the presence of the white cell components indicates culture-negative neutrocytic ascites.

Evidence: The utility of ascitic fluid cell count in the diagnosis of SBP was initially examined in several studies that used a positive bacterial ascitic fluid culture as the "gold standard." These studies had varying results for sensitivity and specificity and used different cutoff levels for ascitic fluid PMN count. Overall, an ascitic fluid PMN count ≥500 cells/mm3 has a sensitivity of 70%–100%, with a specificity of 86%–100%. The current diagnostic standard is an ascitic fluid PMN count ≥250 cells/mm3 which has a sensitivity of 80%–100% and a specificity of 86%–100%.[13] Ascitic leukocyte (or neutrophil) count is not influenced by peripheral leukocytosis (or neutrophilia). Most physicians will also treat a positive culture of a suspicious organism, "bacterascites" in the absence of the threshold neutrophil count, but the significant of this finding is not well established.

In a study of 118 paracenteses on 29 outpatients with cirrhosis (24% on SBP prophylaxis), all had a PMN count <250/mm3. Asymptomatic bacterascites was found in 3 patients, with no sequelae in the 137 days of follow up.

Another study of 270 paracenteses in 67 outpatients treated at 5 hepatology clinics for asymptomatic tense ascites (37% on SBP prophylaxis) found that all patients had a PMN count of <250/mm3. 10 patients were found to have monomicrobial growth on culture with commensal flora. Follow up unknown.

Post procedure Studies Albumin Repletion

Recommendation: Post paracentesis albumin is not necessary for removal of less than 5L. For taps of >5L, albumin replacement may be given at a rate of 1g/L removed over 5. For example, the withdrawal of 6L of ascitic fluid may result in the administration of 30g of albumin, though there is definitely no consensus on its benefits. A lower threshold (after 2L) is sometimes used for patients who have pre-existing hypotension, renal insufficiency or hyponatremia. Caveat – we do not routinely perform large-volume paracentesis (LVPs). Further, albumin has 4 issues of concern, namely, (1) it has a relatively short half-life, of some 6 – 8 hours. After which, due to the lack of intravascular colloid pressure, it will leak into the extravascular space; (2) as a salt, when it shifts from the intra- to extra-vascular space, fluid will move with it; (3) it is a frequently backordered product due to manufacturing difficulties; and (4) it is expensive. The rationale behind its use is as a temporizing measure to prevent a massive fluid shift, intra- to extra-vascularly, in order to compensate for the fluid removed during the paracentesis. Recall that the body believes the ascitic state to be one of homeostasis. A shift out of the intravascular space can result in general hypoperfusion to critical organ systems.

Evidence: Randomized trial of 100 patients undergoing LVP. Patients who did not receive albumin had more hemodynamic deterioration, increased plasma renin activity, worsening renal function and/or severe hyponatremia (20.8% vs 3.8%).

In another controlled trial of patients undergoing LVP, patients were randomized to receive replacement with albumin, dextran 70, or polygeline. Post-procedural circulatory dysfunction was less common with albumin administration (19% vs 34% and 38%, respectively). The benefit was limited to patients with >5L removed. Post-paracentesis plasma volume expansion helps to prevent asymptomatic laboratory abnormalities, some of which have been associated with decreased survival. Recent meta-analysis called into question whether albumin should remain the favored treatment for post-LVP volume expander, however there is some concern that this included studies with unsuitable controls. (Kütting et al.) The consensus based on clinical experience remains that adjunctive treatment is beneficial in LVP and that, when compared in studies using suitable control agents, albumin administration is associated with a significant reduction in mortality.[15]

REFERENCES

1. Chongtham D5, 5ingh MM, Kalantri 5P, Pathak 5, Jain AP. Accuracy of clinical manoeuvres in detection of minimal ascites. Indian] Med 5ci. 1998;52:514-520.

2. Chinnock B, Afarian H, Minnigan H, Butler J, Hendey GW. Physician clinical impression does not rule out spontaneous bacterial peritonitis in patients undergoing emergency department paracentesis. Ann Emerg Med. 2008;52:268-273.

3. Runyon BA. Paracentesis of ascitic fluid. A safe procedure. Arch Intern Med. 1986; 146:2259-2261.

4. Lin CH, 5hih FY, Ma MH, Chiang WC, Yang CW, Ko PC. 5hould bleeding tendency deter abdominal paracentesis? Dig Liver Dis. 2005;37:946-951.

5. Grabau CM, Crago 5F, Hoff LK, et al. Performance standards for therapeutic abdominal paracentesis. Hepatology. 2004;40:484-488.

6. Mc Vay PA, Toy PT. Lack of increased bleeding after paracentesis and thoracentesis in patients with mild coagulation abnormalities. Transfusion. 1991 ;31: 164-171.

7. Pache I, Bilodeau M. 5evere haemorrhage following abdominal paracentesis for ascites in patients with liver disease. Aliment Pharmacol Ther. 2005;21:525-529.

8. Bard C, Lafortune M, Breton G. Ascites: Ultrasound guidance or blind paracentesis? CMAJ. 1986;135:209-210.

9. Nazeer 5R, Dewbre H, Miller AH. Ultrasound-assisted paracentesis performed by emergency physicians vs the traditional technique: A prospective, randomized study. Am] Emerg Med. 2005;23:363-367.

10. Qureshi WA, Harshfield D, Shah H, Netchvolodoff C, Banerjee B. An unusual complication of paracentesis. *Am J Gastroenterol.* 1992;87:1209-1211.

11. Aagaard J, Jensen LI, Sorensen TI, Christensen U, Burcharth F. Recanalized umbilical vein in portal hypertension. *AJR Am J Roentgenol.* 1982;139:1107-1110.

12. Sakai H, Sheer TA, Mendler MH, Runyon BA. Choosing the location for non-image guided abdominal paracentesis. *Liver Int.* 2005;25:984-986.

13. Rimola A, Garcia-Tsao G, Navasa M, et al. Diagnosis, treatment and prophylaxis of spontaneous bacterial peritonitis: A consensus document. international ascites club. *J Hepatol.* 2000;32:142-153.

14. Shriver A, et al. A Randomized Controlled Trial of Procedural Techniques for Large Volume Paracentesis. *Ann Hepatol* 2017 - Clinical Trial. PMID 28233752.

15. Bernardi M, et al. Does the evidence support a survival benefit of albumin infusion in patients with cirrhosis undergoing large-volume paracentesis? *Expert Rev Gastroenterol Hepatol* 2017. PMID 28004601.

16. De Gottardi A, Thévenot T, Spahr L, Morard I, Bresson-Hadni S, Torres F, Giostra E, Hadengue A. Risk of complications after abdominal paracentesis in cirrhotic patients: a prospective study. Clin Gastroenterol Hepatol. 2009 Aug;7(8):906-9. doi: 10.1016/j.cgh.2009.05.004. Epub 2009 May 15. PMID: 19447197.

Paracentesis Faculty Teaching Guide

1. Review indications, contraindications, and precautions
    a. Notable is the lack of evidence regarding the correction of thrombocytopenia and/or coagulopathy
2. Review pre-, peri-, and post-procedural steps
    a. Review patient chart, paying particular attention to creatinine trend
    b. Obtain informed consent ("time out" #1)
    c. Position patient – supine with head of bed at 30 degrees
    d. Obtain set of vital signs – note blood pressure
    e. Locate and mark insertion site using ultrasound – lateral to the nipple line, using an angled probe approach (Z-technique is an acceptable alternative, but discourage due to difficulty in properly performing)
        i. Avoid visible cutaneous collateral vessels, overlying cellulitis/skin infection, and hematoma/ecchymosis.
        ii. Note angle and direction of probe's orientation to abdomen, as well as fluid depth.
        iii. Discourage infraumbilical approach due to potential for bleeding, and inability to differentiate ascitic fluid from urine.
    f. Put on cap and mask
    g. Wash hands – dry with towel accompanying sterile gown
    h. Put on sterile gown and sterile gloves – note that evidence is lacking to support the use of sterile gowns, but we do not believe that one can be too sterile.
    i. Prepare site using 2% chlorhexidine
    j. Drape site – use extra drape to build out contiguous sterile field
    k. "Time out" (#2) – confirm patient, procedure, and site, as well as properly executed consent document (time, date, site, patient signature, individual obtaining consent, witness)
    l. Draw up anesthetic using filter device if available, switch needles for injection, confirm depth (if possible)
    m. Prepare the kit, assembling the needle/catheter device – this allows the anesthetic to take effect
    n. Make a small stab incision lest the catheter tip becomes stuck at the skin level
    o. Insert the needle/catheter device using the identical trajectory as the probe was oriented to the abdomen, taking note of the insertion depth – encourage holding the device akin to a pool cue stick, that is, the nondominant hand stabilizes and guides, while the dominant hand advances
    p. Once ascitic fluid is obtained (there may be a small audible click, the red indicator will turn to white, and aspiration will be possible – HEAR, SEE, and FEEL), advance the entire device 0.5cm thereby facilitating the catheter tip's entry into the abdominal cavity
    q. Holding the needle steady, advance the catheter alone into the cavity, all the way to the hub
    r. Withdraw the needle

s. Fluid is now aspirated for any diagnostic studies – inoculation of the bottles and tubes should be done at the bedside. One of the LP tubes that is included in the kit can be used for the collection of a specimen for gram stain only as it is not possible to gram stain a sample from the culture bottle. Cytology may be collected in a sterile urine specimen cup.
t. If being performed for therapeutic purposes, there are three options:
    i. Connect the high pressure tubing (one end is a male luer lock, the other is the purple 18G needle), and insert the needle into a vacuum container. This may also be done without the use of the needle for some containers.
    ii. As above, but replace the needle with the blue nozzle. This allows the connection to a wall suction canister. Pressure on the regulator can be continuous high (maximum) flow.
    iii. Connect the other tubing to the drainage bag and manually remove the fluid.
u. Once complete, withdraw the needle completely
v. Apply pressure immediately to prevent subsequent leaking
w. Apply bandage
x. Properly discard sharps (sharps container) and equipment (red biohazard bag)
y. Remove protective clothing and discard in red bag
z. Properly label specimens
aa. Obtain post-procedural vital signs – note blood pressure
bb. Wash hands
cc. Document procedure, notify patient's nurse and primary team

Troubleshooting: If fluid is not flowing or stops prematurely:
1. Be sure the stopcock is open in the direction of flow. Remember: stopcock tooth is always in the direction of closed.
2. Be sure there are no clamps on the tubing in the system.
3. Press on the opposite side of the abdomen to move fluid toward the catheter.
4. Have the patient shift slightly toward the side of the catheter in order to move fluid toward the catheter.
5. Remove cap, attach a syringe, and attempt to withdraw fluid manually to see if flow is present.
6. Check a new evacuated container if these are being used as the vacuum may have been lost.
7. Turn the stop cock toward the patient (closed to patient) and manipulate the catheter by twisting or withdrawing slightly, then reopen to drainage.

If none of these steps work, consider withdrawing the catheter. At this point you may be finished, or can re-evaluate the ascites with ultrasound. Only reattempt if there appears to be a satisfactory fluid collection.

Teaching Point: Air bubbles can appear in the tubing as fluid is being drawn out, particularly when using a vacuum device. This indicates air entry at some connection point, rather than bowel perforation.

Management of Complications

Signs of major bleeding:

- Inferior epigastric arterial puncture is most concerning for abdominal bleeding catastrophe.
- If it seems that a vessel has been invaded, abort the procedure immediately, and hold pressure. Monitor the patient closely following the procedure (serial vital signs, H/H) and reverse coagulopathy/transfuse, as necessary.
- If there is concern for any hemodynamic instability in the hours following a procedure, support the patient (access, blood, reversal of coagulopathy) and consult surgery/vascular.
- If the patient is in DIC, supportive care and avoidance of further procedures is warranted.

Spleen/Liver Puncture

- Monitor hemodynamics and H/H closely and serially
- Image for signs of bleeding collection
- Support hemodynamics as needed
- Surgery consultation recommended

Bowel perforation

- Order imaging searching for free air under the diaphragm, monitor closely.
- If confirmed, consult surgery; begin broad spectrum antibiotics; hemodynamic support.

Continuous ascites drainage from procedure site:

- Prevention with recommended insertion technique is best
- Holding additional manual pressure should not be underestimated as time and pressure can diminish nearly all leaking
- May require a single suture, although there is some evidence that purse string closure is ideal for wounds that are larger.
- Do not place an ostomy bag over the site to collect draining fluid as this provides a continuous risk of infection through the skin, and prevents subsequent closure.
- As an alternative, may consider the use of Dermabond, or other skin adhesive.

Paracentesis Ultrasound caveats

- Ultrasound is always employed by our service.
- Use the low frequency, curvilinear or phased sector array, probe for better resolution.
- We do not advocate entry via the infraumbilical route as urine within the bladder may look identical to that of ascitic fluid.
- Always identify ascites, bowel, liver/spleen.
- Do not insert the needle through superficial/collateral veins.
- If there is bowel between skin and the target fluid pocket, do not perform the procedure lest inadvertent bowel puncture.
- Avoid small pockets, and those near vital organs; these are better deferred to IR.

Safety-procedures can be high risk for you as a provider and for the patient. IF YOU ARE UNCOMFORTABLE, do not perform the procedure; contact IR. You have a role in assessing what is safe to be done at the bedside and what isn't.

UM-JMH CENTER FOR PATIENT SAFETY

ABDOMINAL PARACENTESIS

PERFORMANCE CHECKLIST

Name		Date	
Training program/year		Attending	

	Task (Chronological Order)	Incompletely Performed (1 point)	Completely Performed (2 points)	Notes (Complete if not done at all or incompletely performed)
Pre - Procedure	1) Review patients' chart, labs, and imaging (as relevant)			
	2) Obtain informed consent: verify patient, procedure and site			
	3) Position patient: supine with HOB at 30 degrees			
	4) Localize/mark needle insertion site (anatomic/ultrasound): anterior axillary line			
	5) Put on hat and mask; wash hands with soap and water			
	6) Don protective clothing: sterile gown and sterile gloves			
	7) Prepare site using chlorhexidine			
	8) Drape site using sterile technique			
	9) "Time out": verify patient, procedure and insertion site are correct			
	10) Inject anesthetic			
	11) Prepare the kit: assemble the needle/catheter device			
Procedure	12) Insert needle: angular or Z-track technique			
	13) Stop advancement of needle once fluid is aspirated			
	14) Holding needle still, guide catheter over needle			
	15) Withdraw needle			
	16) Aspirate fluid for diagnostic and/or therapeutic purpose			
	17) Remove catheter			
Post - Procedure	18) Clean the area, ensure no fluid leak, and apply dressing			
	19) Throw away sharps			
	20) Discard protective clothing			
	21) Wash hands			
	22) Properly label specimens			
	23) Document procedure			

Number of attempts at procedure: _____

Assessment of Performance: Confidence and technical skill
1: requires assistance with the majority of steps; inconsistently able to perform steps; unsure of order of tasks; beginner; not competent
2: repeatedly hesitant on steps and their order; requires assistance with half of steps; not competent
3: average performance; requires feedback or assistance with less than half of steps; appeared somewhat hesitant or unsure; not competent
4: smooth transition between steps with minimal to no unnecessary moves; requires intervention on minimal to no steps; borderline competent
5: able to perform independently and without supervision; needs no cues to complete procedure; seamless transition from one step to the next; competent

Operator: 1 2 3 4 5	Supervisor: 1 2 3 4 5