Appendix: Supplementary Online Content

Cho J, Jensen TP, Reierson K, et al. Recommendations on the Use of Ultrasound Guidance for Adult Abdominal Paracentesis: A Position Statement of the Society of Hospital Medicine

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This supplementary material has been provided by the authors to give readers additional information about their work. It was last updated on October 2, 2018.

Appendix 1 – Detailed Methods

Expert Panel Formulation

The Society of Hospital Medicine (SHM) Board of Directors delegated the SHM Education Committee with the task of developing recommendations on the use of ultrasound to guide bedside procedures. The chair of the SHM Education Committee appointed two chairs to lead the guideline development project, a subject matter expert in POCUS, and a senior member of the education committee. An additional subject matter expert co-chair was added given the broad scope of the project.

The SHM POCUS Task Force was assembled to carry out this guideline development project under the direction of the SHM Board of Directors, Director of Education, and Education Committee. All expert panel members were physicians or advanced practice providers with expertise in POCUS. Expert panel members were divided into working group members, external peer reviewers, and a methodologist. All expert panel members and two members of the SHM education committee were voting members. Working group members were required to be hospitalists per the SHM definition (1) and have expertise in POCUS. External peer reviewers were nationally recognized physicians with expertise in POCUS from different specialties, including emergency medicine, critical care, anesthesiology, pulmonary/critical care, internal medicine, and cardiology. All external peer reviewers had to have past experience in developing point-of-care ultrasound guidelines, either serving as a chair or member of a guideline development panel. A methodologist with clinical expertise in POCUS and past experience in leading development of POCUS guidelines served on the expert panel. Non-voting Task Force members included a medical librarian, the SHM Education Committee Chair, and the SHM Director of Education (see Acknowledgements).

Disclosures

This project did not receive any funding from any external sponsors or SHM. All Task Force members voluntarily participated, and none received an honorarium for participation. There was no industry input in the development of these guidelines, nor industry presence during any conference calls or meetings. All SHM POCUS Task Force members were required to disclose any potential conflicts of interests. Signed disclosure

statements of all members were reviewed by the SHM Director of Education and an SHM POCUS Task Force chair prior to inclusion on the Task Force. None of the paracentesis working group members reported any financial relationships. Two working group members (not in the paracentesis working group), three external peer reviewers, and one of the chairs reported financial relationships. Decisions to approve participation were guided by the 2008 and 2011 Institute of Medicine (IOM) reports on development of trustworthy Clinical Practice Guidelines (2,3). Prior to submission of this manuscript, all Task Force members were required to submit an updated conflict of interest disclosure statement for inclusion as an author or collaborator on the final manuscript. Conflict of Interest disclosures are included in Appendix 2.

Literature Search Strategy

The literature search was conducted in two independent phases. The first phase included independent literature searches conducted by working group members themselves. Each paracentesis working group member and one co-chair independently performed literature searches to avoid selection bias. Potentially relevant references were compiled, discussed during conferences calls every 2-4 weeks, and selected references were summarized in a shared, online data table. Based on the references gathered during the first phase of literature searches, key clinical questions and draft recommendations were prepared prior to conducting a systematic literature search. The purpose of the first phase literature search was to identify key topics to focus the systematic literature search performed by the certified medical librarian.

The second phase was a systematic literature search conducted by a certified medical librarian for each draft recommendation prepared by the paracentesis working group. The Medline, Embase, CINAHL, and Cochrane medical databases were searched from 1975 to October 2015 initially, and an updated search was conducted to include November 2015 to November 2017. Search limiters were English language and adults only. Google Scholar was also searched without any limiters. Search terms and specific search strings for each draft recommendation are shown in Appendix 3. Articles identified by the comprehensive literature search were systematically screened and selected. All article abstracts were first screened for relevance by at least two members of the paracentesis working group. Full-text versions of screened articles were reviewed, and articles on the use of ultrasound to guide paracentesis were selected. Articles that discussed paracentesis without ultrasound guidance were excluded. Additionally, the following article types were excluded: non-

English language, non-human, age<18, meeting abstracts, meeting posters, letters, case reports, and editorials. All systematic reviews, meta-analyses, randomized controlled trials, and observational studies of ultrasound-guided paracentesis were screened and selected. References listed in narrative review articles were reviewed to ensure no important studies were missed. All full text articles were shared electronically amongst the working group members. Any disagreements about article selection were discussed during conference calls and final selection was based on consensus of the paracentesis working group. Findings from the selected articles were abstracted into a data table. The selected literature was incorporated into the rationales of the draft recommendations during a series of weekly conference calls.

Development of Clinical Recommendations and Consensus

These recommendations were developed using the RAND Appropriateness Method that required panel judgment and consensus. Details about the RAND Appropriateness Method to gather consensus have been previously published (4). Voting members of the SHM POCUS Task Force reviewed and voted on the draft recommendations using the RAND appropriateness method. Panel members were advised to vote on appropriateness based on these 5 transforming factors: 1) Problem priority and importance, 2) Level of quality of evidence, 3) Benefit / harm balance, 4) Benefit / burden balance, 5) Certainty / concerns about PEAF (Preferences / Equity Acceptability / Feasibility).

The draft recommendations were uploaded into an internet-based electronic data collection tool (Redcap™) (Appendix 4). An invitation email was sent to panel members that included a link to vote and the data table with hyperlinks to view full-text PDF's of the reference articles. Panel members participated in two rounds of electronic voting in February 2018 and April 2018. Voting was conducted using a 9-point Likert scale, where 1 denotes extremely inappropriate and 9 denotes extremely appropriate with three zones: 1–3 points = inappropriate zone; 4–6 points = uncertain zone; and 7–9 points = appropriate zone. Based on the feedback from the first round of voting, minor modifications were made to the draft recommendations classified as having "disagreement." The RAND appropriateness method was applied using expert consensus for recommendations. The degree of consensus was assessed using the RAND algorithm during the 2 rounds of voting (see below, Figure 1). Establishing a recommendation required at least 70% agreement that a recommendation was "appropriate." Disagreement was defined as >30% of panelists voting outside of the

zone of the median. A strong recommendation required at least 80% of the votes within one integer of the median, following the RAND rules (see below, Table 1).

The Paracentesis Working Group members reviewed the voting results and narrative comments, to revise the draft recommendations. Any recommendations with disagreement were removed. Some phrases and references from recommendations with disagreement were incorporated in relevant recommendations without disagreement, or added to the Knowledge Gaps section. Recommendations were classified as strong or weak/conditional based on preset rules defining the panel's level of consensus, which determined the wording for each recommendation (see below, Table 2). For strong recommendations, the phrase ''we recommend'' was used, along with the verb ''must'' or ''should'' depending upon whether or not the degree of consensus was perfect vs. very good, respectively. For weak or conditional recommendations, the phrase ''we suggest'' was used, along with the verb "can" or ''may'' depending on whether or not there was "good" vs. "some" consensus, respectively (4).

The final recommendations were reviewed and revised by a writing committee, which consisted of the Paracentesis Working Group, chairs of all 5 working groups, and 2 of the Task Force co-chairs. The writing group was tasked with final review of each recommendation's wording, clinical relevance, usability, and feasibility. The revised manuscript underwent external peer review by POCUS experts from different subspecialties that are members of SHM POCUS Task Force. Final review of the guidelines document was performed by all members of the SHM POCUS Task Force, SHM Education Committee, and SHM Board of Directors. The SHM Board of Directors endorsed the document prior to submission to the Journal of Hospital Medicine.

Figure 1 – RAND Algorithm

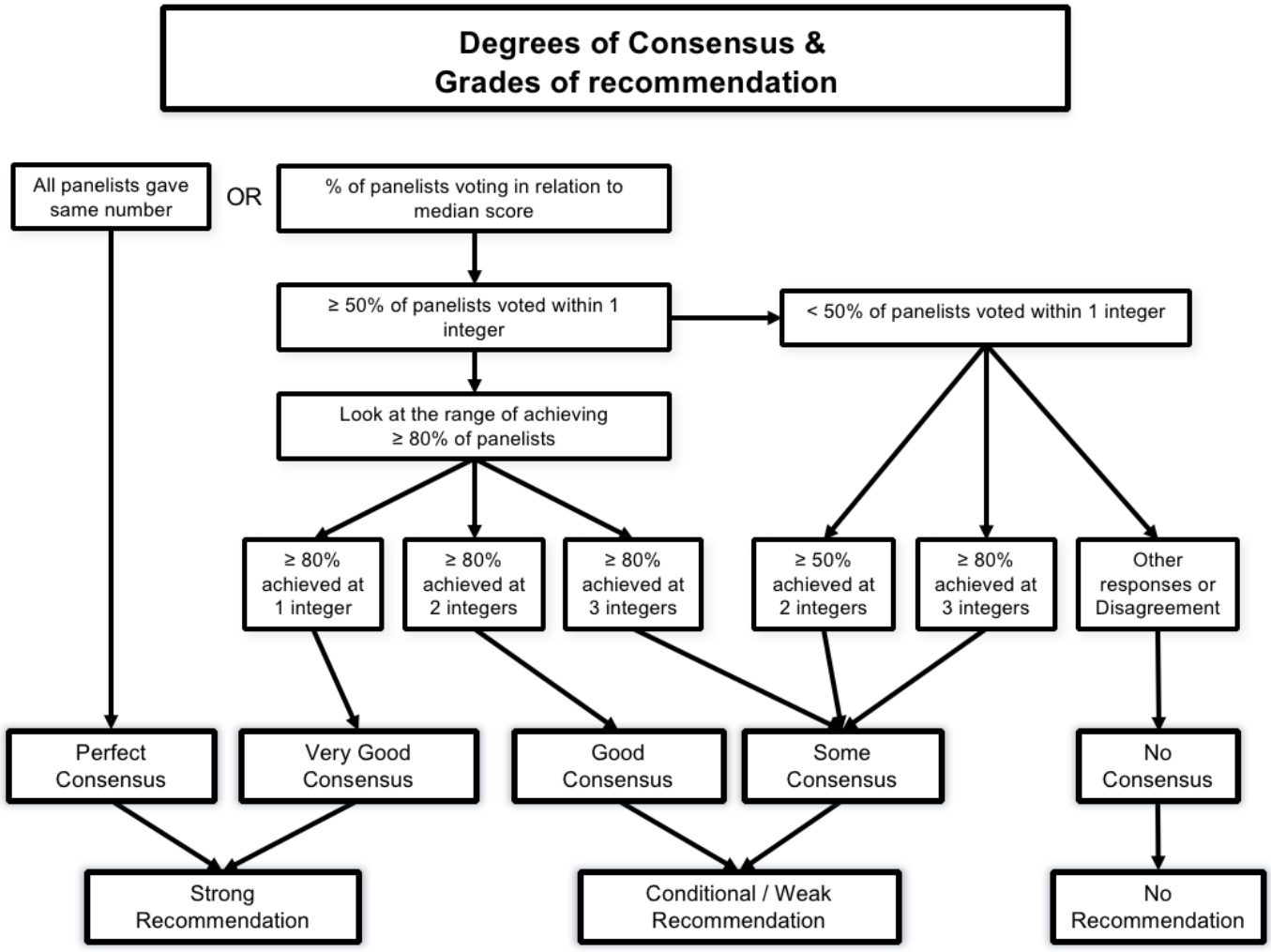


Table 1 – Definitions of Levels of Consensus

Term	Definition
Perfect consensus	All respondents agree on one number between 7-9
Very good consensus	Median and middle 50% (interquartile range) of respondents are found at one integer (*e.g.*, median and interquartile range are both at 8) or 80% of respondents are within one integer of the median (*e.g.*, median is 8, 80% respondents are from 7 to 9)
Good consensus	50% of respondents are within one integer of the median (*e.g.*, median is 8, 50% of respondents are from 7 to 9) or 80% of the respondents are within two integers of the median (*e.g.*, median is 7, 80% of respondents are from 5 to 9).
Some consensus	50% or respondents are within two integers of the median (*e.g.*, median is 7, 50% of respondents are from 5 to 9) or 80% of respondents are within three integers of the median (*e.g.*, median is 6, 80% of respondents are from 3 to 9).
No consensus	All other responses. Any median with disagreement

Table 2 – Degree of Consensus, Strength of recommendation, and Wording

Degree of consensus	Strength of recommendation	Wording [Function of voting]
Perfect consensus	Strong	recommend – must/to be/will
Very good consensus	Strong	recommend – should be/can
Good consensus	Weak/Conditional	suggest – to do
Some consensus	Weak/Conditional	suggest - may do
No consensus Disagreement	NO	No recommendation was made regarding

References

1. Definition of hospitalist available at: https://www.hospitalmedicine.org/Web/About_SHM/Hospitalist_Definition/About_SHM/Industry/Hospital_Medicine_Hospital_Definition.aspx?hkey=fb083d78-95b8-4539-9c5b-58d4424877aa.

2. (IOM) IoM. Clinical Practice Guidelines We Can Trust. Washington, DC: The National Academies Press, 2011.

3. (IOM) IoM. Knowing What Works in Health Care: A Roadmap for the Nation. Washington, DC2008.

4. Fitch, Kathryn, Steven J. Bernstein, Maria Dolores Aguilar, Bernard Burnand, Juan Ramon LaCalle, Pablo Lazaro, Mirjam van het Loo, Joseph McDonnell, Janneke Vader and James P. Kahan. The RAND/UCLA Appropriateness Method User's Manual. Santa Monica, CA: RAND Corporation, 2001. http://www.rand.org/pubs/monograph_reports/MR1269.html.

Appendix 2 – Conflict of Interest Disclosures of SHM Point-of-care Ultrasound Task Force

Task Force Member	Voting Member	Disclosure	Company	Relationship	Related to project
Chairs					
Jeff Bates	Yes	No	--	--	--
Ricardo Franco	Yes	No	--	--	--
Nilam Soni	Yes	Yes	Elsevier-Saunders	Royalty	No
Paracentesis Working Group Members					
Joel Cho (chair)	Yes	No	--	--	--
Trevor Jensen	Yes	No	--	--	--
Benji Matthews	Yes	No	--	--	--
Kreegan Reierson	Yes	No	--	--	--
Anjali Bhagra	Yes	No	--	--	--
Other Working Group Members*					
Saaid Abdel-Ghani	Yes	No	--	--	--
Carolina Candotti	Yes	No	--	--	--
Ria Dancel	Yes	No	--	--	--
Venkat Kalidindi	Yes	No	--	--	--
Ketino Kobaidze	Yes	No	--	--	--
Josh Lenchus	Yes	No	--	--	--
Brian Lucas	Yes	No	--	--	--
Martin Perez	Yes	No	--	--	--
Nitin Puri	Yes	Yes	Fujifilm-Sonosite	Honorarium	No
Sophia Rodgers	Yes	Yes	NCNP	Honorarium	No
Gerard Salame	Yes	No	--	--	--
Dan Schnobrich	Yes	No	--	--	--
David Tierney	Yes	No	--	--	--
Peer Reviewers					
Robert Arntfield	Yes	Yes	Fujifilm-Sonosite Elsevier-Saunders	Honorarium Royalty	No No
Michael Blaivis	Yes	No	--	--	--
Richard Hoppmann	Yes	Yes	Echonous	Advisory Board	No
Paul Mayo	Yes	No	--	--	--
Vicki Noble	Yes	Yes	Cambridge University Press	Royalty	No
Aliaksei Pustavoitau	Yes	No	--	--	--
Kirk Spencer	Yes	No	--	--	--
Vivek Tayal	Yes	No	--	--	--
Methodologist					
Mahmoud El-Barbary	Yes	No	--	--	--
Medical Librarian					
Loretta Grikis	Yes	No	--	--	--
SHM Education Committee					
Daniel Brotman	No	No	--	--	--
Susan Hunt	Yes	No	--	--	--
Satyen Nichani	No	No	--	--	--
SHM Staff					
Nick Marzano	No	No	--	--	--

*Thoracentesis, lumbar puncture, vascular access, and credentialing working groups

Appendix 3 – Paracentesis Literature Search Strings

A comprehensive literature search was performed of the following databases: Medline, Embase, CINAHL, and Cochrane. The following article types were excluded: non-English language, non-human, age<18, conference abstracts and posters, letters, case reports, and editorials. All relevant systematic reviews, meta-analyses, randomized controlled trials, and observational studies were included.

PubMed search for paracentesis and ultrasound:

("Paracentesis"[Mesh] OR paracentesis [tiab] OR paracenteses[tiab] OR "Ascitic Fluid"[Mesh] OR "Ascites"[Mesh] OR "peritoneal drainage"[tiab] OR "peritoneal fluid"[tiab]) AND ("Ultrasonography"[Mesh] OR ultrasound[tiab] OR sonograph*[tiab] OR echograph*[tiab]) AND ("Meta-Analysis" [Publication Type] OR "Randomized Controlled Trial" [Publication Type] OR "Review" [Publication Type]OR "Clinical Trial" [Publication Type] OR "Comparative Study" [Publication Type] OR "Controlled Clinical Trial" [Publication Type] OR "Evaluation Studies" [Publication Type] OR "Guideline" [Publication Type]OR "Practice Guideline" [Publication Type])

Embase search for paracentesis and ultrasound:

(paracentesis/exp OR ascites fluid/exp OR ascites/exp OR paracentesis:ti OR paracentesis:ab OR paracentesis:ti OR paracentesis:ab OR "peritoneal drainage":ti OR "peritoneal drainage": ab OR "peritoneal fluid":ti OR "peritoneal fluid":ab) AND (echography/exp OR ultrasound/exp OR ultrasonography:ti OR sonograph*:ti OR ultrasonography: ti OR sonograph*:ab) AND clinical trial/exp OR comparative study/exp OR controlled clinical trial/exp OR evaluation study/exp OR practice guideline/exp OR meta analysis/exp OR observational study/exp OR review/exp OR "systematic review"/exp)

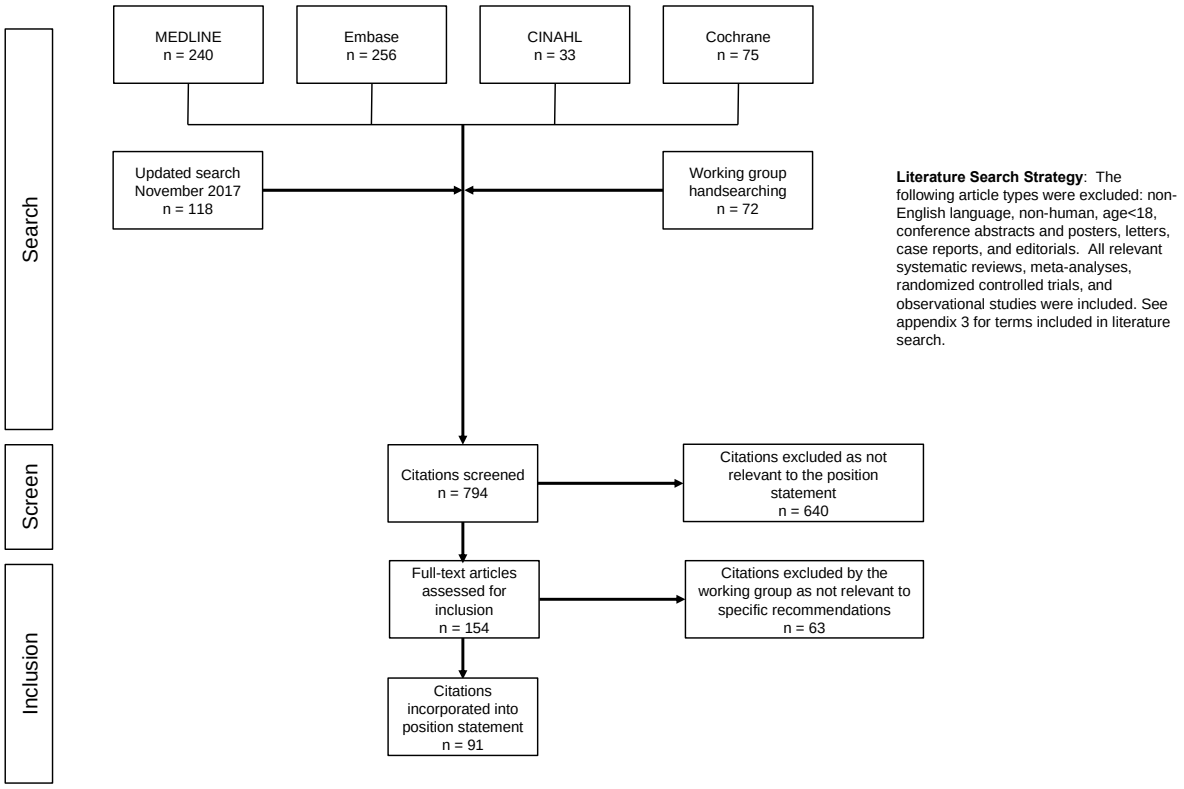
CINAHL search for paracentesis and ultrasound:

(MH "Paracentesis" OR paracentesis(ti) OR paracenteses(ab) OR paracenteses(ti) OR paracenteses(ab) OR "ascites fluid"(ti) OR "ascites fluid"(ab) OR "peritoneal fluid"(ti) OR "peritoneal fluid"(ab) OR "peritoneal drainage"(ti) OR "peritoneal fluid"(ab)) AND (MH "Ultrasonography" OR ultrasound(ti) OR ultrasound(ab) OR sonograph*(ti) OR sonograph*(ab) OR echograph*(ti) OR echograph*(ab) AND (trial(ti) OR trial(ab) OR comparative(ti) OR evaluation(ti) OR guideline*(ti) OR meta-analysis(ti) OR meta-analysis(ab) OR observational(ti) OR observational(ab) OR random*(ti) OR random(ab) OR review(ti) OR review(ab))

COCHRANE search for paracentesis:

(paracentesis OR paracenteses OR "ascitic fluid" OR ascites OR "peritoneal fluid" OR "peritoneal drainage") AND (ultrasound OR ultrasonography OR sonograph* OR echograph*). Limited to trials only

Figure 2 – Literature search strategy



Literature Search Strategy: The following article types were excluded: non-English language, non-human, age<18, conference abstracts and posters, letters, case reports, and editorials. All relevant systematic reviews, meta-analyses, randomized controlled trials, and observational studies were included. See appendix 3 for terms included in literature search.

Paracentesis Recommendations - SHM POCUS Guidelines - Voting Round 2

Instructions: Please rate your level of agreement with each of the recommendations on the use of ultrasound to guide paracentesis. A detailed literature review is provided in the "Comment" box.

We have included background information on the RAND Appropriateness Method below. It is NOT required that you read about RAND RAM before proceeding.

Introduction to RAND Appropriatenss Method (RAM)

RAM provides a structured method to obtain feedback regarding ranking or agreement of a statement or clinical procedure. RAND corporation, in conjunction with UCLA developed this method to evaluate scientific evidence and expert opinion in health care procedures and best practice guidelines. This method has become a leading standard for quality assessment in medicine. More information about the RAND Appropriateness Method, its uses and how it was developed can be found at:

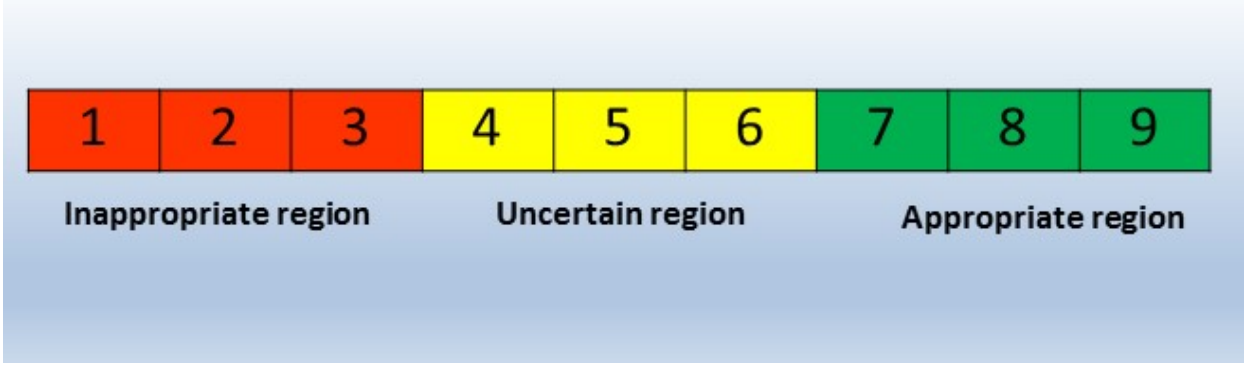
RAND/UCLA Appropriateness Method User's Manual

RAND Rules for Voting

How to Rank the Recommendations

Please rank the recommendations according to the RAND Appropriateness Scale.

1 = Extremely Inappropriate vs. 9 = Extremely Appropriate



When voting please consider the 5 transforming factors with stronger recommendations fulfilling more of these factors.

5 Transforming Factors:

1) Problem Priority / Importance - How critical is the potential outcome of this recommendation?
2) Level of Quality of Evidence (LQE) - How high is the Level of Quality of Evidence?
3) Benefit / Harm balance - How large is the net benefit/harm of the outcome of the recommendation?
4) Benefit / Burden balance - Is the burden worth the benefit?
5) Certainty / Concerns about PEAF (Preferences / Equity Acceptability / Feasibility) - How certain are you this recommendation would be feasible, equitable, acceptable, and preferred by patients?

[Attachment: "RAND EtD table.pdf"]

Last Name:

_____

First Name:

_____

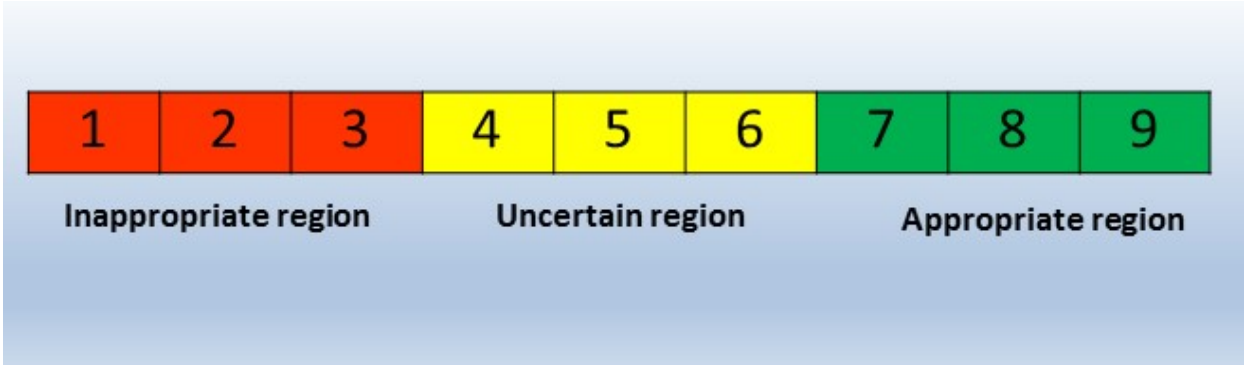
Definitions

1. Abdominal paracentesis is a procedure in which fluid is aspirated from the intraperitoneal space by percutaneous insertion of a needle with or without a catheter through the abdominal wall. Throughout this document, the term "paracentesis" refers to "abdominal paracentesis."
2. In this document, ultrasound-guided paracentesis refers to use of static ultrasound guidance to mark a needle insertion site immediately prior to performing the procedure. Real-time (dynamic) ultrasound guidance refers to tracking the needle tip with ultrasound as it traverses the abdominal wall to enter the peritoneal cavity.
Landmark-based paracentesis refers to paracentesis based on physical examination alone.

Please add any comments:

Clinical Outcomes

Please use this scale to rank the appropriateness of the recommendation(s) below:



Recommendation 1:

Use ultrasound guidance for paracentesis to reduce the risk of serious complications, the most common being bleeding. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")

(Please use the Appropriateness Scale above to select your recommendation)

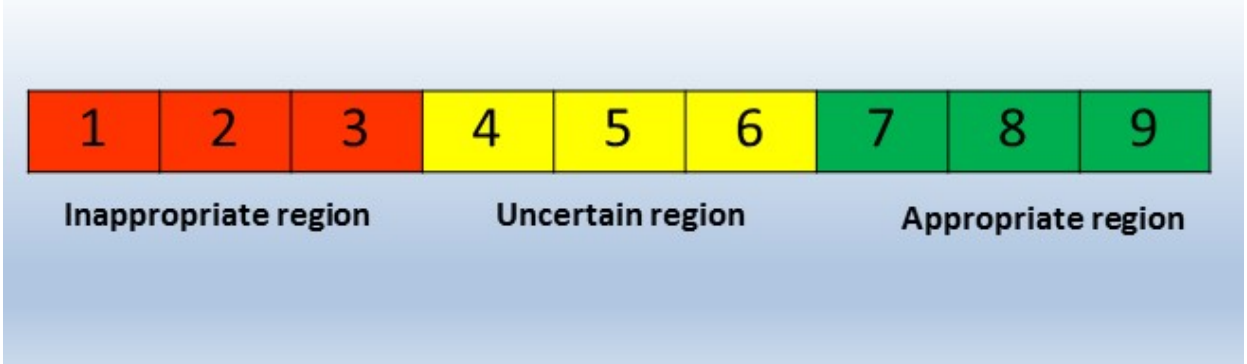
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
The occurrence of minor and serious life-threatening complications from paracentesis have been well described. [1-8] A recent retrospective study that evaluated 515 landmark-guided paracenteses (88%) noted that the most common minor complication was persistent ascites leakage (5%) and the most common serious complication was post-procedural bleeding (1%).[5] Studies have shown that abdominal wall hematoma and hemoperitoneum are common hemorrhagic complications of paracentesis, although inferior epigastric artery pseudoaneurysm has also been described. [6, 9, 10]

Current literature suggests that use of ultrasound-guided paracentesis is a safe procedure, even with reduced platelet counts or elevated international normalized ratio (INR). [11-17] Most comparative studies have shown that ultrasound guidance reduces the risk of bleeding complications compared to use of landmarks alone [2, 4, 7, 18-20], but a few studies did not find a significant difference. [12, 21, 22] One large retrospective observational study that looked at administrative data of 69,859 paracentesis from more than 600 hospitals demonstrated that ultrasound guidance reduced the odds of bleeding complications by 68% (OR, 0.32; 95% CI, 0.25-0.41).). The bleeding complication rates with and without the use of ultrasound guidance were 0.27% (CI 0.26-0.29) vs. 1.25% (CI 1.21-1.29) ($P < .0001$), respectively. More importantly, paracentesis complicated by bleeding was associated with a higher in-hospital mortality rate (12.9% vs. 3.7%) in this study and, as a result, the all-cause mortality rate was higher for all patients that underwent paracentesis without ultrasound guidance (4.3 % vs. 3.2%). [18]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation(s) below:



Recommendation 2:

Use ultrasound guidance to avoid attempting paracentesis in patients with insufficient volume of intraperitoneal free fluid to drain. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")

(Please use the Appropriateness Scale above to select your recommendation)

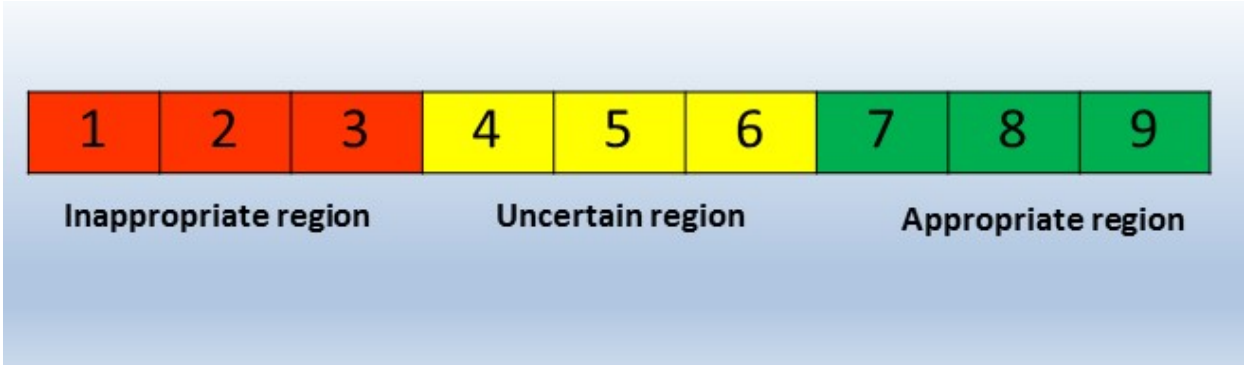
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Abdominal physical examination is not a reliable method for determining presence or volume of intraperitoneal free fluid, as no specific physical examination finding has consistently shown both high sensitivity and specificity for detecting intraperitoneal free fluid. [2, 22-29] Patient factors that limit the diagnostic accuracy of physical examination include body habitus, abdominal wall edema, and gaseous bowel distention.

In comparative studies, ultrasound has been found to be significantly more sensitive than physical examination to detect peritoneal free fluid [25, 28], and has been shown to detect as little as 100ml of peritoneal free fluid [30, 31], with diagnostic accuracy increasing with larger volumes of fluid. [31-33] In one randomized trial of 100 patients suspected of having ascites, patients were randomized to landmark-based versus ultrasound-guided paracentesis. Of the 56 patients in the ultrasound guided group, 14 patients suspected of having ascites on physical examination were found to have no or insufficient volume of ascites to attempt paracentesis. [22] Another study with 41 ultrasound examination on cancer patients suspected of having intraperitoneal free fluid by history and physical examination demonstrated that only 19 (46%) were deemed to have sufficient volume of ascites by ultrasound to attempt paracentesis. [14]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 3:

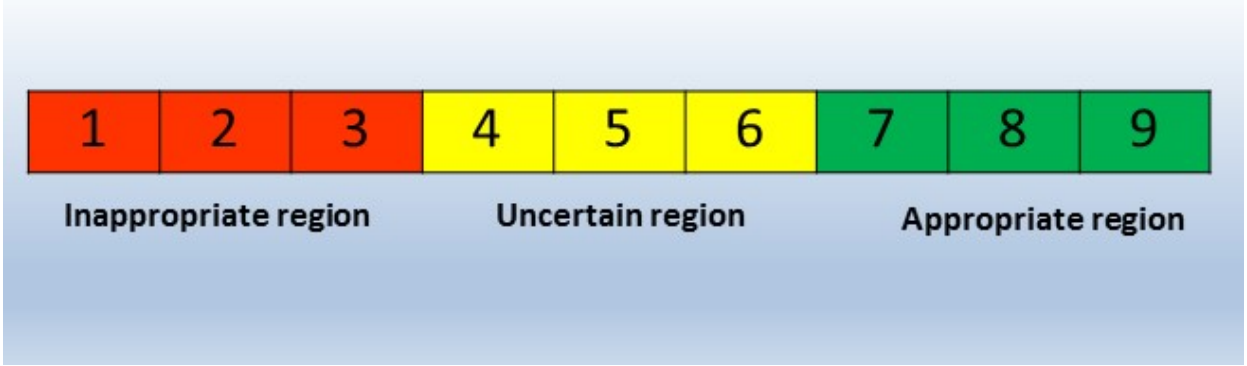
Use ultrasound guidance for paracentesis to improve the overall procedure success rates. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Ultrasound improves paracentesis success rates by avoiding attempts in patients with an insufficient volume of fluid to drain (see Recommendation 2); localizing the largest, drainable collection of fluid; and selecting the most accessible needle insertion site to drain the fluid. Success rates of landmark-based paracentesis in patients suspected of having intraperitoneal free fluid by physical examination are not well described in the literature, but reported success rates of paracentesis when using ultrasound guidance to select a needle insertion site are thought to be about 95-100%. [14, 22, 34, 35] In one randomized trial comparing ultrasound-guided vs. landmark-based paracentesis, ultrasound-guided paracentesis had a significantly higher success rate (95% of procedures performed) compared to the success rate of the landmark-based technique (61% of procedures performed). Furthermore, 87% of the initial failures in the landmark-based group were subsequently successful when ultrasound guidance was used. Ultrasound revealed that the rest of the patients (13%) did not have enough fluid to attempt ultrasound-guided paracentesis. [22]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 4:

Ultrasound guidance for paracentesis may reduce the hospital length of stay and costs. (Round 1 Voting: Disagreement with no consensus = No recommendation can be made)

(Please use the Appropriateness Scale above to select your recommendation)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

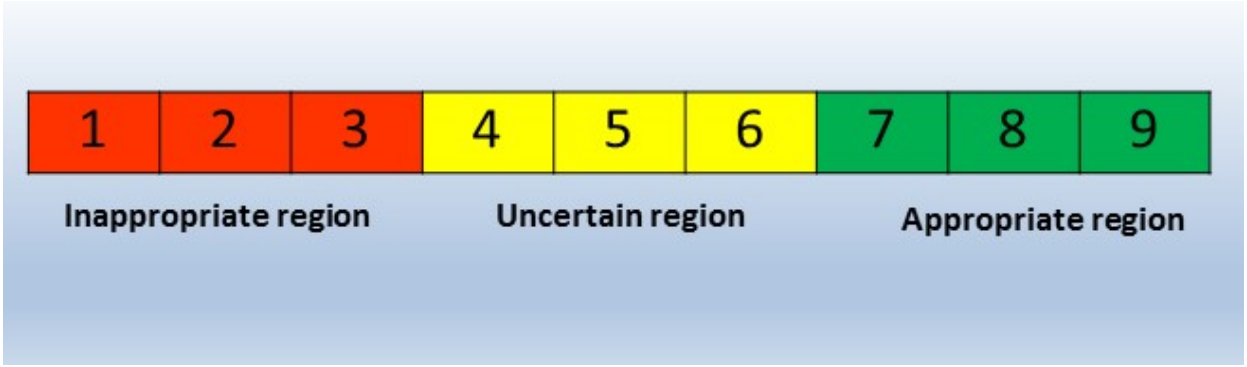
o Rationale:
The use of ultrasound guidance for paracentesis may reduce the inpatient length of stay and overall costs by reducing the incidence of procedure-related complications. A retrospective study by Patel et al with 1,297 abdominal paracenteses showed ultrasound-guided paracentesis was associated with a lower incidence of adverse events compared to landmark-based paracentesis (1.4% vs. 4.7%; (p=0.01). An adjusted analysis showed significant reductions in adverse events (OR 0.35, 95%CI 0.165 to 0.739; p=0.006) and hospitalization costs ($8761 ± $5956 vs. $9848 ± $6581;p< 0.001) for paracentesis with vs. without ultrasound guidance.

Additionally, the adjusted average length of stay was 0.2 days shorter for paracentesis with ultrasound guidance vs. without ultrasound guidance (5.6 vs. 5.8 days; p< 0.0001). [19] Another large retrospective study by Mercaldi et al. included 101,188 patients that underwent paracentesis. This review showed hospitalization costs were increased for patients when paracentesis was done without ultrasound guidance, which appeared to be primarily mediated through higher incidence bleeding complications. Fewer bleeding complications occurred when paracentesis was performed with ultrasound guidance (0.27%) vs. without ultrasound guidance (1.27%), and bleeding complications were associated with increased hospitalization costs ($19,066, p< 0.0001) and increased length of stay (4.3 days, p< 0.0001).[18] It is important to note that both of these studies were retrospective reviews of administrative databases using International Classification of Diseases - Ninth revision (ICD-9) codes for paracentesis and Current Procedural Terminology (CPT) codes for use of ultrasound. As with any retrospective administrative database review, associations between procedures, complications, and use of ultrasound may be limited by erroneous coding and documentation.

Please add any comments:

Technique

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 5:

Use ultrasound to assess the volume and location of intraperitoneal free fluid to guide clinical decision-making about whether or not paracentesis can be safely performed. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

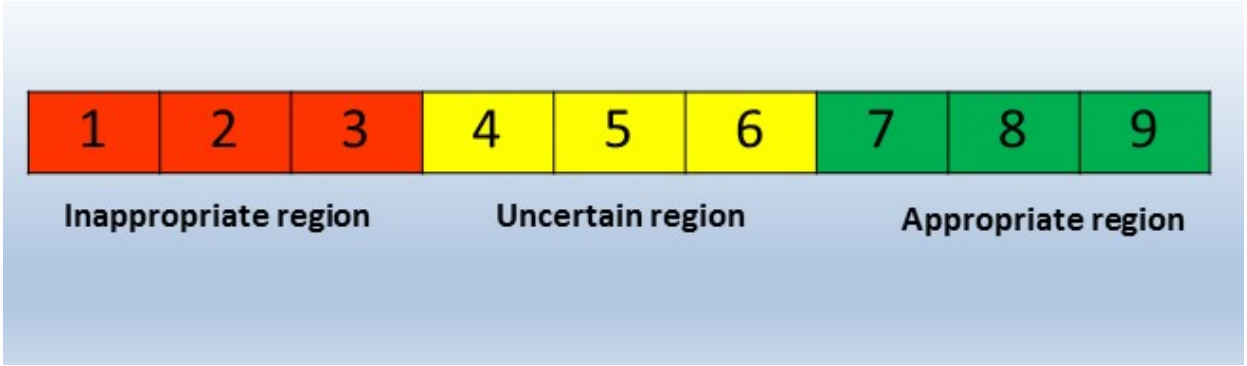
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
The presence and approximate volume of peritoneal fluid collections are important determinants of whether paracentesis, another procedure, or no procedure should be performed in a given clinical scenario. The overall diagnostic accuracy of physical examination to detect ascites is 58% [27], and in general, many providers are unable to detect ascites by physical examination until 1L of fluid has accumulated. One small study showed that 500 to 1100ml of fluid must accumulate before shifting dullness could be detected. [36] In contrast, ultrasound has been shown to detect as little as 100ml of peritoneal free fluid, [30, 31] which is superior to physical examination [25, 28]

Studies have shown that ultrasound can be used to differentiate ascites from other pathologies (e.g. matted bowel loops, metastases, abscesses, lymphocele) in patients with suspected ascites [37], and to better understand the etiology and distribution of the ascites. [38-40] Sonographic measurements allow semiquantitative assessment of the volume of intraperitoneal free fluid, which may correlate with amount of fluid removed in therapeutic paracentesis procedures. [41, 42] Furthermore, depth of a fluid collection by ultrasound may be an independent risk factor for the presence of spontaneous bacterial peritonitis (SBP), with one study showing that a maximum fluid collection depth of < 5cm had a negligible risk for SBP. [43]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 6:

Use ultrasound to identify a needle insertion site based on size of the fluid collection, thickness of the abdominal wall, and proximity to abdominal organs. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

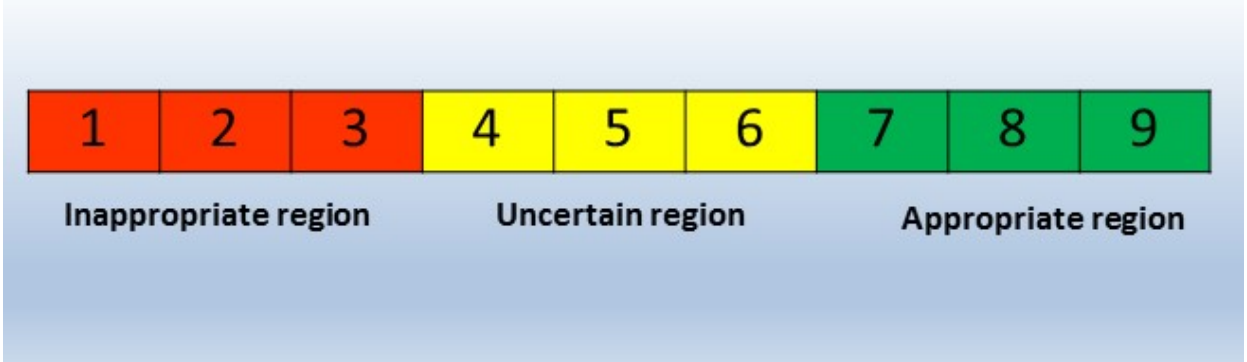
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
When paracentesis is performed using landmarks alone, the left lower quadrant has traditionally been recommended because the abdominal wall is generally thinner, depth of a peritoneal free fluid collection is greater, and stool-filled cecum is avoided. [2, 44]

When providers perform paracentesis using ultrasound guidance, any fluid collection that is directly visualized and accessible may be considered for paracentesis. The presence of ascites using ultrasound is best detected using a low-frequency transducer, such as phased array or curvilinear transducer, which provides deep penetration into the abdomen and pelvis to assess peritoneal free fluid. [20, 29, 45-47] An optimal needle insertion site should be determined based on a combination of visualization of largest fluid collection, avoidance of underlying abdominal organs, and thickness of abdominal wall. [2, 46, 48, 49]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 7:

Evaluate the needle puncture site using color flow Doppler ultrasound to identify and avoid abdominal wall vessels along the anticipated trajectory of the needle. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

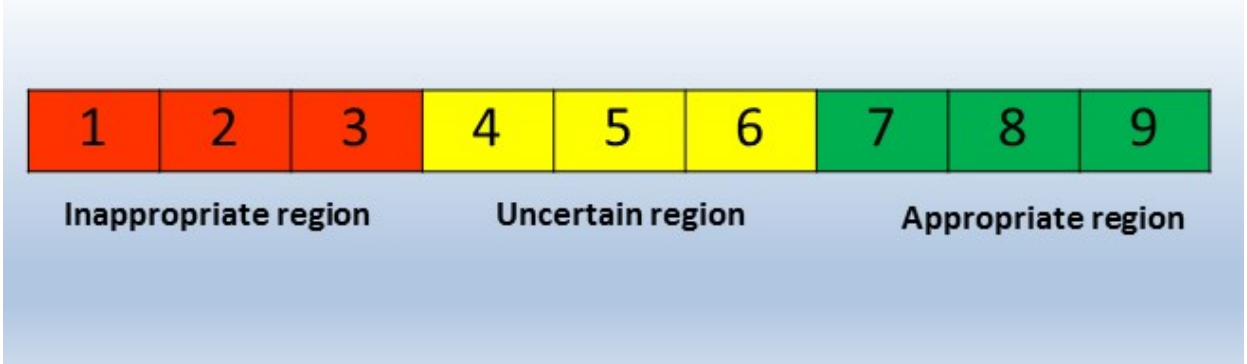
o Rationale:
The anatomy of the superficial vessels of the abdominal wall varies greatly, especially the lateral branches. [50, 51] Although uncommon, inadvertent laceration of an inferior epigastric artery or one of its large branches is associated with significant morbidity and mortality. [8, 51-55] A review of 126 cases at a single institution from 1992 to 2002 of rectus sheath hematoma, which most likely happens due to laceration of inferior or superior gastric artery, showed mortality rate of 1.6%, even with aggressive intervention. [56] In addition to the inferior epigastric arteries, several other vessels are at risk of injury during paracentesis, including the inferior epigastric veins, thoracoepigastric veins, subcostal artery and vein branches, deep circumflex iliac artery and vein, and recanalized subumbilical vasculature. [57-59] Laceration of any of the abdominal wall vessels could potentially result in catastrophic bleeding.

Identification of abdominal wall blood vessels is most commonly performed with a high-frequency transducer using a color flow Doppler ultrasound mode. [8, 45, 46, 55] A low-frequency transducer capable of color flow Doppler ultrasound may be utilized in patients with a thick abdominal wall.

Studies suggest that detection of abdominal wall blood vessels with ultrasound may reduce the risk of bleeding complications. One study showed that 43% of patients had a vascular structure present at one or more of the three traditional landmark paracentesis sites. [60] Another study directly compared bleeding rates between an approach utilizing a low-frequency transducer to only identify the largest collection of fluid versus a two-transducer approach utilizing both low and high-frequency transducers to identify the largest collection of fluid and evaluate for any superficial blood vessels. In this study that included 5,777 paracenteses, paracentesis-related minor bleeding rates were similar in both groups, but major bleeding rates were less in the group utilizing color flow Doppler to evaluate for superficial vessels (0.3% vs. 0.08%), though this difference did not reach statistical significance (p=0.07). [61]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 8:

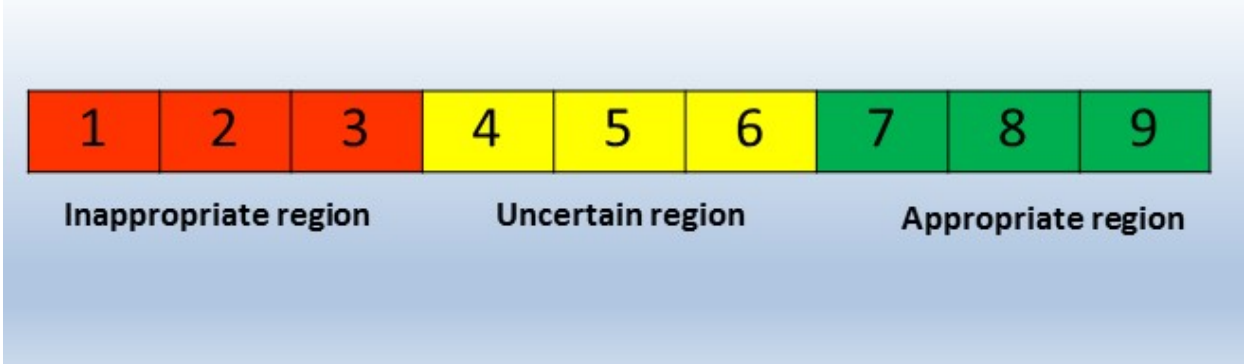
Evaluate the needle insertion site in multiple planes to ensure clearance from underlying abdominal organs and detect any superficial blood vessels along the anticipated needle trajectory. (Round 1 Voting: Weak recommendation with good consensus = "SUGGEST use...")
(Please use the Appropriateness Scale above to select your recommendation)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Most ultrasound machines have a slice thickness of < 4mm at the focal zone. [62] Considering the narrow ultrasound beam thickness, it is important to recognize that each ultrasound image represents a very thin 2-dimensional cross-section of the underlying tissues, and nearby critical structures, such as loops of small bowel or edges of solid organs, could be inadvertently punctured if the selected needle insertion site is only visualized in one plane. Therefore, it is important to evaluate the needle insertion site and surrounding areas in multiple planes by tilting the transducer and rotating the transducer to orthogonal planes. [40] Additionally, evaluation with color flow Doppler is performed in a similar fashion to ensure no large blood vessels are along the anticipated trajectory of the needle in the subcutaneous tissues.

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 9:

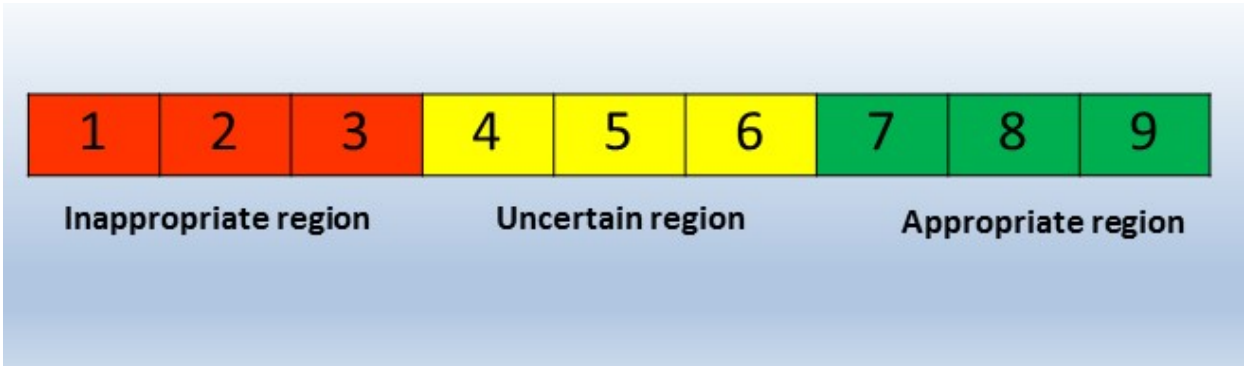
Mark a needle insertion site with ultrasound immediately before performing the procedure and ensure the patient remains in the same position between marking the site and performance of the procedure. (Round 1 Voting: Weak recommendation with good consensus = "SUGGEST use...")
(Please use the Appropriateness Scale above to select your recommendation)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Free-flowing peritoneal fluid and abdominal organs, especially loops of small bowel, can easily shift when a patient changes position or takes a deep breath. [31, 37, 46] Therefore, if the patient changes position or there is a delay between marking the needle insertion site and performing the procedure, the patient should be re-evaluated with ultrasound to ensure the needle insertion site initially marked is still the safest site for paracentesis. [60]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 10:

Consider using real-time ultrasound guidance for paracentesis when the fluid collection is small or difficult to access.
(Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

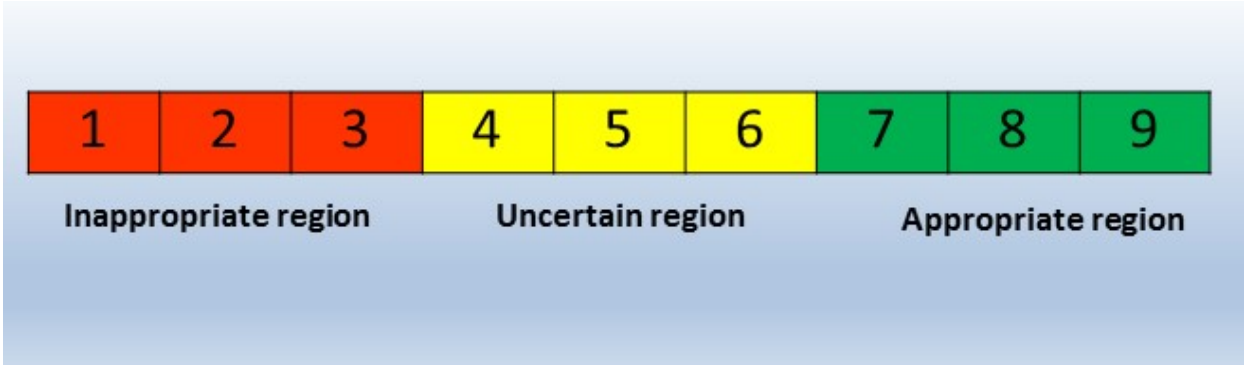
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Use of real-time ultrasound guidance for paracentesis has been described to drain abdominal fluid collections. [22, 41, 46] Several studies have commented that real-time ultrasound guidance may be necessary in attempting paracentesis in obese patients, with small fluid collection, or when performing the procedure near critical structures, such as loops of small bowel, liver, or spleen. [35, 63]

Please add any comments:

Training

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 11:

Use dedicated training sessions, including didactics, supervised practice on patients, and simulation-based practice, to teach novices to perform ultrasound-guided paracentesis. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

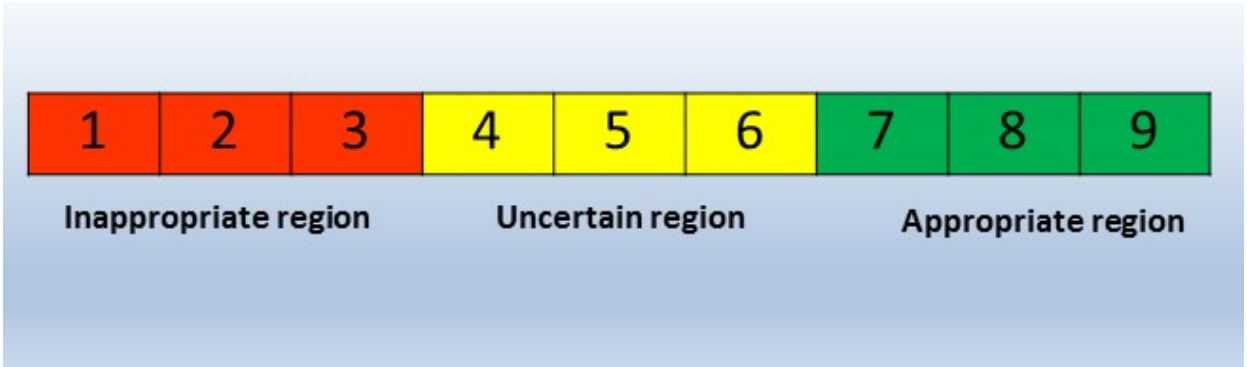
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Healthcare providers must gain multiple skills to perform ultrasound-guided paracentesis. Trainees must learn how to operate the ultrasound machine to identify the most appropriate needle insertion site based on the abdominal wall thickness, fluid collection size, proximity to nearby abdominal organs, and presence of blood vessels. Education regarding the use of ultrasound guidance for paracentesis is both desired [64, 65], and being increasingly taught to health care providers who perform paracentesis. [22, 66-68]

Several approaches have shown high uptake of essential skills to perform ultrasound-guided paracentesis after short training sessions. One study showed that first-year medical students can be taught to use point-of-care ultrasound to accurately diagnose ascites after three 30 minute teaching sessions. [69] Another study showed that emergency medicine residents can achieve high levels of proficiency in the pre-procedural ultrasound evaluation for paracentesis with only 1 hour of didactic training. [22] Other studies also appear to support the concept that adequate proficiency is achievable within brief, focused training sessions. [70-77] However, it should be noted that these skills likely decay significantly over time without ongoing maintenance education.[78]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 12:

Demonstration of competence in performing ultrasound-guided paracentesis is needed prior to independently attempting the procedure on patients. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

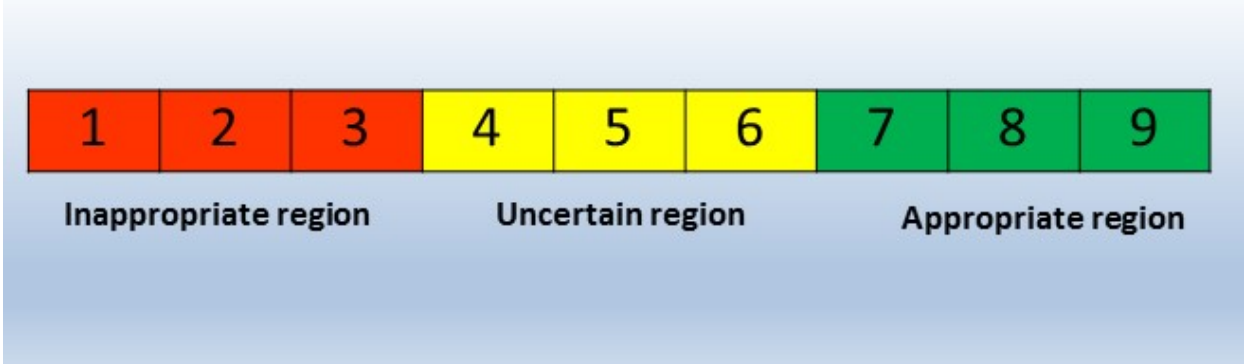
◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Training of novice providers to become competent in ultrasound-guided paracentesis includes acquisition of clinical knowledge about paracentesis, skills in basic abdominal ultrasonography, and manual techniques to perform the procedure. Competence in ultrasound-guided paracentesis cannot be assumed for those graduating from internal medicine residency in the US. While clinical knowledge about paracentesis remains a core competency of graduating internal medicine residents per the American Board of Internal Medicine (ABIM), demonstration of competence in performing ultrasound-guided or landmark-based paracentesis is not currently mandated. [79]

A recent national survey of internal medicine residency program directors revealed that curricula and resources available to train residents in bedside diagnostic ultrasound and ultrasound-guided procedures, including paracentesis, remain quite variable. [65] A list of consensus-derived ultrasound competencies for ultrasound-guided paracentesis has been proposed that may serve as a guide to both training curriculum development and practitioner evaluation [68, 80]

Please add any comments:

Please use this scale to rank the appropriateness of the recommendation below:



Recommendation 13:

When available, use simulation-based practice to facilitate acquisition of required knowledge and skills to perform ultrasound-guided paracentesis. (Round 1 Voting: Strong recommendation with very good consensus = "SHOULD use...")
(Please use the Appropriateness Scale above to select your recommendation)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ ABSTAIN. I know nothing about this topic.

o Rationale:
Simulation-based practice has been shown to increase competence in bedside diagnostic ultrasonography and procedural techniques for ultrasound-guided procedures, including paracentesis. [71, 74, 81-83]. One study showed that internal medicine residents were able to achieve a high level of proficiency to perform ultrasound-guided paracentesis after a 3-hour simulation-based mastery learning session.[82] A follow-up study suggested that after sufficient simulation-based training, non-interventional radiologist can perform ultrasound-guided paracentesis as well as interventional radiologist. [81]

Please add any comments:

Please provide any final thoughts or comments.

Appendix 5 – Final Voting Results for Paracentesis Recommendations

Approved Recommendations with strong endorsement
Approved Recommendations with weak endorsement
Unapproved Recommendations, with disagreement

Recommendation	# of Panelists	Median	Zone	# of votes out of Zone	# of votes within X of median			Consensus
					1 pt	2 pts	3 pts	
1: Use ultrasound guidance for paracentesis to reduce the risk of serious complications, the most common being bleeding.	27	9	Appropriate	1 (4%)	26 (96%)	→	→	Very Good
2: Use ultrasound guidance to avoid attempting paracentesis in patients with insufficient volume of intraperitoneal free fluid to drain.	27	9	Appropriate	0 (0%)	27 (100%)	→	→	Very Good
3: Use ultrasound guidance for paracentesis to improve the overall procedure success rate.	27	9	Appropriate	0 (0%)	25 (93%)	→	→	Very Good
4: Ultrasound guidance for paracentesis may reduce the hospital length of stay and costs.	27	7	Appropriate	10 (37%)	→	→	→	No
5: Use ultrasound to assess the volume and location of intraperitoneal free fluid to guide clinical decision-making about whether or not paracentesis can be safely performed.	27	9	Appropriate	0 (0%)	27 (100%)	→	→	Very Good
6: Use ultrasound to identify a needle insertion site based on size of the fluid collection, thickness of the abdominal wall, and proximity to abdominal organs.	27	9	Appropriate	1 (4%)	23 (85%)	→	→	Very Good
7: Evaluate the needle puncture site using color flow Doppler ultrasound to identify and avoid abdominal wall vessels along the anticipated trajectory of the needle.	27	9	Appropriate	2 (7%)	22 (81%)	→	→	Very Good

8: Evaluate the needle insertion site in multiple planes to ensure clearance from underlying abdominal organs and detect any superficial blood vessels along the anticipated needle trajectory.	27	8	Appropriate	3 (11%)	24 (89%)			Very Good
9: Mark a needle insertion site with ultrasound immediately before performing the procedure and ensure the patient remains in the same position between marking the site and performance of the procedure.	27	8	Appropriate	2 (7%)	25 (93%)			Very Good
10: Consider using real-time ultrasound guidance for paracentesis when the fluid collection is small or difficult to access.	27	9	Appropriate	4 (15%)	22 (81%)			Very Good
11: Use dedicated training sessions, including didactics, supervised practice on patients, and simulation-based practice, to teach novices to perform ultrasound-guided paracentesis.	27	8	Appropriate	1 (4%)	26 (96%)			Very Good
12: When available, use simulation-based practice to facilitate acquisition of required knowledge and skills to perform ultrasound-guided paracentesis.	27	9	Appropriate	1 (4%)	25 (93%)			Very Good
13: Demonstration of competence in performing ultrasound-guided paracentesis is needed prior to independently attempting the procedure on patients.	27	9	Appropriate	2 (7%)	25 (93%)			Very Good