Supplementary Material for the 2024 Clinical Practice Guideline Update by the Infectious Diseases Society of America on Complicated Intra-abdominal Infections: Diagnostic Imaging of Suspected Acute Diverticulitis in Adults and Pregnant People

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METHODS

Panel formation and conflicts of interest

The chair of the guideline panel was selected by the leadership of IDSA. Fifteen additional panelists comprised the full panel. The panel included clinicians with expertise in infectious diseases, pediatric infectious diseases, surgery, emergency medicine, microbiology, and pharmacology. Panelists were diverse in gender, geographic distribution, and years of clinical experience. Guideline methodologists oversaw all methodological aspects of the guideline development and identified and summarized the scientific evidence for each clinical question. IDSA staff oversaw all administrative and logistic issues related to the guideline panel.

All members of the expert panel complied with the IDSA policy on conflict of interest (COI), which requires disclosure of any financial, intellectual, or other interest that might be construed as constituting an actual, potential, or apparent conflict. Evaluation of such relationships as potential conflicts of interest was determined by a review process which included assessment by the Standards and Practice Guideline Committee (SPGC) Chair, the SPGC liaison to the Guideline panel and the Board of Directors liaison to the SPGC, and if necessary, the Conflicts of Interests Task Force of the Board. This assessment of disclosed relationships for possible COI was based on the relative weight of the financial relationship (i.e., monetary amount) and the relevance of the relationship (i.e., the degree to which an independent observer might reasonably interpret an association as related to the topic or recommendation of consideration). The reader of these guidelines should be mindful of this when the list of disclosures is reviewed. See the Notes section at the end of this guideline for the disclosures reported to IDSA.

Practice recommendations

Clinical Practice Guidelines are statements that include recommendations intended to optimize patient care by assisting practitioners and patients in making shared decisions about appropriate health care for specific clinical circumstances. These are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options [IOM 2011]. The "IDSA Handbook on Clinical Practice Guideline Development" provides more detailed information on the processes followed throughout the development of this guideline [IDSA CPG Handbook].

Review and approval process

Feedback was obtained from five external individual peer expert reviewers as well as the endorsing organizations. The IDSA Standards and Practice Guidelines Subcommittee (SPGS) and Board of Directors reviewed and approved the guideline prior to publication.

Process for updating

IDSA guidelines are regularly reviewed for currency. The need for updates to the guideline is determined by a scan of current literature and the likelihood that any new data would impact the recommendations. Any changes to the guideline will be submitted for review and approval to the appropriate Committees and Board of IDSA.

Clinical questions

Each clinical question was formatted according to the PICO style: Patient/Population (P), Intervention/Indicator (I), Comparator/Control (C), Outcome (O). For each PICO question, outcomes of interest were identified a priori and rated for their relative importance for decision-making.

Literature search

A medical librarian designed the literature searches and MeSH terms for Ovid Medline, Embase, and Cochrane Library. Searches were limited to studies published in English. The initial formal literature searches were performed in July to November 2018, and updated literature searches were conducted in March 2021 and October 2022. To supplement the electronic searches, reference lists of related articles and guidelines were reviewed for relevance.

MEDLINE

#1 exp Tomography, X-Ray Computed/

#2 exp Ultrasonography/

#3 (ultraso* or ultra-so* or echograph* or echo-graph* or echotomograph* or echoto-mograph* or sonograph* or sono-graph* or echocardiograph* or echo-cardiograph* or echoencephalograph* or echo-encephalograph* or endosonograph* or endo-sonograph*).tw,kf.

#4 ((tomodensitometr* or (ct or comput* or cat or electron)) adj3 (cine or scan* or xray* or x-ray* or tomograph*)).tw,kf.

#5 (HIDA or ((hepatobiliar* or hepato-biliar*) adj2 (scan* or imag*))).tw,kf.

#6 exp Magnetic Resonance Imaging/

#7 (MRI or MRIs or (magn* adj3 resonanc*) or ((magn* or MR or MRs) adj2 (imaging* or tomograph* or tomo-graph*))).tw,kf,jw.

#8 or/1-7

#9 exp Diverticulitis/

#10 diverticul*.tw,kf.

#11 or/9-10

#12 8 and 11

#13 Animals/ not (Animals/ and Humans/)

#14 ((animal or animals or canine* or cat or cats or dog or dogs or feline or hamster* or mice or monkey or monkeys or mouse or murine or pig or pigs or piglet* or porcine or primate* or rabbit* or rats or rat or rodent* or sheep*) not (human* or patient*)).ti,kf.

#15 12 not (13 or 14)

#16 limit 15 to english

#17 limit 16 to yr="2021 -Current"

#18 remove duplicates from 17

EMBASE

#1 exp x-ray computed tomography/

#2 exp echography/

#3 (ultraso* or ultra-so* or echograph* or echo-graph* or echotomograph* or echoto-mograph* or sonograph* or sono-graph* or echocardiograph* or echo-cardiograph* or echoencephalograph* or echo-encephalograph* or endosonograph* or endo-sonograph*).tw,kw,kf.

#4 ((tomodensitometr* or (ct or comput* or cat or electron)) adj3 (cine or scan* or xray* or x-ray* or tomograph*)).tw,kw,kf.

#5 (HIDA or ((hepatobiliar* or hepato-biliar*) adj2 (scan* or imag*))).tw,kw,kf.

#6 exp nuclear magnetic resonance imaging/

#7 (MRI or MRIs or (magn* adj3 resonanc*) or ((magn* or MR or MRs) adj2 (imaging* or tomograph* or tomo-graph*))).tw,kw,jx,kf.

#8 or/1-7

#9 diverticulitis/

#10 diverticul*.tw,kw,kf.

#11 or/9-10

#12 8 and 11

#13 (exp animal/ or exp juvenile animal/ or adult animal/ or animal cell/ or animal experiment/ or animal model/ or animal tissue/ or nonhuman/) not human/

#14 ((animal or animals or canine* or cat or cats or dog or dogs or feline or hamster* or mice or monkey or monkeys or mouse or murine or pig or pigs or piglet* or porcine or primate* or rabbit* or rats or rat or rodent* or sheep*) not (human* or patient*)).ti,kw.

#15 12 not (13 or 14)

#16 limit 15 to english

#17 limit 16 to yr="2021 -Current"

#18 remove duplicates from 17

COCHRANE (WILEY)

#1 (ultraso* or ultra-so* or echograph* or echo-graph* or echotomograph* or echoto-mograph* or sonograph* or sono-graph* or echocardiograph* or echo-cardiograph* or echoencephalograph* or echo-encephalograph* or endosonograph* or endo-sonograph*):ti,ab,kw

#2 ((tomodensitometr* or (ct or comput* or cat or electron)) NEAR/3 (cine or scan* or xray* or x-ray* or tomograph*)):ti,ab,kw

#3 (HIDA or ((hepatobiliar* or hepato-biliar*) NEAR/2 (scan* or imag*))):ti,ab,kw

#4 (MRI or MRIs or (magn* NEAR/3 resonanc*) or ((magn* or MR or MRs) NEAR/2 (imaging* or tomograph* or tomo-graph*))):ti,ab,kw,so

#5 #1 OR #2 OR #3 OR #4

#6 diverticul*:ti,ab,kw

#7 #5 AND #6

Study selection

Titles and abstracts were screened in duplicate for all identified citations using Rayyan [Ouzzani 2016]. All potentially relevant citations were subjected to a full-text review, using predefined inclusion and exclusion criteria tailored to meet the specific population, intervention, and comparator of each clinical question. The steps of the literature selection process were supervised and reviewed by a guideline methodologist for the final selection of the relevant articles.

The following eligibility criteria were used:

Inclusion criteria:

- *Patient population*- Adults or pregnant people with suspected diverticulitis
- *Intervention (diagnostic imaging modalities)*- Ultrasound, CT (including contrast), MDCT, or MRI
- *Comparator*- Clinical or surgical findings (e.g., histopathology) or another imaging modality
- *Outcomes*- Diagnostic accuracy (e.g., sensitivity, specificity)

- *Study design*- Randomized controlled trials (RCTs) with no date limit, observational studies published 2005-present (limit was extended from 2010 to 2005 due to lack of studies on MRI from 2010 onward).

Exclusion criteria:

- *Patient population*- Children, patients with suspected appendiceal diverticulitis or colonic diverticular bleeding
- *Intervention*- CT colonography, MRCP, POCUS (rationale: lower standard than rads US), Unenhanced CT/without contrast
- *Comparator*- No comparator
- *Study design*- Observational studies published prior to 2010, abstracts and conference proceedings, letters to the editor, editorials, and review articles

Data extraction and analysis

A guideline methodologist in conjunction with panelists extracted the data for each pre-determined patient-important outcome. If a relevant publication was missing raw data for an outcome prioritized by the panel, an attempt was made to contact the author(s) for the missing data. Where applicable, data were pooled using random-effects model (fixed effects model for pooling of rates) using RevMan [RevMan].

Evidence to decision

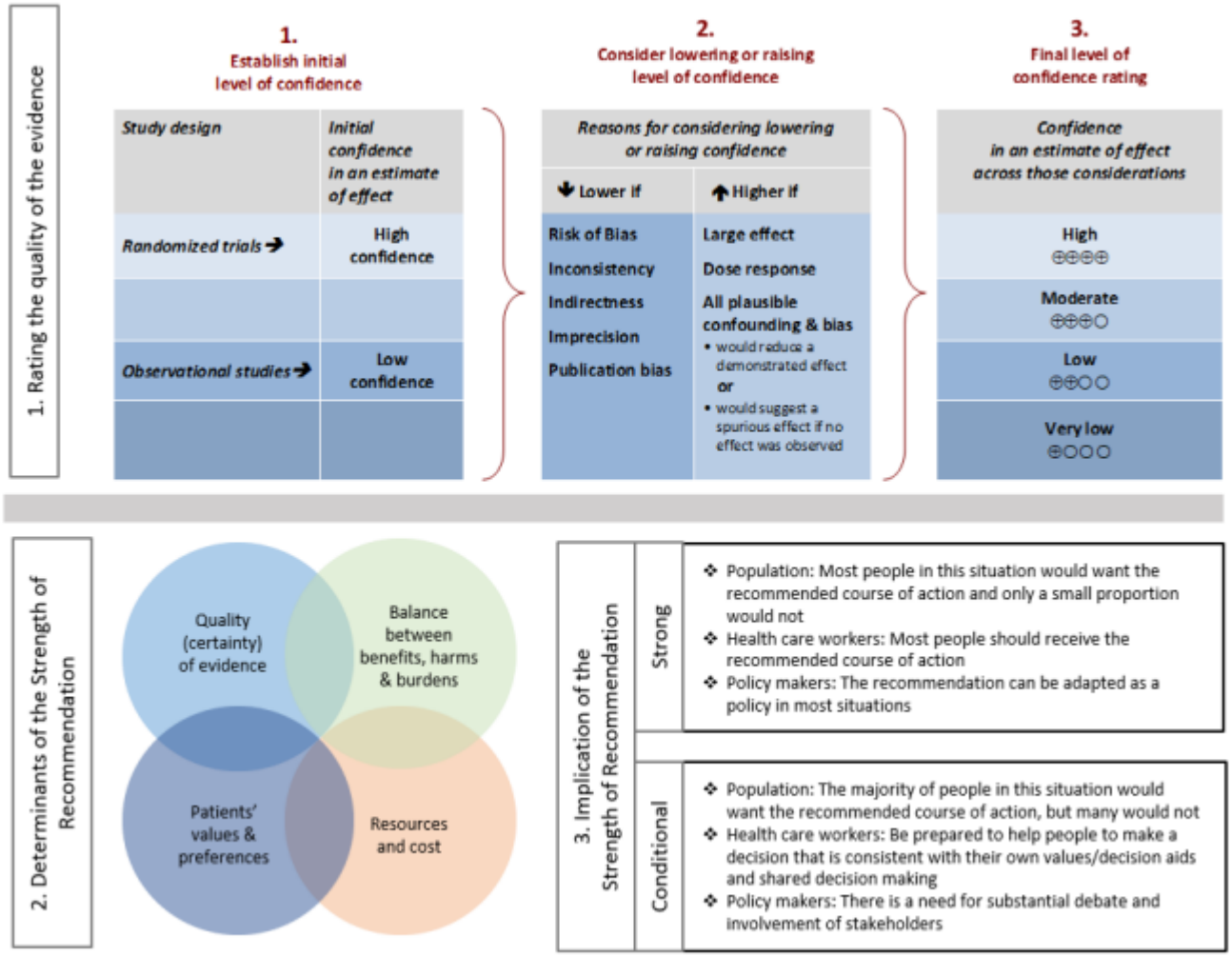
Guideline methodologists prepared the evidence summaries for each question and assessed the risk of bias and the certainty of evidence. Risk of bias was assessed by using the QUIPS tool for studies addressing risk/prognostic factors [Hayden 2013] and the QUADAS-2 tool for diagnostic test accuracy studies [Whiting 2011]. The certainty of evidence was determined first for each critical and important outcome and then for each recommendation using the GRADE approach for rating the confidence in the evidence [Guyatt 2008, GRADE Handbook]. Evidence profiles were developed using the GRADEpro Guideline Development Tool [Guyatt 2008] and reviewed by panel members responsible for each PICO.

The Evidence to Decision framework [GRADEpro] was used to translate the evidence summaries into practice recommendations. All recommendations were labeled as either “strong” or “conditional” according to the GRADE approach [IDSA CPG Handbook]. The words “we recommend” indicate strong recommendations and “we suggest” indicate conditional recommendations. Supplementary Figure 1 provides the suggested interpretation of strong and conditional recommendations for patients, clinicians, and healthcare policymakers. For recommendations where the comparator treatment or tests are not formally stated, the comparison of interest is implicitly referred to as “not using the intervention” (either not using a specific treatment or a diagnostic test).

All members of the panel participated in the preparation of the draft guideline and approved the recommendations.

TABLES AND FIGURES

Supplementary Figure 1. Approach and implications to rating the quality of evidence and strength of recommendations using GRADE methodology (unrestricted use of figure granted by the U.S. GRADE Network)

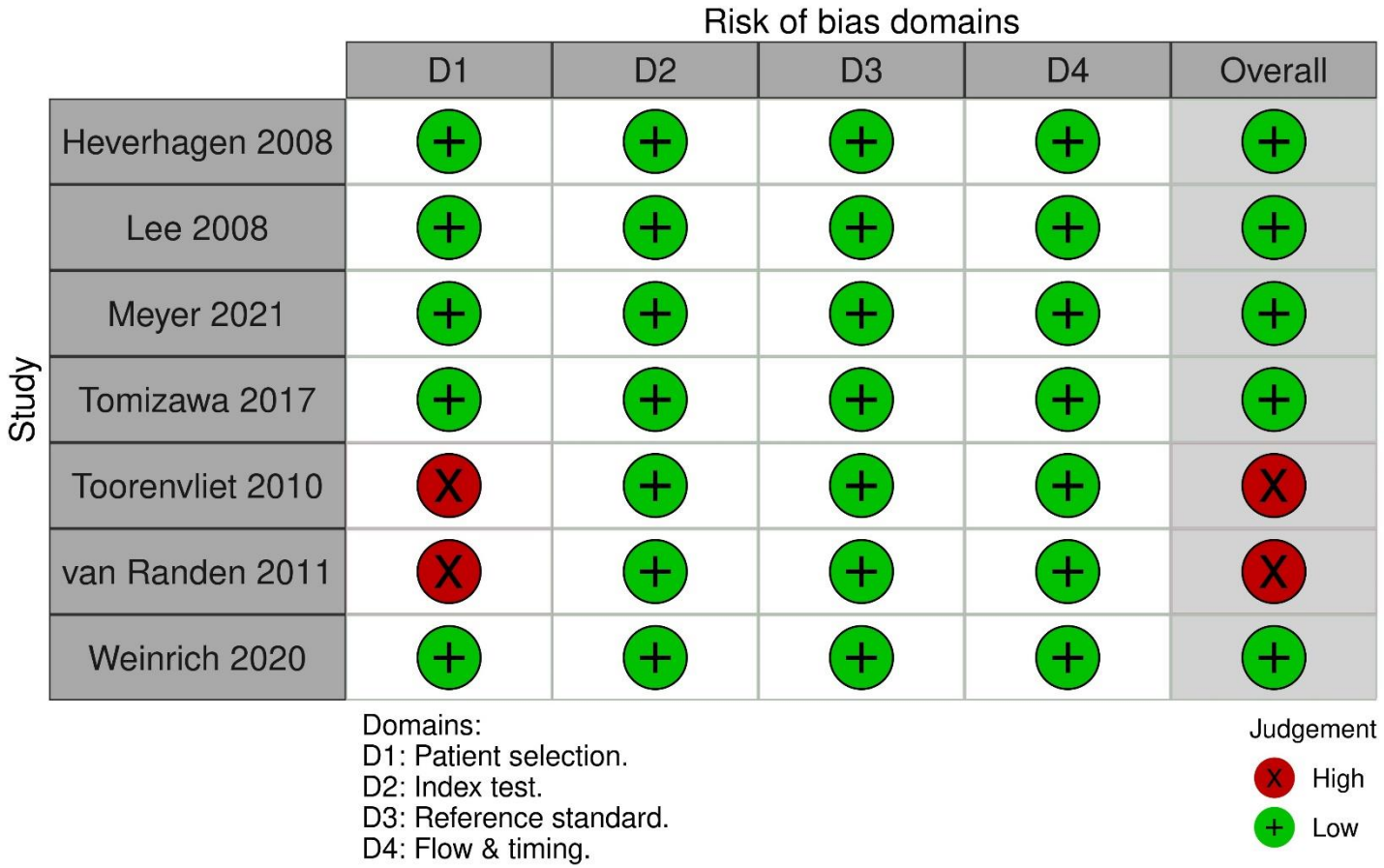


Supplementary Table 1. Characteristics of included studies for diverticulitis

Author, year of publication	Location, years of data collection	Study design	Number of patients, diagnosis, and age / Pre-test probability	Population included	Index test	Reference standard	Flow and timing
Heverhagen 2008	Germany Years not stated	Prospective cohort study	55 patients with suspected diverticulitis Age 59 years (unclear if median/mean, range 29-76) 47 diagnosed with diverticulitis, pre-test probability: 85.5%	Patients who reported to the ER with clinically suspected acute colonic diverticulitis	MRI	Surgery and pathology (n =16), CT (n = 31, 8 of whom also had surgery/pathology), and clinical follow-up of 3+ months including US (n = 39, 23 of whom also had CT)	All patients underwent MRI scans before and after contrast agent administration. MRI was only performed for the purposes of the study and results were not considered for clinical decision-making.
Lee 2008	Korea 2005-2006	Prospective cohort study	38 patients Age range 16-75 years 10/38 diagnosed with diverticulitis, pre-test probability: 26.3%	Adults presenting to the ED with clinically suspected appendicitis or right colonic diverticulitis who underwent CT	CT	Final diagnosis	38/100 patients were selected for CT according to an algorithm.
Meyer 2021	Germany 2005-2015	Retrospective review	460 patients Mean age 61 years (range 18-92) 144 diagnosed with diverticulitis, pre-test probability: 43.9%	Adults with clinical suspicion of diverticular disease of the colon who had CT performed	CT with IV contrast and without rectal contrast (group M1 data)	Surgical findings (including histopathology) or clinical follow-up of at least 4 weeks	All patients underwent CT.
Tomizawa 2017	Japan 2010-2015	Retrospective cohort study	76 patients with abdominal pain Mean±SD age males 65.8±18.8 years, females 53.7±19.3 years 5 diagnosed with diverticulitis, pre-test probability: 6.6%	Patients who underwent abdominal US as the first imaging test to diagnose abdominal symptoms	US	"Final diagnosis"	US performed as first-line imaging.
Toorenvliet 2010	The Netherlands 2005-2006	Prospective cohort study	802 patients with abdominal pain Mean±SD age 60.4±12.3 years 57 diagnosed with colonic diverticulitis, pre-test probability: 7.1%	Patients presenting with abdominal pain at the ED	US, CT	Intraoperative findings or pathology or if not operated on, clinical and/or radiological diagnosis in combination with the clinical response to therapy	Radiologist decided if US or CT was undertaken first. If US inconclusive, CT was done.

van Randen 2011	The Netherlands 2005-2006	Prospective cohort study	1021 adults with abdominal pain Mean 47 years (range 19-94 years) 118 diagnosed with diverticulitis, pre-test probability: 11.6%	Patients presenting to the ED with abdominal pain for >2 hours and <5 days referred for imaging	US, CT	Final diagnosis as determined by an expert panel (included histopathology)	Patients underwent both US and CT by different radiologists/residents
Weinrich 2020	Germany 2009-2017	Retrospective cohort study	1,069 patients with suspected colonic diverticulitis Mean age 60.3 years (range 20-98) 561 diagnosed with diverticulitis, pre-test probability: 52.5%	ED and inpatients undergoing MDCT for suspected colonic diverticulitis	CT	Medical record review (surgical pathology, labs, imaging, etc.), including 6 months of follow-up	MDCT performed

Supplementary Table 2. Risk of bias for included studies



Supplementary Table 3. GRADE Evidence Profile: Should CT vs. MRI be used to diagnose diverticulitis in adults with suspected diverticulitis?

CT (Weinrich 2020, Meyer 2021)		**MRI** (Heverhagen 2008)	
Sensitivity	0.92 to 0.99	Sensitivity	0.94
Specificity	0.97 to 1.00	Specificity	0.88

Prevalence	53% (per Weinrich 2020)	86% (per Heverhagen 2008)	44% (per Meyer 2021)

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1,000 patients tested						Test accuracy CoE
								pre-test probability of 53% (per Weinrich 2020)		pre-test probability of 86% (per Heverhagen 2008)		pre-test probability of 44% (per Meyer 2021)		
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	CT	MRI	CT	MRI	CT	MRI	
True positives (patients with diverticulitis)	3 studies (Heverhagen 2008, Meyer 2021, Weinrich 2020) 1452 patients	cross-sectional (cohort type accuracy study)	not serious	serious[a]	not serious	serious[b]	none	488 to 525	0 to 498	791 to 851	0 to 808	405 to 436	0 to 414	⨁⨁◯◯ LOW
								10 fewer to 525 more TP in CT		**17 fewer to 851 more TP in CT**		**9 fewer to 436 more TP in CT**		
False negatives (patients incorrectly classified as not having diverticulitis)								5 to 42	32 to 530	9 to 69	52 to 860	4 to 35	26 to 440	
								10 more to 525 fewer FN in CT		**17 more to 851 fewer FN in CT**		**9 more to 436 fewer FN in CT**		
True negatives (patients without diverticulitis)	3 studies (Heverhagen 2008, Meyer	cross-sectional (cohort type	not serious	serious[a]	not serious	serious[b]	none	456 to 470	0 to 414	136 to 140	0 to 123	543 to 560	0 to 493	⨁⨁◯◯ LOW

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1,000 patients tested						Test accuracy CoE
								pre-test probability of 53% (per Weinrich 2020)		pre-test probability of 86% (per Heverhagen 2008)		pre-test probability of 44% (per Meyer 2021)		
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	CT	MRI	CT	MRI	CT	MRI	
	2021, Weinrich 2020)	accuracy study)						**42 more to 470 more TN in CT**		**13 more to 140 more TN in CT**		**50 more to 560 more TN in CT**		
False positives (patients incorrectly classified as having diverticulitis)	1452 patients							0 to 14	56 to 470	0 to 4	17 to 140	0 to 17	67 to 560	
								42 fewer to 470 fewer FP in CT		**13 fewer to 140 fewer FP in CT**		**50 fewer to 560 fewer FP in CT**		

Explanations

a. Indirect comparisons
b. Small sample size for MRI

Supplementary Table 4. GRADE Evidence Profile: Should CT vs. US be used to diagnose diverticulitis in adults with suspected diverticulitis?

CT (Lee 2008, Toorenvliet 2010, van Randen 2011)		**US** (Tomizawa 2017, Toorenvliet 2010, van Randen 2011)	
Sensitivity	0.81 to 0.95	Sensitivity	0.61 to 1.00
Specificity	0.93 to 0.99	Specificity	0.99 to 1.00

Prevalence	12.9% (mean from studies)

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1,000 patients tested		Test accuracy CoE
								pre-test probability of 12.9% (mean from studies)		
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	CT	US	
True positives (patients with diverticulitis)	4 studies (Lee 2008, Tomizawa 2017, Toorenvliet 2010, van Randen 2011) 1937 patients	cross-sectional (cohort type accuracy study)	serious[a]	very serious[b]	not serious	serious[c]	none	104 to 123	79 to 129	⨁◯◯◯ VERY LOW
								25 more to 6 fewer TP in CT		
False negatives (patients incorrectly classified as not having diverticulitis)								6 to 25	0 to 50	
								25 fewer to 6 more FN in CT		
	4 studies (Lee 2008, Tomizawa 2017, Toorenvliet		serious[a]	very serious[b]	not serious	not serious	none	810 to 862	862 to 871	

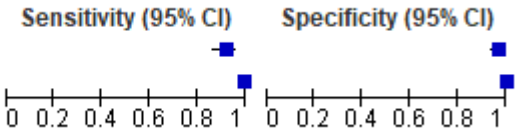
Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1,000 patients tested		Test accuracy CoE
								pre-test probability of 12.9% (mean from studies)		
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	CT	US	
True negatives (patients without diverticulitis)	2010, van Randen 2011) 1937 patients	cross-sectional (cohort type accuracy study)						**52 fewer to 9 fewer TN in CT**		⨁◯◯◯ VERY LOW
False positives (patients incorrectly classified as having diverticulitis)								9 to 61	0 to 9	
								52 more to 9 more FP in CT		

Explanations

a. Per QUADAS-2 assessment
b. Populations were patients with abdominal pain; indirect comparisons
c. Wide CIs for US

Supplementary Figure 2. Initial CT for adults with suspected diverticulitis

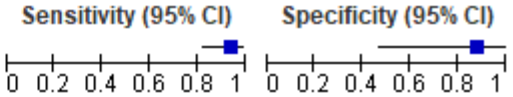
Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Meyer 2021	132	5	12	179	0.92 [0.86, 0.96]	0.97 [0.94, 0.99]
Weinrich 2020	556	1	5	507	0.99 [0.98, 1.00]	1.00 [0.99, 1.00]



Total n: 2 studies, 1,397 patients
Median sensitivity: 0.96 (range 0.92-0.99)
Median specificity: 0.99 (range 0.97-1.00)

Supplementary Figure 3. Initial MRI for adults with suspected diverticulitis

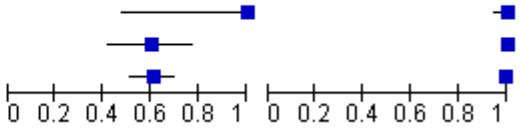
Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Heverhagen 2008	44	1	3	7	0.94 [0.82, 0.99]	0.88 [0.47, 1.00]



Total n: 55 patients

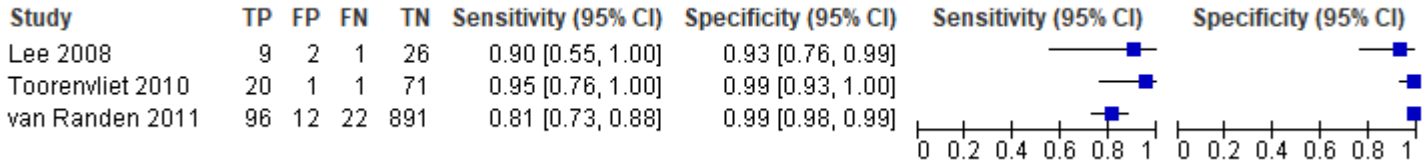
Supplementary Figure 4. Initial US for adults with abdominal pain

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Tomizawa 2017	5	0	0	71	1.00 [0.48, 1.00]	1.00 [0.95, 1.00]
Toorenvliet 2010	20	0	13	454	0.61 [0.42, 0.77]	1.00 [0.99, 1.00]
van Randen 2011	72	8	46	895	0.61 [0.52, 0.70]	0.99 [0.98, 1.00]



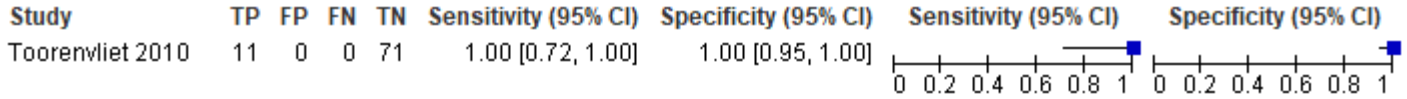
Total n: 3 studies, 1,584 patients
Median sensitivity: 0.61 (range 0.61-1.00)
Median specificity: 0.99 (range 0.99-1.00)

Supplementary Figure 5. Initial CT for adults with abdominal pain



Total n: 3 studies, 1,152 patients
Median sensitivity: 0.90 (range 0.81-0.95)
Median specificity: 0.99 (range 0.93-0.99)

Supplementary Figure 6. Subsequent CT for adults with abdominal pain



Total n: 82 patients

Supplementary Table 5. Distinguishing uncomplicated vs. complicated diverticulitis in diverticulitis diagnosed by US

Imaging Modality	Sensitivity (95% CI)	Specificity (95% CI)
US (Ripolles 2021)	84% (78-99)	96% (88-99)
US, where 1A (complicated) is classified as uncomplicated (Ripolles 2021)	83% (69-93)	99% (96-100)

REFERENCES

Guyatt GH, Oxman AD, Vist GE, et al.; GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ, **2008**; 336: 924-926.

Hayden JA, van der Windt DA, Cartwright JL, Cote P, Bombardier C. Assessing bias in studies of prognostic factors. Ann Intern Med, **2013**; 158(4): 280-286.

Heverhagen JT, Sitter H, Zielke A, Klose KJ. Prospective evaluation of the value of magnetic resonance imaging in suspected acute sigmoid diverticulitis. Dis Colon Rectum **2008**; 51(12): 1810-1815.

Infectious Diseases Society of America. IDSA Handbook on Clinical Practice Guideline Development. Available at: https://www.idsociety.org/practice-guideline/clinical-practice-guidelines-development-training-and-resources/. Accessed May 1, 2021.

IOM (Institute of Medicine). Clinical Practice Guidelines We Can Trust. Washington, DC: The National Academies Press, **2011**.

Lee IK, Jung SE, Gorden DL, et al. The diagnostic criteria for right colonic diverticulitis: prospective evaluation of 100 patients. Int J Colorectal Dis **2008**; 23(12): 1151-1157.

McMaster University and Evidence Prime Inc. GRADEpro GDT. Available at: https://gradepro.org/. Accessed 24 May 2020.

Meyer S, Schmidbauer M, Wacker FK, Ringe KI. To fill or not to fill? - Value of the administration of positive rectal contrast for CT evaluation of diverticular disease of the colon. Rofo **2021**; 193(7): 804-812.

Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev, **2016**; 5(1): 210.

Review Manager 5 (RevMan 5). 5.4 ed. Copenhagen: The Cochrane Collaboration, 2020.

Schünemann H, Brożek J, Guyatt GH, Oxman A. Introduction to GRADE Handbook. Available at: https://gdt.gradepro.org/app/handbook/handbook.html. Accessed 25 May 2020.

Tomizawa M, Shinozaki F, Hasegawa R, et al. Abdominal ultrasonography for patients with abdominal pain as a first-line diagnostic imaging modality. Exp Ther Med **2017**; 13(5): 1932-1936.

Toorenvliet BR, Bakker RF, Breslau PJ, Merkus JW, Hamming JF. Colonic diverticulitis: a prospective analysis of diagnostic accuracy and clinical decision-making. Colorectal Dis **2010**; 12(3): 179-186.

van Randen A, Laméris W, van Es HW, et al. A comparison of the accuracy of ultrasound and computed tomography in common diagnoses causing acute abdominal pain. Eur Radiol **2011**; 21(7): 1535-1545.

Weinrich JM, Bannas P, Avanesov M, et al. MDCT in the setting of suspected colonic diverticulitis: prevalence and diagnostic yield for diverticulitis and alternative diagnoses. AJR Am J Roentgenol **2020**; 215(1): 39-49.

Whiting PF, Rutjes AW, Westwood ME, et al. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med **2011**; 155(8): 529-536.