# American College of Radiology
# ACR Appropriateness Criteria®
# Suspected Small-Bowel Obstruction

**<u>Variant 1:</u>** **Suspected small-bowel obstruction. Acute presentation. Initial imaging.**

| Procedure | Appropriateness Category | Relative Radiation Level |
|---|---|---|
| CT abdomen and pelvis with IV contrast | Usually Appropriate | ☢☢☢ |
| CT abdomen and pelvis without IV contrast | May Be Appropriate | ☢☢☢ |
| MRI abdomen and pelvis without and with IV contrast | May Be Appropriate | O |
| Radiography abdomen and pelvis | May Be Appropriate (Disagreement) | ☢☢☢ |
| Fluoroscopy small bowel follow-through | May Be Appropriate | ☢☢☢ |
| MRI abdomen and pelvis without IV contrast | May Be Appropriate | O |
| CT abdomen and pelvis without and with IV contrast | Usually Not Appropriate | ☢☢☢☢ |
| CT enteroclysis | Usually Not Appropriate | ☢☢☢☢ |
| CT enterography | Usually Not Appropriate | ☢☢☢☢ |
| MR enterography | Usually Not Appropriate | O |
| US abdomen and pelvis | Usually Not Appropriate | O |
| Fluoroscopy small bowel enteroclysis | Usually Not Appropriate | ☢☢☢ |
| MR enteroclysis | Usually Not Appropriate | O |

**<u>Variant 2:</u>** **Suspected intermittent or low-grade small-bowel obstruction. Indolent presentation.**

| Procedure | Appropriateness Category | Relative Radiation Level |
|---|---|---|
| CT abdomen and pelvis with IV contrast | Usually Appropriate | ☢☢☢ |
| CT enterography | Usually Appropriate | ☢☢☢☢ |
| CT enteroclysis | May Be Appropriate | ☢☢☢☢ |
| MR enterography | May Be Appropriate | O |
| CT abdomen and pelvis without IV contrast | May Be Appropriate | ☢☢☢ |
| Fluoroscopy small bowel enteroclysis | May Be Appropriate | ☢☢☢ |
| Fluoroscopy small bowel follow-through | May Be Appropriate | ☢☢☢ |
| MRI abdomen and pelvis without and with IV contrast | May Be Appropriate | O |
| MR enteroclysis | May Be Appropriate | O |
| MRI abdomen and pelvis without IV contrast | May Be Appropriate | O |
| CT abdomen and pelvis without and with IV contrast | Usually Not Appropriate | ☢☢☢☢ |
| Radiography abdomen and pelvis | Usually Not Appropriate | ☢☢☢ |
| US abdomen and pelvis | Usually Not Appropriate | O |

**SUSPECTED SMALL-BOWEL OBSTRUCTION**

Expert Panel on Gastrointestinal Imaging: Kevin J. Chang, MD[a]; Daniele Marin, MD[b]; David H. Kim, MD[c]; Kathryn J. Fowler, MD[d]; Marc A. Camacho, MD, MS[e]; Brooks D. Cash, MD[f]; Evelyn M. Garcia, MD[g]; Benjamin W. Hatten, MD, MPH[h]; Avinash R. Kambadakone, MD[i]; Angela D. Levy, MD[j]; Peter S. Liu, MD[k]; Courtney Moreno, MD[l]; Christine M. Peterson, MD[m]; Jason A. Pietryga, MD[n]; Alan Siegel, MD, MS[o]; Stefanie Weinstein, MD[p]; Laura R. Carucci, MD.[q]

## Summary of Literature Review

### Introduction/Background

Small-bowel obstruction (SBO) is responsible for up to 16% of hospital admissions for abdominal pain with mortality ranging between 2% to 8% overall, and as high as 25% when associated with bowel ischemia [1,2].

Radiologic imaging plays the key role in the diagnosis and management of SBO because neither patient presentation, the clinical examination, nor laboratory testing are sufficiently sensitive or specific enough to diagnose or guide management [2-8]. Imaging not only diagnoses the presence of SBO but also can aid in the differentiation of high-grade from low-grade obstruction. This differentiation helps to guide referring physicians between surgical treatment for high-grade or complicated SBO versus conservative management with enteric tube decompression. Imaging also serves to localize the site of obstruction and evaluate possible causes of obstruction with the most common cause being adhesions, accounting for 70% of all cases. Other causes include hernias, malignancies, Crohn disease, intussusception, volvulus, gallstone ileus, obstructive foreign bodies and bezoars, trauma, endometriosis, and iatrogenic causes. Finally, imaging can play a role in the detection of related findings that may prompt surgical treatment such as ischemia, internal hernia, or volvulus [2-8].

This document refers to imaging appropriateness in diagnosis of adult patients, >18 years of age.

### Special Imaging Considerations

#### Water-Soluble Contrast Challenge

Many surgical services now incorporate a protocol termed a water-soluble contrast challenge to help predict the success of conservative measures. Fluoroscopy is not necessary in this protocol, which some institutions call an “abbreviated” small-bowel follow-through (SBFT). This limited protocol involves oral or enteric tube administration of 100 mL of a hyperosmolar iodinated contrast agent, such as diatrizoate meglumine and diatrizoate sodium diluted in 50 mL of water, with follow-up radiographs performed at 8 hours and 24 hours after ingestion to differentiate partial or low-grade SBO from a complete or high-grade SBO, depending on whether the oral contrast reaches the colon by 24 hours [9-12]. Patients in which contrast reaches the colon by 24 hours rarely require surgery. However, the use of a water-soluble contrast challenge in the immediate postoperative period was not shown to predict the need for re-exploration [13]. Early reports of possible therapeutic benefits for water-soluble contrast agents in patients with postoperative SBO also remain controversial and uncertain [14-16].

### Discussion of Procedures by Variant

#### Variant 1: Suspected small-bowel obstruction. Acute presentation. Initial imaging.

The typical acute presentation of a patient suspected of having SBO includes intermittent crampy central abdominal pain, distension, nausea, and vomiting. Physical examination findings include abdominal distension with either absent or high-pitched bowel sounds. Abnormal laboratory findings such as an elevated white blood cell count, elevated lactic acid, or elevated serum amylase raise the suspicion for a complication such as ischemia. Most cases of SBO are low grade and may be treated conservatively with enteric tube decompression, intravenous (IV) fluids,

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[a]Boston University Medical Center, Boston, Massachusetts. [b]Duke University Medical Center, Durham, North Carolina. [c]Panel Chair, University of Wisconsin Hospital & Clinics, Madison, Wisconsin. [d]Panel Vice-Chair, University of California San Diego, San Diego, California. [e]The University of South Florida Morsani College of Medicine, Tampa, Florida. [f]University of Texas Health Science Center at Houston and McGovern Medical School, Houston, Texas; American Gastroenterological Association. [g]Virginia Tech Carilion School of Medicine, Roanoke, Virginia. [h]University of Colorado School of Medicine Anschutz Medical Campus, Aurora, Colorado; American College of Emergency Physicians. [i]Massachusetts General Hospital, Boston, Massachusetts. [j]Medstar Georgetown University Hospital, Washington, District of Columbia. [k]Cleveland Clinic, Cleveland, Ohio. [l]Emory University, Atlanta, Georgia. [m]Penn State Health, Hershey, Pennsylvania. [n]University of Alabama at Birmingham, Birmingham, Alabama. [o]Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire. [p]University of California San Francisco, San Francisco, California. [q]Specialty Chair, Virginia Commonwealth University Medical Center, Richmond, Virginia.

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pain medication, and sometimes antibiotics. However, imaging and laboratory findings that suggest a higher grade SBO with a complication, such as ischemia, closed-loop obstruction, volvulus, or complete obstruction, may prompt more urgent surgical treatment.

Patients with high-grade SBO may present with more severe abdominal pain, as well as a higher risk of bowel ischemia and perforation. However, physical examination and laboratory tests are neither sufficiently sensitive nor specific to determine which patients with SBO have coexistent strangulation or ischemia. Early imaging diagnosis and intervention is therefore critical for successful treatment and minimization of mortality, which can be as high as 25% in the setting of ischemia. The goals of imaging in high-grade SBO are to evaluate the severity of the obstruction, identify the etiology/site of the obstruction, and to detect the presence of complications, such as volvulus, strangulation, closed-loop obstruction, and ischemia. Specific imaging signs that suggest ischemia include abnormally decreased or increased bowel wall enhancement, intramural hyperdensity on noncontrast CT, bowel wall thickening, mesenteric edema, ascites, and pneumatosis or mesenteric venous gas. The presence of ischemia warrants immediate surgery.

**CT Abdomen and Pelvis**

Multiple publications have confirmed the use and accuracy of a standard abdominal and pelvic CT examination in patients with a suspected high-grade SBO. A diagnostic accuracy of more than 90% has been reported [4,5,17], with high accuracy for distinguishing SBO from an adynamic small-bowel ileus [6], and for identifying the cause of obstruction [17-20]. Patients with a suspected high-grade obstruction do not require any oral contrast medium because the nonopacified fluid in the bowel provides adequate intrinsic contrast. Additionally, oral contrast use in a known or suspected high-grade SBO does not add to diagnostic accuracy and can delay diagnosis, increase patient discomfort, and increase the risk of complications, particularly vomiting and aspiration. The use of positive oral contrast agents can also potentially limit the ability to detect abnormal bowel wall enhancement in the case of ischemia and hypoperfusion. However, SBO may be identified in patients who have undergone CT with oral (with or without IV) contrast (ie, when SBO was not specifically suspected at the time the study was ordered/protocolled).

Multidetector CT scanners with multiplanar reconstruction capabilities have been noticeably more effective for evaluating SBO and other abdominal pathology [21-26]. Multiplanar reformations have also been found to increase accuracy and confidence in locating the transition zone in SBO, which can be a useful adjunct if an operative intervention is planned [24,27,28]. CT with IV contrast is preferable for routine imaging of suspected SBO, in part to demonstrate whether the bowel is perfusing normally or is potentially ischemic, and in a minority of cases, to provide information about the potential etiology, such as Crohn disease and neoplasm. Noncontrast CT appears to have comparable accuracy for diagnosing or excluding high-grade SBO, although determination for ischemia is reduced [29].

In addition to CT's high accuracy for detecting SBO, CT has been shown to be very helpful in guiding management. CT is very useful for assessing SBO complications, namely, ischemia and strangulation [2,3,8,30-32], as well as conditions that lead directly to both obstruction and ischemia if untreated (ie, internal hernias and closed-loop SBO) [33,34]. When present, CT signs of ischemia are highly specific [35-38]. Unfortunately, CT is not very sensitive for identifying ischemia; in one study, the prospective sensitivity, based on the initial radiology report, was only 14.8% [33]. Even retrospectively, the sensitivity of two experienced radiologists was 29.6% and 40.7% (consensus review of a third radiologist was 51.9%). However, the use of dual-energy CT may aid in the detection of bowel ischemia because the use of iodine maps and virtual monoenergetic images can increase the conspicuity of bowel enhancement as demonstrated in early studies [39-41]. Another study found that using maximal attenuation of a region of interest when assessing bowel-wall enhancement was a reliable method for evaluating intestinal ischemia in SBO and showed good correlation with the pathology results [37,42]. When combined with clinical findings, CT's sensitivity for detecting strangulation and associated complications can be improved [42-47]. Ultimately, CT has been useful in effectively triaging patients into operative versus nonoperative treatment groups [27,48-60]. Signs such as intraperitoneal fluid, mesenteric edema, and the absence of small-bowel feces suggest that early surgical intervention should be considered.

**CT Enteroclysis**

In the clinical setting of acute pain and distention, the use of CT enteroclysis is not favorable, because patients cannot tolerate the active infusion of oral contrast into an obstructed small-bowel. CT enteroclysis is generally favored over conventional enteroclysis because it avoids the problem of overlapping small-bowel loops, and it has been shown to demonstrate a larger number of bowel abnormalities and more abnormalities outside the bowel [61].

To our knowledge; however, CT enteroclysis is not widely used in the United States at present, especially for acute presentations of bowel obstruction.

**CT Enterography**
CT enterography does not require intubation of the small-bowel but instead relies on large volumes of orally ingested contrast in a set time interval. In the setting of suspected obstruction of this clinical scenario, patients cannot generally tolerate the oral contrast administration requirements. As in the case of CT enteroclysis, the use in the acute patient presentation is not favorable because of a lack of tolerance to ingest a relatively large volume of fluid if the bowel is obstructed.

**Fluoroscopy Small Bowel Enteroclysis**
There is solid evidence that enteroclysis is highly reliable in revealing sites of low- and high-grade SBO [62,63], as well as for distinguishing adhesions from obstructing neoplasms or other etiologies [62]. Despite this evidence, enteroclysis is not useful in the acute situation of suspected obstruction in which the patient is ill. In this clinical scenario, such patients cannot tolerate the invasive nature of the examination.

**Fluoroscopy Small Bowel Follow-Through**
Opinions remain divided on the usefulness of SBFT examinations with an orally administered barium contrast or water-soluble contrast. Some investigators have found this examination useful for managing suspected SBO in 68% to 100% of cases [64]. However, the ability to diagnose ischemic loops or bowel perforation can be limited. SBFT does not typically evaluate for other etiologies of abdominal pain that may be detected on CT. As such, the SBFT could be considered a problem-solving examination following an equivocal CT, particularly with suspected low-grade or intermittent or partial obstruction [65]. Early reports of possible therapeutic benefits of the use of water-soluble contrast agents in patients with postoperative SBO remain controversial and uncertain [14-16].

**MR Enteroclysis**
MR enteroclysis is not useful in the acute situation of suspected obstruction in which the patient is ill. In this clinical scenario, such patients cannot tolerate the invasive nature of the examination. MR enteroclysis appears to compare favorably with CT enteroclysis in evaluating a low-grade obstruction [66], although neither MR enteroclysis nor CT enteroclysis are in wide use because patients are often unable to tolerate the degree of small-bowel distension necessary. Children, and particularly pregnant patients, with known or suspected SBO, as well as younger patients with repetitive episodes of obstruction, are the ideal population to undergo MRI. In pregnant patients, only noncontrast sequences are obtained. In other patients, MR enteroclysis can be performed either as an IV contrast enhanced study or a noncontrast study.

**MR Enterography**
In the setting of suspected obstruction of this clinical scenario, patients cannot generally tolerate the oral contrast administration requirements related to the enterography technique. To our knowledge; however, little data are available on comparing MR enterography with other imaging examinations in patients with a suspected SBO.

**MRI Abdomen and Pelvis**
Increasing evidence supports the role of MRI for detecting and characterizing SBO. Because of absent evidence of any incremental diagnostic gain, compared with CT, MRI should not be used routinely to evaluate suspected high-grade SBO [67]. However, there may be situations in which MRI could be an appropriate alternative to CT, particularly for those who have had multiple prior CT examinations or are expected to get multiple future imaging examinations. Examinations may be difficult to interpret related to patient pain and discomfort and associated patient motion in the acute setting.

**Radiography Abdomen and Pelvis**
Abdominal radiography has been the traditional starting point for the imaging evaluation of suspected SBO [68]. However, studies testing the use of abdominal radiographs have yielded disparate results [4,5,18,69]. Although some investigators have reported an 80% to 90% success rate in diagnosing SBO using radiographs [5], an overall accuracy somewhat approaching that of CT [7], others have achieved rates only in the 30% to 70% range [4,7,18]. In other studies, abdominal radiographs proved to be of little or no help in assessing the site or cause of SBO [70,71] and were even misleading in 20% to 40% of patients [18]. A relatively recent study; however, found that abdominal radiographs were accurate for detecting acute SBO. It should be stressed; however, that it may be difficult to differentiate an SBO from a postoperative ileus in the perioperative period based on a single examination. Serial examinations showing persistent dilated small-bowel loops with air-fluid levels and relative or complete paucity of gas in the colon favor SBO.

Despite the relatively high accuracy of abdominal radiographs in detecting SBO, CT provides much more information, including the site and cause of the obstruction and complications of SBO. As a result, CT findings generally influence patient management much more than do abdominal radiographs.

In light of these inconsistent results, it is reasonable to expect that abdominal radiographs will not be definitive in many patients with a suspected SBO. Radiographs could prolong the evaluation period. Therefore, in patients with a known or suspected SBO, fluoroscopic-contrast examinations (SBFT, conventional enteroclysis), and particularly, cross-sectional imaging examinations (CT, MRI, ultrasound [US]), as well as specialized cross-sectional imaging examinations (CT enterography, CT enteroclysis, MR enterography, and MR enteroclysis), may be more useful options for diagnosis.

**US Abdomen and Pelvis**

Because of CT's high accuracy for diagnosing and characterizing SBO and because of the inherent limitation of US in adults in this situation, US has rarely been used for this purpose in the United States. Compared with US, CT (or MRI) generally provides more information as to the status of the entire gastrointestinal tract, the 3-D anatomy, and the underlying causes and complications of SBO, and it is preferred by surgeons for adult patient management. US was reported to have a nearly 90% success rate for diagnosing SBO [71-75], with a sensitivity of 91% and a specificity of 84%, in a prospective study of 76 patients with suspected SBO who underwent bedside US [76]. In an older study [77], CT proved superior to US in diagnosing intestinal obstructions. In the pediatric age group, US has proven useful in evaluating intussusception [63], midgut volvulus [78], and other causes of SBO [79].

**Variant 2: Suspected intermittent or low-grade small-bowel obstruction. Indolent presentation.**

Patients with suspected intermittent or low-grade SBO may have a more indolent presentation in which the patient may be asymptomatic at baseline with intermittent symptoms. If a SBO is present, it may be intermittent or very low-grade, requiring provocative measures such as bowel distention to visualize this process on a consistent basis.

In low-grade SBO, there is sufficient luminal patency to allow contrast to flow beyond the point of obstruction. Low-grade or intermittent SBO can therefore be more difficult to diagnose with modalities that do not maximally distend or exaggerate the caliber of the small-bowel lumen. The patient may be relatively asymptomatic and with a more nonspecific presentation with other differential considerations possible. On imaging, it may be difficult to visualize dilated abnormal loops and a transition point. In these cases, volume-challenge or dynamic enteral examinations may be preferred to accentuate mild or subclinical obstructions and to better challenge the distensibility of small-bowel. The multiplanar reformatting capabilities of multidetector CT scanners has also helped in evaluating these patients.

**CT Abdomen and Pelvis**

Although standard abdominal and pelvic CT examinations in patients with a suspected high-grade SBO have shown diagnostic accuracies of greater than 90% [4,5,17], low-grade or intermittent obstruction has been less accurately diagnosed with a sensitivity of only 48% to 50% and a specificity of 94% [7,80]. In this situation of suspected intermittent or low-grade SBO, the bowel loops may look unremarkable with intrinsic enteral fluid or standard oral contrast administration at CT. Oral contrast may be purposefully given to these patients when SBO is a consideration. When a transition point is identified without passage of orally administered positive contrast, optional re-imaging within 24 hours may depict passage of oral contrast beyond the transition point, indicating incomplete or partial obstruction [81]. When a transition point is not identified, optimized distention of the bowel (through either CT enteroclysis or CT enterography) may be needed to make an intermittent or mild obstruction apparent.

**CT Enteroclysis**

CT enteroclysis offers improved sensitivity and specificity over standard CT examinations in evaluating suspected intermittent or low-grade SBO [68,82-84]. The placement of a nasoduodenal tube with active controlled infusion of oral contrast optimizes detection of subtle causes of mild obstructions. There is solid evidence that enteroclysis is highly reliable in revealing sites of low-grade SBO [62,63,85], as well as for distinguishing adhesions from obstructing neoplasms or other etiologies [62]. CT enteroclysis is generally favored over conventional enteroclysis because it avoids the problem of overlapping small-bowel loops; it also has been shown to demonstrate a larger number of bowel abnormalities and more abnormalities outside the bowel [61]. CT enteroclysis should be considered, especially for patients who have a history of malignancy [68]. To our knowledge; however, CT enteroclysis is not widely used in the United States at present because of the practical challenges of nasojejunal intubation and the often-associated issues related to conscious sedation and continuous patient monitoring.

### CT Enterography

CT enterography does not require intubation of the small-bowel and, therefore, has greater patient acceptance [86]. The increased distention of small-bowel related to the oral contrast ingestion protocol optimizes detection of bowel pathology. To our knowledge; however, its clinical usefulness for diagnosing intermittent or low-grade SBO has not been convincingly established, although one small series showed promise [87]. Although there is little evidence that CT enterography can be used reliably to identify intermittent- or low-grade SBO, the bowel is typically distended to a greater degree than with standard CT and potentially may be of benefit if CT enteroclysis is not performed at an institution.

### Fluoroscopy Small-Bowel Enteroclysis

Methods of examination that challenge the distensibility of the small-bowel, including conventional (ie, fluoroscopic) enteroclysis and CT enteroclysis, offer improved sensitivity and specificity over standard barium small-bowel and CT examinations in evaluating suspected intermittent or low-grade SBO [18,68,82-84,88]. There is solid evidence that enteroclysis is highly reliable in revealing sites of low-grade SBO [62,63], as well as for distinguishing adhesions from obstructing neoplasms or other etiologies [62]. However, enteroclysis has low patient acceptance.

### Fluoroscopy Small-Bowel Follow-Through

Opinions remain divided on the usefulness of SBFT examinations with an orally administered barium contrast. Some investigators have found this examination useful for managing suspected SBO in 68% to 100% of cases [64]. The SBFT could be considered a problem-solving examination following an equivocal CT, particularly with low-grade or intermittent or partial obstruction [65]. Because SBFT is limited by nonuniform small-bowel filling, it cannot test distensibility and has limitations posed by intermittent fluoroscopy; some authorities argue that enteroclysis is the more appropriate imaging examination in problematic SBO cases, especially in low-grade or intermittent obstruction [62,89]. Early reports of possible therapeutic benefits of the use of water-soluble contrast agents in patients with postoperative SBO remain controversial and uncertain [14-16].

### MR Enteroclysis

MR enteroclysis appears to compare favorably with CT enteroclysis in evaluating a low-grade obstruction [66], although neither MR enteroclysis nor CT enteroclysis are in wide use because patients are often unable to tolerate the degree of small-bowel distension necessary. The ability of MR enteroclysis to monitor small-bowel filling in real-time without the use of ionizing radiation is an advantage over fluoroscopic and CT enteroclysis. Children and, particularly, pregnant patients with known or suspected SBO, as well as younger patients with repetitive episodes of obstruction, are the ideal population to undergo MRI. In pregnant patients, only noncontrast sequences are obtained. In other patients, MR enteroclysis can be performed either as an IV-contrast enhanced study or a noncontrast study.

### MR Enterography

MR enterography may be superior to routine MRI examinations and is better accepted by patients than MR enteroclysis. To our knowledge; however, little data are available on comparing MR enterography with other imaging examinations in patients with a suspected SBO.

### MRI Abdomen and Pelvis

Increasing evidence supports the role of MRI for detecting and characterizing SBO. The use of fast multiplanar pulse sequences such as half-Fourier acquisition single-shot turbo spin-echo and balanced gradient-echo sequences allow for functional assessment of the distensibility of strictures. Without optimized bowel preparation, bowel loops at MR with standard protocol (ie, without bowel distension) may be unremarkable at intermittent or low-grade obstructions.

### Radiography Abdomen and Pelvis

Abdominal radiography has been the traditional starting point for the imaging evaluation of suspected SBO [68]. However, studies testing the use of abdominal radiographs have yielded disparate results [4,5,18,69]. Although some investigators have reported an 80% to 90% success rate in diagnosing SBO using radiographs [5], an overall accuracy somewhat approaching that of CT [7], others have achieved rates only in the 30% to 70% range [4,7,18]. In other studies, abdominal radiographs proved to be of little or no help in assessing the site or cause of SBO [70,71] and were even misleading in 20% to 40% of patients [18]. In the setting of intermittent or low-grade obstructions as described in this clinical variant in which the imaging findings are much more subtle than high-grade obstructions, abdominal radiography is even less likely to provide positive findings.

### US Abdomen and Pelvis

Because of CT's high accuracy for diagnosing and characterizing SBO and because of the inherent limitation of US in adults in this situation, it has rarely been used for this purpose in the United States. Compared with US, CT (or MRI) generally provides more information as to the status of the entire gastrointestinal tract, the 3-D anatomy, and the underlying causes and complications of SBO, and it is preferred by surgeons for adult patient management. US was reported to have a nearly 90% success rate for diagnosing SBO [71-75], with a sensitivity of 91% and a specificity of 84%, in a prospective study of 76 patients with suspected SBO who underwent bedside US [76]. In an older study [77], CT proved superior to US in diagnosing intestinal obstructions. In the pediatric age group, US has proven useful in evaluating intussusception [63], midgut volvulus [78], and other causes of SBO [79].

### Summary of Recommendations

- **Variant 1:** CT abdomen and pelvis with IV contrast is usually appropriate for the initial imaging of a suspected SBO with an acute presentation. The panel did not agree on recommending radiographs of the abdomen and pelvis in patients with an acute presentation of suspected SBO. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. This procedure is controversial but may be appropriate as an initial imaging examination to direct further workup (which would usually include a CT of the abdomen and pelvis with IV contrast).
- **Variant 2:** CT abdomen and pelvis with IV contrast or CT enterography is usually appropriate for the imaging of a suspected intermittent or low-grade SBO with an indolent presentation. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). However, CT enterography could be performed as a complementary examination if small-bowel distension aids in accentuating small bowel pathology that is not initially evident on a CT without oral contrast.

### Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

### Appropriateness Category Names and Definitions

| Appropriateness Category Name | Appropriateness Rating | Appropriateness Category Definition |
|---|---|---|
| Usually Appropriate | 7, 8, or 9 | The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients. |
| May Be Appropriate | 4, 5, or 6 | The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal. |
| May Be Appropriate (Disagreement) | 5 | The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned. |
| Usually Not Appropriate | 1, 2, or 3 | The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable. |

**Relative Radiation Level Information**

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [90].

| Relative Radiation Level Designations | | |
|---|---|---|
| **Relative Radiation Level*** | **Adult Effective Dose Estimate Range** | **Pediatric Effective Dose Estimate Range** |
| O | 0 mSv | 0 mSv |
| ☢ | <0.1 mSv | <0.03 mSv |
| ☢☢ | 0.1-1 mSv | 0.03-0.3 mSv |
| ☢☢☢ | 1-10 mSv | 0.3-3 mSv |
| ☢☢☢☢ | 10-30 mSv | 3-10 mSv |
| ☢☢☢☢☢ | 30-100 mSv | 10-30 mSv |

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".

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