PRACTICE MANAGEMENT GUIDELINES
FOR SMALL BOWEL OBSTRUCTION

EAST Practice Parameter Workgroup for Management of Small Bowel Obstruction

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I. Statement of the Problem

The description of patients presenting with small bowel obstruction dates back to the third or fourth century, when early surgeons created enterocutaneous fistulas to relieve a bowel obstruction. Despite this success with operative therapy, the nonoperative management of these patients with attempted reduction of hernias, laxatives, ingestion of heavy metals (e.g., lead or mercury), and leeches to remove toxic agents from the blood was the rule until the late 1800s, when antisepsis and aseptic surgical techniques made operative intervention safer and more acceptable. A better understanding of the pathophysiology of bowel obstruction and the use of isotonic fluid resuscitation, intestinal tube decompression, and antibiotics have greatly reduced the mortality rate for patients with mechanical bowel obstruction.[1, 2] However, the means for determining when a period of observation is warranted versus early surgical intervention continues to be an area of debate. With the advances in imaging techniques additional information can be supplied to the clinical information obtained from the history and physical. The question of whether these technological advancements have allowed a more sophisticated evaluation of these patients is yet to be determined. In addition which tests supply the most information has yet to be clearly described.

Additionally the optimal length of observation continues to be debated. In the era of a push toward shorter hospital stays correctly identifying patients who are to fail observation is even more important. It is important to determine if clinical or radiographic clues can increase our sensitivity in determining such patients.

Finally, as minimally invasive surgery grows and finds new applications are there reproducible benefits to the patients in pursuing these intervention as both a diagnostic and therapeutic intervention.

II. Process

A computerized search of the National Library of Medicine MEDLINE database was undertaken using the PubMed Entrez interface. English language citations during the period of 1991 through 2006 using the primary search strategy:

intestinal obstruction[mh] AND intestine, small[mh] AND humans[mh] NOT (case reports[pt] OR letter[pt] OR comment[pt] OR news[pt])

Review articles were also excluded. The PubMed Related Articles algorithm was also employed to identify additional articles similar to the items retrieved by the primary strategy. Of approximately 550 articles identified by these two techniques, those dealing with either prospective or retrospective studies examining small bowel obstruction were selected, comprising 131 institutional studies evaluating diagnosis and management of adult patients with suspected or proven small bowel obstruction. The articles were reviewed by a group of eleven trauma / critical care surgeons who collaborated to produce this practice management guideline. (Table 1)

The correlation between the evidence and the level of recommendations is as follows:

Level 1: This recommendation is convincingly justifiable based on the available scientific information alone. It is usually based on Class I data, however, strong Class II evidence may form the basis for a level 1 recommendation, especially if the issue does not lend itself to testing in a randomized format. Conversely, weak or contradictory Class I data may not be able to support a level 1 recommendation.

Level 2: This recommendation is reasonably justifiable by available scientific evidence and strongly supported by expert critical care opinion. It is usually supported by Class II data or a preponderance of Class III evidence.

Level 3: This recommendation is supported by available data but adequate scientific evidence is lacking. It is generally supported by Class III data. This type of recommendation is useful for educational purposes and in guiding future studies.[3]

III. Recommendations (Figure 1 – Flow diagram)

Diagnosis:

1. All patients being evaluated for small bowel obstruction should have plain films due to the fact that plain films are as sensitive as CT to differentiate obstruction vs. non-obstruction. **LEVEL III**
2. All patients with inconclusive plain films for complete or high grade SBO should have a CT as CT scan gives incremental information over plain films in regard to differentiating grade of obstruction and etiology of small bowel obstruction leading to changes in planned management. **LEVEL I**
3. Multiple signs on CT suggesting strangulation should suggest a low threshold for operative intervention (Table 2). **LEVEL II**
4. MRI and ultrasound are an alternative to CT with similar sensitivity and identification of etiology, but have several logistical limitations. **LEVEL III**
5. There is a variety of literature that contrast studies should be considered in patients who fail to improve after 48 hours of conservative management as a normal contrast study can rule out operative small bowel obstruction. **LEVEL II**
6. Nonionic low osmolar weight contrast is an alternative to barium for contrast studies to evaluate for SBO for diagnostic purposes. **LEVEL I**

Management:

1. Patients with plain film finding of small bowel obstruction and Clinical markers (fever, leukocytosis, tachycardia, metabolic acidosis and continuous pain) or peritonitis on physical exam warrant exploration. **LEVEL I**

2. Patients without the above mentioned clinical picture, and a partial SBO or a complete SBO can undergo non-operative management safely; although, complete obstruction has a higher level of failure. **LEVEL I**

3. Patients without resolution of the there SBO by day 3-5 of non-operative management should undergo water soluble study or surgery. **LEVEL III**

4. There is no significant difference with regard to the decompression achieved, the success of nonoperative treatment, or the morbidity rate after surgical intervention comparing long tube decompression with the use of nasogastric tubes. **LEVEL I**

5. Water soluble contrast (Gastrograffin) given in the setting of partial SBO can improve bowel function (time to BM), decrease length of stay, and is both therapeutic and diagnostic. **LEVEL II**

6. In a highly selected group of patients the laparoscopic treatment of small bowel obstruction should be considered and leads to a shorter hospital length of stay. **LEVEL II**

Scientific Foundation

A. Historical Background

Mechanical small-bowel obstruction is the most frequently encountered surgical disorder of the small intestine. Although a wide range of etiologies for this condition exist, intra-abdominal adhesions related to prior abdominal surgery is the etiologic factor in up to 75% of cases of small-bowel obstruction. More than 300,000 patients are estimated to undergo surgery to treat adhesion-induced small-bowel obstruction in the United States annually.[4]

B. Diagnostic Evaluation of Small Bowel Obstruction

The diagnostic evaluation should focus on the following goals: distinguishing mechanical obstruction from ileus; determining the etiology of the obstruction; discriminating partial (low grade) from complete (high grade) obstruction; and discriminating simple from strangulating obstruction.

Important elements to obtain on history include prior abdominal operations (suggesting the presence of adhesions) and the presence of abdominal disorders (e.g., intra-abdominal cancer or inflammatory bowel disease) that may provide insights into the etiology of obstruction. Upon examination, a meticulous search for hernias (particularly in the inguinal and femoral regions) should be conducted. The stool should be checked for gross or occult blood, the presence of which is suggestive of intestinal strangulation.

Plain Films

The diagnosis of small-bowel obstruction is usually confirmed with radiographic examination. The abdominal series consists of a radiograph of the abdomen with the

patient in a supine position, a radiograph of the abdomen with the patient in an upright position, and a radiograph of the chest with the patient in an upright position. There is class III evidence to suggest that plain films are as sensitive as CT for the detection of a high grade bowel obstruction (86% vs. 82%).[5] Data also suggests that plain films are less sensitive in the setting of low grade or partial bowel obstruction. The sensitivity of abdominal radiographs in the detection of small-bowel obstruction ranges from 70 to 86%.[6, 7] Despite these limitations, abdominal radiographs remain an important study in patients with suspected small-bowel obstruction because of their widespread availability and low cost.

Computed tomographic (CT)

There is numerous Class II data to suggest that CT provides incremental information over other imaging forms to the level, etiology and accuracy at differentiating low grade from high grade bowel obstruction leading to changes in planned management.[8-10] Computed tomographic (CT) scanning is 80 to 90% sensitive and 70 to 90% specific in the detection of small-bowel obstruction.[11] The findings of small-bowel obstruction include a discrete transition zone with dilation of bowel proximally, decompression of bowel distally, intraluminal contrast that does not pass beyond the transition zone, and a colon containing little gas or fluid.

There is class II data to suggest that CT is 85 -100% sensitive for ischemia and strangulation later confirmed by surgery.[12-15] Ischemia was suggested on CT with: serrated beak, unusual course of mesenteric vasculature, mesenteric haziness, reduced wall enhancement, wall thickening, mesenteric fluid, mesenteric venous congestion, and ascites.[16-18] CT scanning also offers a global evaluation of the abdomen and may therefore reveal the etiology of obstruction.[19-21] The global picture afforded is especially relevant when evaluating the acute abdomen when multiple etiologies are on the differential diagnosis.

Enteroclysis

A limitation of CT scanning is its low sensitivity (<50%) in the detection of low-grade or partial small-bowel obstruction. A subtle transition zone or unsuspected closed loop obstruction may be difficult to identify in the axial images obtained during CT scanning. In such cases, contrast examinations of the small bowel, either small-bowel series (small-bowel follow-through) or enteroclysis, can be helpful.[22] Nonionic low osmolar weight contrast is an alternative to barium for contrast studies to evaluate for SBO.[23] These examinations are more labor intensive and less-rapidly performed than CT scanning, but may offer greater sensitivity in the detection of luminal and mural etiologies of obstruction, such as primary intestinal tumors, with sensitivity and specificity approaching 100% when coupled with CT.[24] Enteroclysis is rarely performed in the acute setting, but offers greater sensitivity than small-bowel series in the detection of lesions that may be causing partial small-bowel obstruction.[25]

Ultrasound

Class II data suggests ultrasound is comparable to plain film for the diagnosis, etiology and strangulation in small bowel obstruction and can better identify free fluid which may signal the need for operative intervention.[26-30]

MRI

Class II data reports the accuracy MRI at least approaches that of CT with both differentiating obstruction vs no obstruction at an almost 100% sensativity.[31] MRI has also been shown to be effective in defining location and etiology of obstruction with at least equivalent accuracy of CT.[32-34] Limitations of MRI include: lack of availability after hours, poor definition of mass lesions, and poor visualization of colonic obstructions did not show inflammation as well as CT, and does not show viability.[35, 36]

C. Evaluation of the Evidence Supporting Early Operative Management

The standard therapy for small-bowel obstruction is expeditious surgery. The rationale for this approach is to minimize the risk for bowel strangulation, which is associated with

an increased risk for morbidity and mortality. The literature would suggest that clinical signs supported by simple imaging studies can identify the vast majority of patients presenting with surgical small bowel obstruction.[37, 38] Early operative intervention in patients with fever, leukocytosis, peritonitis, tachycardia, metabolic acidosis, and continuous pain will identify strangulation 45% of the time[39-41] Complete SBO should be operated on early as the primary mode of therapy. Studies would suggest that 31-43% of patients with complete SBO or peritonitis will resolve without requiring some form of bowel resection. [42, 43]

Other reported benefits of the operative management of SBO is the description by class II data that reports lower reoccurrence rate and longer disease free intervals with operative intervention when compared to conservative management. [44-47]

D. Evaluation of the Evidence Supporting Conservative Management

Exceptions to the recommendation for expeditious surgery for intestinal obstruction include partial small-bowel obstruction, obstruction occurring in the early postoperative period, intestinal obstruction as a consequence of Crohn's disease, and carcinomatosis.

Progression to strangulation (3-6% with conservative management) is unlikely to occur with partial small-bowel obstruction, and an attempt at nonoperative resolution is warranted.[48] Level II data suggests that nonoperative management has been documented to be successful in 65 to 81% of patients with partial small-bowel obstruction or in patients without peritonitis.[1] Of those successfully treated non-operatively, only 5 to 15% have been reported to have symptoms that were not substantially improved within 48 hours after initiation of therapy.[49-52] Therefore, most patients with partial small obstruction whose symptoms do not improve within 48 hours after initiation of nonoperative therapy should undergo surgery. There has been some level III data to suggest that this time period can be safely lengthened to 5 days without increase the likelihood of strangulation necessitating bowel resection although definite data to support these claims is not available.[2] Patients undergoing non-operative therapy should be

followed with serial abdominal exams for signs of peritonitis which would necessitate immediate operative intervention.

Adjuncts to Conservative Management

Hypertonic contrast in PSBO

The administration of hypertonic water-soluble contrast agents, such as Gastrografin used in upper GI and small-bowel follow-through examinations, causes a shift of fluid into the intestinal lumen, thereby increasing the pressure gradient across the site of obstruction. Level II data suggests that this effect may speed the return of bowel function (time to bowel movement) and decrease the length of stay of patients undergoing non-operative management of partial small bowel obstruction.[53-58]

E. Operative Approach

Successful laparoscopic surgery for bowel obstruction is being reported with greater frequency. Reported data suggest that up to 60% of small-bowel obstruction cases caused by adhesions may be amenable to laparoscopic therapy.[59] The reported conversion rate is 20-51.9%[60-67] and the complication rate (bowel injury) is 6.5-18.0%.[60, 68] Conversion to open procedure have been reported secondary to density of adhesions, inability to fix the obstruction, cause of obstruction not amenable to laparoscopic therapy, intestinal necrosis, and intestinal perforation. Factors that favor laparoscopic success are SBO post appendectomy, with bands as cause, with less then two previous surgeries, and shorter time of symptoms.[69] It has been reported that conversion rate can be decreased to as low as 6.9% when the surgery is guided by preoperative enteroclysis.[70] The laparoscopic treatment of small bowel obstruction appears to be effective and leads to a shorter hospital stay in a highly selected group of patients.[71, 72] There has also been literature to support that patients treated with laparoscopic intervention have lower hernia rate and SBO but require the same amount of operative intervention.[73] Patients fitting the criteria for consideration of laparoscopic management include those with (1) mild abdominal distention allowing adequate visualization, (2) a proximal obstruction, (3) a partial obstruction, and (4) an anticipated single-band obstruction. Currently, patients who have advanced, complete, or distal small bowel obstructions are not candidates for laparoscopic treatment. Unfortunately, the majority of patients with obstruction are in this

group. Similarly, patients with matted adhesions or those who remain distended after nasogastric intubation should be managed with conventional laparotomy. Therefore, the future role of laparoscopic procedures in the treatment of these patients remains to be defined.

F. Adjuncts to Surgery

Antibiotics

Broad-spectrum antibiotics are commonly administered because of concerns that bacterial translocation may occur in the setting of small-bowel obstruction; however, there are no controlled data to support or refute this approach.[74]

Long Tube

Prospective randomized trials demonstrated no significant differences with regard to the decompression achieved, the success of nonoperative treatment, or the morbidity rate after surgical intervention compared with the use of nasogastric tubes. Furthermore, the use of these long tubes has been associated with a significantly longer hospital stay, duration of postoperative ileus, and postoperative complications in some series. Therefore, it appears that long intestinal tubes offer no benefit in the preoperative setting over nasogastric tubes.[75, 76]

Hyaluronic acid-carboxycellulose membrane (Seprafilm)

The overall rate of post-operative SBO showed no difference with or without Seprafilm. However, Seprafilm did have lower (1.8 vs 3.4%) of SBO requiring reoperation.[77-80]

V. Summary

To summarize, plain abdominal radiographs are usually diagnostic of bowel obstruction in more than 60% of the cases, but further evaluation (possibly by CT or barium radiography) may be necessary in 20% to 30% of cases. CT examination is particularly useful in patients with a history of abdominal malignancy, in postsurgical patients, and in patients who have no history of abdominal surgery and present with symptoms of bowel

obstruction. Barium studies are recommended in patients with a history of recurring obstruction or low-grade mechanical obstruction to precisely define the obstructed segment and degree of obstruction.

VI. Future Investigations

Future studies should be conducted in a prospective, randomized fashion concentrating on the timing of operative intervention for small bowel obstruction.

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[2] Seror D

Practice Management Guidelines for Management of Small Bowel Obstruction in the Setting of Previous Abdominal Surgery
1991 – Present

First Author	Year	Reference Title	Class	Conclusions
Diagnosis – Plain Film/KUB				
Lappas JC	2001	Abdominal radiography findings in small-bowel obstruction: relevance to triage for additional diagnostic imaging. *AJR Am J Roentgenol. 2001 Jan;176(1):167-74.*	III	(N=81; retrospective) Plain films help differentiate low grade from high grade but CT gives incremental and needed if plain film was inconclusive
Maglinte DD	1997	Reliability and role of plain film radiography and CT in the diagnosis of small-bowel obstruction. *AJR Am J Roentgenol. 1996 Dec;167(6):1451-5.*	III	Plain films and CT have equal sensitivity for grade of obstruction. They recommend plain films initially on all suspected SBO with CT as a follow-up if needed for clinical purposes.
Diagnosis -CT				
Bogusevicius A	2002	Prospective randomised trial of computer-aided diagnosis and contrast radiography in acute small bowel obstruction. *Eur J Surg. 2002;168(2):78-83.*	I	Computer program that differentiates between complete and partial SBO when 36 clinical variables, including the plain radiographic findings, are entered, but the time to diagnosis was only 1 hour with the computer program and 16 hours with contrast radiography.
Zalcman M	2000	Helical CT signs in the diagnosis of intestinal ischemia in small-bowel obstruction. *AJR Am J Roentgenol. 2000 Dec;175(6):1601-7.*	II	(N=144: retrospective) They specifically looked for reduced wall enhancement, wall thickening, mesenteric fluid mesenteric venous congestion, and ascites in order to determine presence of ischemia. Strangulation was prospectively diagnosed if reduced wall enhancement or 2 of the other 4 signs were present.
Lazarus DE	2004	Frequency and relevance of the "small-bowel feces" sign on CT in patients with small-bowel obstruction. *AJR Am J Roentgenol. 2004 Nov;183(5):1361-6.*	II	(N=34: retrospective) The feces sign helped identify the point of obstruction and was more likely in higher degrees of obstruction.
Obuz F	2003	The efficacy of helical CT in the diagnosis of small bowel obstruction. *Eur J Radiol. 2003 Dec;48(3):299-304.*	II	(N=41; Prospective) Helical CT (1998-2001) CT was 83% accurate in differentiating obstruction vs non-obstruction, 85% accurate in determining cause, and 100% accurate in determining strangulation/ischemia.
Suri S	1999	Comparative evaluation of plain films, ultrasound and CT in the diagnosis of intestinal obstruction. *Acta Radiol. 1999 Jul;40(4):422-8.*	II	(N=32; Prospective) Suspected SBO who had plain radiographs, US and CT scan (1990-93). Plain radiography was 75% accurate, US was 84% accurate, and CT was 94% accurate at determining obstruction vs no obstruction. Level of obstruction 60%, 70%, and 93%. Cause of obstruction 7%, 23%, and 87%.

Taourel PG	1995	Value of CT in the diagnosis and management of patients with suspected acute small-bowel obstruction. *AJR Am J Roentgenol. 1995 Nov;165(5):1187-92.*	II	(N=57; Prospective) Patients with suspicion of SBO (1991 - 1994). The surgeon was interviewed prior to the CT scan. In 33 pts the clinician wanted to differentiate between SBO or ileus and in 24 pts the clinician wanted to know the cause of SBO. CT correctly changed the differentiation between SBO & ileus in 21% of cases. CT changed the diagnosis (cause) of SBO in 43% and correctly changed presence or absence of strangulation in 23.
Catalano O	1997	The faeces sign. A CT finding in small-bowel obstruction. *Radiologe. 1997 May;37(5):417-9.*	III	(N=94; Retrospective) Feces sign was only present in 7% of cases, only 1 of which had strangulation.
Chou CK	2000	Differentiation of obstructive from non-obstructive small bowel dilatation on CT. *Eur J Radiol. 2000 Sep;35(3):213-20.*	III	(N=146; Retrospective) Evaluated 4 criteria: continuity of proximal SB, transition zone, intraluminal fluid, & colonic contents. The probability of true obstruction was calculated for each sign. Continuity 69%, Transition zone abrupt 80%, high amount of SB fluid 79%, minimal colonic contents 90%.
Daneshmand S	1999	The utility and reliability of computed tomography scan in the diagnosis of small bowel obstruction. *Am Surg. 1999 Oct;65(10):922-6.*	III	Retrospective study of 103 pts (1997-8) with suspected SBO. Comparison of plain radiographs with CT in determining partial vs complete SBO and in determining cause. Plain films were 75% sensitive and 53% specific for partial vs complete. CT was 92% sensitive and 71% specific. Cause was correctly determined or inferred to be adhesions by CT in 91% of cases.
Gollub MJ	2006	Does the CT whirl sign really predict small bowel volvulus?: Experience in an oncologic population. *J Comput Assist Tomogr. 2006 Jan-Feb;30(1):25-32.*	III	Retrospective analysis of 1200+ CT scans of pts with suspected SBO at a cancer center. Whirl sign was found in 33 pts by a senior radiologist and 14 pts by a senior radiology resident. The whirl sign had a sensitivity of 64% for volvulus by the senior radiologist and much less by the resident. They concluded that the whirl sign is a relatively poor predictor of volvulus in this population
Ha HK	1997	Differentiation of simple and strangulated small-bowel obstructions: usefulness of known CT criteria. *Radiology. 1997 Aug;204(2):507-12.*	III	(N=84; Retrospective) Patients with known outcomes, simple vs strangulated SBO (1991-1996). They identified 6 CT findings as best at determining strangulation: reduced wall enhancement, serrated beak, ascites, and unusual course of mesenteric vasculature, mesenteric haziness, and mesenteric venous engorgement. Using these signs they were able to find 85% of strangulations
Jaffe TA	2006	Small-bowel obstruction: coronal reformations from isotropic voxels at 16-	III	Retrospective analysis of added value of coronal reformations

		section multi-detector row CT. *Radiology. 2006 Jan;238(1):135-42. Epub 2005 Nov 17.*		(2003-4) in 100 pts with suspected SBO. Coronal images added confidence to the three reader's diagnostic accuracy of obstruction vs no obstruction.
Kim JH	2004	Usefulness of known computed tomography and clinical criteria for diagnosing strangulation in small-bowel obstruction: analysis of true and false interpretation groups in computed tomography. *World J Surg. 2004 Jan;28(1):63-8.*	III	Retrospective study of 146 CTs looking for strangulation vs no strangulation (1992-98). Three radiologists were 72% - 82% accurate in determining strangulation. The four clinical criteria, fever, tenderness, tachycardia, leukocytosis, without CT findings were equally accurate, however!
Makita O	1999	CT differentiation between necrotic and nonnecrotic small bowel in closed loop and strangulating obstruction. *Abdom Imaging. 1999 Mar-Apr;24(2):120-4.*	III	Retrospective analysis of CT findings differentiating necrosis from non-necrosis in 25 pts with proven strangulation. Findings predictive of necrosis were: ascites, vascular dilatation, mesenteric attenuation, and radial distribution, but mesenteric attenuation was most predictive.
Diagnosis –MRI				
Beall DP	2002	Imaging bowel obstruction: a comparison between fast magnetic resonance imaging and helical computed tomography. *Clin Radiol. 2002 Aug;57(8):719-24.*	II	Prospective comparison of helical CT (oral/IV contrast) with ultrafast HASTE MRI in 44 pts with suspected SBO (1997 - 1998). Findings: CT (71%, Sensitivity; 71% Specificity) MR (95% sensitivity; 100% Specificity). in differentiating obstruction vs no obstruction. No mention of differentiating high-grade vs low grade obstruction. Limitations of MRI include lack of availability after hours, poor definition of cause of obstruction, and poor visualization of colonic obstructions.
Kim JH	2000	Usefulness of MR imaging for diseases of the small intestine: comparison with CT. *Korean J Radiol. 2000 Jan-Mar;1(1):43-50.*	III	Prospective comparison of helical CT (oral/IV contrast) with HASTE MRI in 34 pts with a variety of SB diseases (1996 - 1999). 15 pts had suspected SBO. MRI and CT were both 100% accurate in diagnosing or excluding SBO. MRI was better at determining the precise cause of obstruction (73% v 60%). MRI poor at looking at omentum.
Lee JK	1998	MR imaging of the small bowel using the HASTE sequence. *AJR Am J Roentgenol. 1998 Jun;170(6):1457-63.*	III	MR with HASTE sequence can distinguish between normal small bowel and abnormal small bowel. Motion did not affect these studies
Regan F	1998	Fast MR imaging and the detection of small-bowel obstruction. *AJR Am J Roentgenol. 1998 Jun;170(6):1465-9.*	III	HASTE MR can be highly accurate in diagnosing SBO and identifying the level of obstruction 26/29 patients with SBO were said to have been correctly identified by HASTE MR (sensitivity 90%, specificity 86%) and 73% had the correct level of obstruction identified. Limitations identified include:

				absence of dilation in situations where prolonged NG suction has been employed, MRI is not good at identifying masses including malignancies, did not show inflammation as good as CT, and does not show viability.
Diagnosis –Ultrasound				
Schmutz GR	1997	Small bowel obstruction: role and contribution of sonography. *Eur Radiol. 1997;7(7):1054-8.*	II	Ultrasound was performed on 123 patients who were evaluated for small bowel obstruction. Of these patients14 had too much gas on initial evaluation and the study was not concluded. Overall accuracy was 81%. Determination of location of obstruction was 80% accurate in the true positives. Determination of cause of obstruction was 63% accurate in the true positives. The studies were performed by an experienced radiologist. Ultrasound was better in identifying the cause of obstruction than plain films.
Czechowski J	1996	Conventional radiography and ultrasonography in the diagnosis of small bowel obstruction and strangulation. *Acta Radiol. 1996 Mar;37(2):186-9.*	III	Retrospective review of 96 pts (1992-1993) who had acute abdomen and conventional radiography was not diagnostic. The study compares plain radiography versus ultrasound in patients with suspected small bowel obstruction. The authors claim that US added information such as the location of the obstruction and whether strangulation was present (absence of peristalsis, extraluminal fluid).
Grassi R	2004	The relevance of free fluid between intestinal loops detected by sonography in the clinical assessment of small bowel obstruction in adults. *Eur J Radiol. 2004 Apr;50(1):5-14.*	III	Retrospective review of 184 patients (2002) in whom SBO was eventually confirmed. These pts all had both plain films and US. Purpose of the study was to determine if intraperitoneal fluid was helpful in differentiating high-grade vs low-grade obstruction. The authors report that US was 100% accurate in finding free fluid but in 34 pts (20%), the free fluid was explained by medical causes. When these pts were excluded from analysis, surgery confirmed free fluid and either thin walled small bowel or impending necrosis in all pts.
Ko YT	1993	Small bowel obstruction: sonographic evaluation. *Radiology. 1993 Sep;188(3):649-53.*	III	Retrospective review of 54 pts with known or suspected BO (1987 – 1992). Pts had already had plain films except for 2 pregnant pts. SBO was correctly diagnosed in 89%. Level of obstruction was correctly predicted in 76%. Cause of obstruction 20%. Ultrasound is better than plain film but does

				not show strangulation well.
Diagnosis –Enteroclysis				
Boudiaf M	2004	Small-bowel diseases: prospective evaluation of multi-detector row helical CT enteroclysis in 107 consecutive patients. *Radiology. 2004 Nov;233(2):338-44.*	II	CT enteroclysis is well tolerated reliable imaging allows detection of extraluminal disease. Should be routine for patients with low grade obstruction in a non-acute setting.
Umschaden HW	2000	Small-bowel disease: comparison of MR enteroclysis images with conventional enteroclysis and surgical findings. *Radiology. 2000 Jun;215(3):717-25.*	II	MR enteroclysis was performed on 18 patients with inflammatory disease and 12 patients with small bowel obstruction. Findings between conventional and MR enteroclysis had a high concordance rate.
Barloon TJ	1994	Does a normal small-bowel enteroclysis exclude small-bowel disease? A long-term follow-up of consecutive normal studies. *Abdom Imaging. 1994 Mar-Apr;19(2):113-5.*	III	Enterocolysis accurately shows closed loop obstruction in 25/27 patients.
Maglinte DD	1991	Preoperative diagnosis by enteroclysis of unsuspected closed loop obstruction in medically managed patients. *J Clin Gastroenterol. 1991 Jun;13(3):308-12.*	III	Retrospective study of 27 patients who were found to have closed loop obstruction on conventional enteroclysis performed 2-8 after admission for small bowel obstruction. Of these patients, 25 were taken to the operating room and found the have a non-strangulated closed loop obstruction.
Diagnosis – Contrast Studies				
Anderson CA	1997	Contrast radiography in small bowel obstruction: a prospective, randomized trial. *Mil Med. 1997 Nov;162(11):749-52.*	I	Prospective randomized study comparing early barium UGI versus plain radiography in patients admitted for small bowel obstruction. The results did not show any difference in time to surgery, complications or length of stay between groups. But, barium study correctly differentiated between operative and non-operative SBO.
Blackmon S	2000	The use of water-soluble contrast in evaluating clinically equivocal small bowel obstruction. *Am Surg. 2000 Mar;66(3):238-42; discussion 242-4.*	III	(418 patients: retrospective)The study looks at the use of gastograffin transit time to help in the diagnosis of patients admitted for with a diagnosis of small bowel obstruction. Patients are given gastrograffin and undergo serial abdominal films. If the contrast does not reach the colon in 6 hours the study is said to be positive. One of the problems with this study is that close to 50% (65) of patients with a positive study did not require surgery. 2 deaths from gastrografin aspiration.
Brochwicz-Lewinski MJ	2003	Small bowel obstruction--the water-soluble follow-through revisited. *Clin Radiol. 2003 May;58(5):393-7.*	I	Prospective randomized study of patients with suspected small bowel obstruction who were divided in two groups based on if they had an upper gi with small bowel follow through(SBFT) or not. The group with the SBFT had a lower

				incidence of operation but this difference did not achieve statistical difference. The length of stay was not affected by the SBFT. The patients were randomized and the surgeons changed their clinical management plan based on the results.
Makanjuola D.	1998	Computed tomography compared with small bowel enema in clinically equivocal intestinal obstruction. *Clin Radiol. 1998 Mar;53(3):203-8.*	III	49 pts had both CT and 'small bowel enema'. 43/49 pts had definite intestinal obstruction (42 per surgery). SBE was more sensitive in detecting Bowel obstruction than CT (100% vs 83%). The 7 missed by CT had short segment stenosis. Conclusion: In clinically suspicious cases of obstruction where CT is neg, use SBE
Sandikcioglu TG	1994	Contrast radiography in small bowel obstruction. A randomized trial of barium sulfate and a nonionic low-osmolar contrast medium. *Acta Radiol. 1994 Jan;35(1):62-4.*	I	Nonionic low osmolar weight contrast is an alternative to barium for contrast studies to evaluate for SBO.
Chung CC	1996	A prospective study on the use of water-soluble contrast follow-through radiology in the management of small bowel obstruction. *Aust N Z J Surg. 1996 Sep;66(9):598-601.*	II	Safe procedure, early surgery should occur if patients have "significant obstruction" (contrast doesn't reach cecum in 4 hours) and a 4 hour cutoff for contrast reaching the cecum in predictive of outcome for SBO in those with history of surgery.
Joyce WP	1992	The value of water-soluble contrast radiology in the management of acute small bowel obstruction. *Ann R Coll Surg Engl. 1992 Nov;74(6):422-5.*	II	Water-soluble contrast study is safe and easy to use and diagnostic study of choice for suspected SBO. Normal contrast study can rule out operative SBO.
Peck JJ	1999	The role of computed tomography with contrast and small bowel follow-through in management of small bowel obstruction. *Am J Surg. 1999 May;177(5):375-8.*	III	With equivocal findings of SBO first CT and then SBFT should be used. The combined sensitivity and specificity are 95% and 86% respectively, higher than those of each alone.
Enochsson L	2001	Contrast radiography in small intestinal obstruction, a valuable diagnostic tool? *Eur J Surg. 2001 Feb;167(2):120-4.*	III	The outcome of oral contrast studies can be predicted by plain radiographs. Contrast studies are safe and may be therapeutic.
Dixon PM	1993	The small bowel enema: a ten year review. *Clin Radiol. 1993 Jan;47(1):46-8.*	III	Routine use of small bowel enema in evaluation of patients with suspected small bowel pathology demonstrates a very high sensitivity (93.1%) and specificity (96.9%) and obstruction had a sensitivity of 98%.
Conservative Management – General Considerations				
Conservative Management – Clinical Indicators/Time Period				
Miller G	2000	Natural history of patients with adhesive small bowel obstruction. *Br J Surg. 2000 Sep;87(9):1240-7.*	III	Patients are never free of risk for post-op obs 2nd to adhesions (14% present >20 yrs post-op). Rate of recurrence was 33%

				overall (32% for operation, 34% (NS) for cons. Mgmt), each recurrence raised risk of future recurrence. Colorectal procedures were more likely to result in matted adhesions v. single bands and result in more readmits. Recurrence rates b/w op and non-op were similar.
Nauta RJ	2005	Advanced abdominal imaging is not required to exclude strangulation if complete small bowel obstructions undergo prompt laparotomy. *J Am Coll Surg. 2005 Jun;200(6):904-11.*	III	Paper validates that complete SBO warrants no additional imaging other than plain films. 71% of PSBO by plain film without peritonitis resolved with conservative management. In patients with complete SBO, there was a very high rate of bowel resection (31%). This suggests that a complete SBO is a surgical disease.
Seror D	1993	How conservatively can postoperative small bowel obstruction be treated? *Am J Surg. 1993 Jan;165(1):121-5; discussion 125-6.*	III	73% response to conservative tx in all SBO (Complete and Partial). No difference in WBC, fever, pulse in those who required surgery. No worse outcome in those watched over 5 days BUT no one that hadn't gotten better by 5 days got better w/o surgery. Weak support of conclusions.
Williams SB	2005	Small bowel obstruction: conservative vs. surgical management. *Dis Colon Rectum. 2005 Jun;48(6):1140-6.*	III	Incidence of recurrent SBO is higher in conservatively managed pts than in operatively managed pts (40.5% v. 26.8%). Time to recurrence in conservative managed patients was shorter (153 v. 411 days)
Miller G	2002	Readmission for small-bowel obstruction in the early postoperative period: etiology and outcome. *Can J Surg. 2002 Aug;45(4):255-8.*	III	Defined early post-op bowel obstruction as within 50 days because had big group who presented b/w 35-50 days. Most frequent procedure was a small bowel operation for SBO. 23% required operation. 3.3% strangulation. Suggests non-operative management of post-op obstruction.
Shih SC	2003	Adhesive small bowel obstruction: how long can patients tolerate conservative treatment? *World J Gastroenterol. 2003 Mar;9(3):603-5.*	III	Paper really suggests if you wait too long, you will have complications.
Fevang BT	2002	Early operation or conservative management of patients with small bowel obstruction? *Eur J Surg. 2002;168(8-9):475-81.*	II	Significant difference in strangulation between early and late operation; suggests surgeons can choose which patients need immediate surgery based on clinical evaluation. Operate for continuous pain, fever, tachycardia, peritonitis, leukocytosis, met acidosis
Ryan MD	2004	Adhesional small bowel obstruction after colorectal surgery.	III	The 3 year rate for SBO following a colorectal procedure is

		ANZ J Surg. 2004 Nov;74(11):1010-2.		3.6%. 48% required OR on first admission for SBO, only 1 for strangulation.
Conservative Management – Adjuncts				
Assalia A	1994	Therapeutic effect of oral Gastrografin in adhesive, partial small-bowel obstruction: a prospective randomized trial. *Surgery. 1994 Apr;115(4):433-7.*	I	100 cc of GG sped return of bowel function (time to first stool) from 23.4h to 6.2 hrs. GG decreased LOS from 4.4d to 2.2d. Trend to improvement in conservative mgmt but not stat sig (21% control v. 10% GG P=0.52). No GG complications
Biondo S	2003	Randomized clinical study of Gastrografin administration in patients with adhesive small bowel obstruction. *Br J Surg. 2003 May;90(5):542-6.*	I	All patients who passed Gastrografin to the colon w/in 24 hours tolerated early feeding and did not require operation. They operated on every patient who did not pass GG to the colon in 24 hrs with no further trial of rx – CANNOT say that failure to pas GG predicts non-op failure (they didn't try) but they claim that every patient who failed had a closed loop at surgery (not strangulation).
Burge J	2005	Randomized controlled trial of Gastrografin in adhesive small bowel obstruction. *ANZ J Surg. 2005 Aug;75(8):672-4.*	I	100 cc of GG reduced time to resolution of sbo from 21 to 12 hrs. LOS decreased by 1 day.GG did not change the number of people who failed non-op mgmt
Chen SC	2006	Specific oral medications decrease the need for surgery in adhesive partial small-bowel obstruction. *Surgery. 2006 Mar;139(3):312-6.*	I	Patients treated with MgOxide, Lactobacillus, and Simethicone for PSBO (by GG study) had a higher incidence of non-op mgmt (77 V 90% p<0.01). This combination of meds may reduce need for operation in PSBO
Choi HK	2002	Therapeutic value of gastrografin in adhesive small bowel obstruction after unsuccessful conservative treatment: a prospective randomized trial. *Ann Surg. 2002 Jul;236(1):1-6.*	I	They randomized GG v. surgery after 48hrs of cons mgmt and showed that most of the GG patients did not require surgery.
Fevang BT	2000	Upper gastrointestinal contrast study in the management of small bowel obstruction--a prospective randomised study. *Eur J Surg. 2000 Jan;166(1):39-43.*	I	In this non-blinded study GG mixed with barium had no effect on resolution of SBO, need for operation, rate of strangulation. Resolution was not different from the literature (PSBO 76%; Complete 41%).
Yagci G	2005	Comparison of Urografin versus standard therapy in postoperative small bowel obstruction. *J Invest Surg. 2005 Nov-Dec;18(6):315-20.*	II	Time to first stool shorter in Urografin group. UG group had better non-op mgmt rate (89.4 to 75.4% p<0.05). UG group had shorter LOS (2.73d v. 6.1d).

Gowen GF	2003	Long tube decompression is successful in 90% of patients with adhesive small bowel obstruction. *Am J Surg. 2003 Jun;185(6):512-5.*	III	In patients w/o signs of strangulation a nasally placed long tube (using endoscopy to pass into the jejunum) had a 90% resolution rate for SBO
Roadley G	2004	Role of Gastrografin in assigning patients to a non-operative course in adhesive small bowel obstruction. *ANZ J Surg. 2004 Oct;74(10):830-2.*	III	Finding GG in the colon 4h post administration reliably predicts successful non-op mgmt.
Conservative Management – Antibiotics				
Sagar PM	1995	Intestinal obstruction promotes gut translocation of bacteria. *Dis Colon Rectum. 1995 Jun;38(6):640-4.*	II	Bacteria were found in mesenteric lymph nodes at a much greater frequency in obstructed v. non-obs patients (39.9% v. 7.3% p, 0.001). Post-op septic complications were more likely in pts that had + mes. Lymph nodes (36.1 v. 11.1% P<0.05)
Conservative Management – Nutrition				
Operative Intervention – General Considerations				
Fevang BT	2004	Long-term prognosis after operation for adhesive small bowel obstruction. *Ann Surg. 2004 Aug;240(2):193-201.*	III	Study suggesting lower risk of recurrence if treated surgically. However risk of needing surgery if future episode is the same. The highest risk is after 5 years, but can occur even decades later. Multiple matted adhesions have more recurrence than single bands (at least those rx'd surgically)
Landercasper J	1993	Long-term outcome after hospitalization for small-bowel obstruction. *Arch Surg. 1993 Jul;128(7):765-70; discussion 770-1.*	III	Rate of recurrence is higher with non-op mgmt (38% v. 21% p<0.001). Complete SBO v. Partial – no difference in recurrence either op or non-op. Op v. non-op no diff in mortality
Early Operative – Clinical Indications/Subgroups				
Tortella BJ	1995	Incidence and risk factors for early small bowel obstruction after celiotomy for penetrating abdominal trauma. *Am Surg. 1995 Nov;61(11):956-8.*	II	(N=341; Prospective) Patients who had a laparotomy for penetrating trauma. The hypothesis is that they would have a higher incidence of post-operative SBO, defined as SBO in 6 months post-exploration. The incidence was higher, 7.4% as compared to a reported 0.69% for post-operative SBO
Meagher AP	1993	Non-operative treatment of small bowel obstruction following appendicectomy or operation on the ovary or tube. *Br J Surg. 1993 Oct;80(10):1310-1.*	III	(N=330; Retrospective) Patients with Appendectomy/tubo-ovarian procedures are more likely to require operative intervention (95% vs. 53
Potts FE 4th	1999	Utility of fever and leukocytosis in acute surgical abdomens in octogenarians and beyond. *J Gerontol A Biol Sci Med Sci. 1999 Feb;54(2):M55-8.*	III	(N=117) Patients with fever and leukocytosis that are in their 80's most likely have Acute cholecystitis and viscous perforation.

Velasco JM	1998	Postlaparoscopic small bowel obstruction. Rethinking its management. *Surg Endosc. 1998 Aug;12(8):1043-5.*	III	(N=5) Post laparoscopic SBOs will need surgical resolution and will not resolve spontaneously as up to73% will do after laparotomy
Huang JC	2005	Small bowel volvulus among adults. *J Gastroenterol Hepatol. 2005 Dec;20(12):1906-12.*	III	(N=19) Volvulus although rare in adults can occur, and will always need surgical therapy.
Takeuchi K	2004	Clinical studies of strangulating small bowel obstruction. *Am Surg. 2004 Jan;70(1):40-4.*	III	(N=280; retrospective) Purpose was to identify aspects of clinical or laboratory exam that would identify patients with gangrenous bowel. Only 92 (24%) of the 280 patients required surgery and 37 of these had strangulation or intestinal gangrene (13) with small bowel resection. Only factors that were significant for gangrenous small bowel were SIRS (12/13) versus (1/24), elevated or low WBC, and base deficit or acidosis.
Tsumura H	2004	Systemic inflammatory response syndrome (SIRS) as a predictor of strangulated small bowel obstruction. *Hepatogastroenterology. 2004 Sep-Oct;51(59):1393-6.*	III	(N=95) SIRS and abdominal guarding are predictive of strangulation in SBO.
Ellis CN	1991	Small bowel obstruction after colon resection for benign and malignant diseases. *Dis Colon Rectum. 1991 May;34(5):367-71.*	III	(N=118) Patients with surgical correction of SBO after history of colon surgery. Patients often get SBO from reoccurrence and it carries higher morbidity and mortality
Matter I	1997	Does the index operation influence the course and outcome of adhesive intestinal obstruction? *Eur J Surg. 1997 Oct;163(10):767-72.*	III	(N=248) Purpose to look for what types of operations would lead to future SBO. . The previous surgeries were divided into 4 groups: Upper abdominal, small bowel resection, appendectomy /gynecology, and colon resection. The procedure that led to most SBO/yr was appendectomy - 3.1. SBO occurred earliest after resection of small bowel and then colon, with in the first year. Complete obstruction was highest after small bowel resection, 20/26, though only 3 required surgery.
Montz FJ	1994	Small bowel obstruction following radical hysterectomy: risk factors, incidence, and operative findings. *Gynecol Oncol. 1994 Apr;53(1):114-20.*	III	(N=98) Retrospective review patients who had radical hysterectomy for non-adnexal gynecologic cancer. Radiation greatly increases incidence of SBO.
Early Operative – Radiographic Indications				
Chen SC	2005	Progressive increase of bowel wall thickness is a reliable indicator for surgery in patients with adhesive small bowel obstruction. *Dis Colon Rectum. 2005 Sep;48(9):1764-71.*	II	(N=121) US demonstrating increase in bowel wall thickness > 3mm are indicator for surgery. Divided into 2 groups: Group 1 – initial SB wall thickness > 3mm, group 2 – SB wall < 3mm. 9(18.4%) of group 1 patients needed surgery and only 4 (5.6%) of group 2.

Chen SC	1999	Oral urografin in postoperative small bowel obstruction. *World J Surg. 1999 Oct;23(10):1051-4.*	II	Urografin in the colon at 8 hours predicts successful non-operative treatment. Oral gastrographin is a good diagnostic tool for prediction of the success of non-operative management of SBO
Perea Garcia J	2004	Adhesive small bowel obstruction: predictive value of oral contrast administration on the need for surgery. *Rev Esp Enferm Dig. 2004 Mar;96(3):191-200.*	II	Conclusion is that earlier use of contrast can lead to earlier decision as to need of surgery or progression of non-operative management of SBO. .
Early Operative – Time Period				
Sosa J	1993	Management of patients diagnosed as acute intestinal obstruction secondary to adhesions. *Am Surg. 1993 Feb;59(2):125-8.*	III	(N=97) Retrospective analysis of 115 admissions for 97 patients with SBO. 3 groups: early operation (< 24 hours) n = 21, non-operative management group B1 failed, n = 33, and successful, n = 62. Primary reason for early operation was tenderness or surgeon's choice. 4 bowel resections 2ndary to strangulation in this group. The group with the only 2 deaths, highest complication rate 36%, and highest strangulation rate was group B1.
Late Operative – Clinical Indications/Subgroups				
Ellozy SH	2002	Early postoperative small-bowel obstruction: a prospective evaluation in 242 consecutive abdominal operations. *Dis Colon Rectum. 2002 Sep;45(9):1214-7.*	II	(N=95) Prospective surveillance of 242 operations performed of 225 patients and monitoring for early post-operative SBO (EPSBO). The majority of the procedure involved the colon, and 45 patients had previous SBO. There were 23 incidents of EPSBO. 20 resolved by day 6 with just NG suction. The other 3 had surgery on day 2, day 16 and day 29 with the latter with SB necrosis and resection. There were no factors identified with this small group of patients predictive of EPSBO
Andersson RE	2001	Small bowel obstruction after appendicectomy. *Br J Surg. 2001 Oct;88(10):1387-91.*	III	Interesting study looking at the national registry of all Swedish hospitals and the appendectomies done over the past 30+ years. 245400 patients underwent appendectomy over that time period and there were 2659 SBO operations since on the patients. There were 245400 matched controls with 245 operations for SBO. Cumulated risk of surgery for SBO after appendectomy after 4 weeks is 0.41, at 1 year, 0.63, at 10 years 0.97, and at 30 years 1.30. This is lower then previously though. The cumulative risk increases with the operative diagnosis with mesenteric adenitis at 1.42 at 30 years, perforated appendicitis at 2.76, and other at 3.24. Acute appendicitis carries the lowest risk of appendicitis at 0.75

Edna TH	1998	Small bowel obstruction in patients previously operated on for colorectal cancer. *Eur J Surg. 1998 Aug;164(8):587-92.*	III	(N=472) Study of 472 patients with operation for colorectal CA followed for 5.5 years to establish the incidence of SBO. 351 had a curative procedure, the other 121 palliative. 36/351 of the curative developed an SBO that needed surgery, while 5/121 of the palliative procedures developed SBO post operation. Etiology of SBO cancer in half and these patients' post-op mortality was much higher. > 1000 cc blood loss at initial surgery leads to a higher rate of SBO, as does the greater dissection of a curative procedure
Fraser SA	2002	Immediate postlaparotomy small bowel obstruction: a 16-year retrospective analysis. *Am Surg. 2002 Sep;68(9):780-2.*	III	(N=52) Retrospective review of 15 years of experience to find 52 patients with immediate post-operative SBO. 22 of these patients needed surgical correction. Timing of SBO was about 8 days post-op. timing to beginning of symptoms to surgery was 5 days. Rate of non-operative treatment was 60%, and these patients had less complications and less LOS
Siporin K	1993	Small bowel obstruction after abdominal aortic surgery. *Am Surg. 1993 Dec;59(12):846-9.*	III	(N=44) Retrospective review of 1475 patients with either AAA repair or Graft replacement of the Aorta for occlusive disease to identify the incidence of SBO in this population. 44 patients with SBO in the immediate post-operative period (to 30 days) found. 18 required operation, lysis of adhesions and 2 resections.
Butler JA	1991	Small bowel obstruction in patients with a prior history of cancer. *Am J Surg. 1991 Dec;162(6):624-8.*	III	(N=54; Retrospective) Patients with complete or partial SBO after surgery at some time for cancer. 37 (69%) of these patients had operative therapy. 67% of the group had chemo/radiation therapy. 50% had known recurrence. 25/37 with surgery had recurrent cancer as the cause of the CA. Only 11 patients cleared non-operatively. 49% of the operative patients had major complications, and the operative mortality was 16%, in hospital mortality of 22%.
Late Operative – Radiographic Indications				
Choi HK	2005	Value of gastrografin in adhesive small bowel obstruction after unsuccessful conservative treatment: a prospective evaluation. *World J Gastroenterol. 2005 Jun 28;11(24):3742-5.*	II	(N=212) 100cc of Gastrografin used 48h post SBO without improvement delineated those who needed surgery (contrast not in colon at 24h) and those who did not (contrast in colon at 24h). The need for OR reduced by 74% with a strangulation rate of 0.8%.
Onoue S	2002	The value of contrast radiology for postoperative adhesive small bowel obstruction.	II	(N=107) 40 cc Gastrografin + 40cc water provided within 24h of SBO admission after NGT decompression and IVF.

		Hepatogastroenterology. 2002 Nov-Dec;49(48):1576-8. Related Articles, Links		Gastrografin is useful in identifying and treating SBO non-operatively, though the incidence of strangulation is not affected.
Late Operative – Time Period				
Cox MR	1993	The safety and duration of non-operative treatment for adhesive small bowel obstruction. *Aust N Z J Surg. 1993 May;63(5):367-71.*	III	(N=123) 2 or more indicators (fever, tachycardia, constant pain, WBC>16) of SB strangulation on admission demonstrates by OR 76% non-viable SB. Without indicators, 69% managed non-op with resolution of SB. Evidence does not support author's statement to abandon non-op at 48h.
Operative Approach – Laproscopic vs. Open				
Borzellino G	2004	Laparoscopic approach to postoperative adhesive obstruction. *Surg Endosc. 2004 Apr;18(4):686-90.*	III	(N=65) Using laparoscopy, 6.5% intraop complication, 20% conversion rate and 15.4% recurrence. US guide to enter abdomen without any injury on entrance. Relative contraindications such as massive distention, no free quadrant, and suspected strangulation discussed. Author emphasizes success with numbers above.
Chopra R	2003	Laparoscopic lysis of adhesions. *Am Surg. 2003 Nov;69(11):966-8.*	III	(N=75) Using laparoscopy, 4.3% SB resection, 32% conversion rate, and overall lower OR time, infectious complications, post-op ileus, and LOS. Author states "viable option."
Duepree HJ	2003	Does means of access affect the incidence of small bowel obstruction and ventral hernia after bowel resection? Laparoscopy versus laparotomy. *J Am Coll Surg. 2003 Aug;197(2):177-81.*	III	(N=716) Use of laparoscopy for bowel resection decreases ventral hernia and SBO requiring hospital readmission. SB requiring operative intervention was similar between laparoscopy and open.
Wullstein C	2003	Laparoscopic compared with conventional treatment of acute adhesive small bowel obstruction. *Br J Surg. 2003 Sep;90(9):1147-51.*	III	(N=104) Using laparoscopy, 17.3% perforation, 51.9% conversion, and longer operative times. Post-operative complications, return of bowel function, and LOS less for laparoscopy.
Leon EL	1999	Laparoscopic management of small bowel obstruction: indications and outcome. *J Gastrointest Surg. 1998 Mar-Apr;2(2):132-40.*	III	(N=40) Laparoscopy successful 35% assisted 30%, and 35% conversion. . Reasons for conversion included dense adhesions, need for bowel resection, Crohns, 2 cancers and large lymph nodes. Those converted longer LOS.
Levard H	2001	Laparoscopic treatment of acute small bowel obstruction: a multicentre retrospective study. *ANZ J Surg. 2001 Nov;71(11):641-6.*	III	(N=308) Laparoscopy conversion rate 45.4%. Factors that favor laparoscopic success are SBO post appendectomy, with bands as cause, with less then 2 previous surgeries, and shorter time of symptoms. Those not converted had shorter LOS, fewer complications, and earlier bowel function.

Liauw JJ	2005	Laparoscopic management of acute small bowel obstruction. *Asian J Surg. 2005 Jul;28(3):185-8.*	III	(N=9) Conversion rate of 22%.
Suter M	2000	Laparoscopic management of mechanical small bowel obstruction: are there predictors of success or failure? *Surg Endosc. 2000 May;14(5):478-83.*	III	(N=15) Enteroclysis guided laparoscopy conversion rate of 6.7%.
Suzuki K	2003	Elective laparoscopy for small bowel obstruction. *Surg Laparosc Endosc Percutan Tech. 2003 Aug;13(4):254-6.*	III	(N=40) Laparoscopy conversion rate of 40%. Intraop enterotomies 10%. Late recurrence 2.5%
Tsumura H	2004	Laparoscopic adhesiolysis for recurrent postoperative small bowel obstruction. *Hepatogastroenterology. 2004 Jul-Aug;51(58):1058-61.*	III	(N=83) 57% initial success rate with duration of surgery (>120min) and bowel diameter (>4cm) predictive of conversion. Reoperation rate of 9%. Bowel perforation and need for conversion increased post-op complications.
Pekmezci S	2002	Enteroclysis-guided laparoscopic adhesiolysis in recurrent adhesive small bowel obstructions. *Surg Laparosc Endosc Percutan Tech. 2002 Jun;12(3):165-70.*	III	(N=21) 57% laparoscopy only, 24% assisted, 19% conversion rate. Utilizing laparoscopy (+/- assisted) diminished time for bowel function and LOS.
Strickland P	1999	Is laparoscopy safe and effective for treatment of acute small-bowel obstruction? *Surg Endosc. 1999 Jul;13(7):695-8.*	III	(N=25) Complete adhesiolysis 72%. Lap assisted 24%. Open 4%. Utilizing laparoscopy (+/- assisted) diminished time for bowel function and LOS.
Operative Approach – Adjuncts				
Fazio VW	2006	Reduction in adhesive small-bowel obstruction by Seprafilm adhesion barrier after intestinal resection. *Dis Colon Rectum. 2006 Jan;49(1):1-11.*	I	(N=1791) Pt blinded randomized multicenter trial to eval Seprafilm. The overall rate of post-operative SBO showed no difference with or without Seprafilm. However, Seprafilm did have lower (1.8 vs 3.4%) of SBO requiring reoperation (N=90).
Kieffer RW	1993	Indications for internal stenting in intestinal obstruction. *Mil Med. 1993 Jul;158(7):478-9.*	III	(N=16) Using internal stenting with Baker jejunal tube, recurrent rate of obstruction was 25%. Non-obstructive intra-abdominal complication rate 18.7%.
Meissner K	2000	Effectiveness of intestinal tube splinting: a prospective observational study. *Dig Surg. 2000;17(1):49-56.*	II	(N=186) With internal splinting, 9% complications, 2% procedural complications, 3% reoperation. No early SBO. Lower late SBO compared to historical outcome data.
Kudo FA	2004	Use of bioresorbable membrane to prevent postoperative small bowel obstruction in transabdominal aortic aneurysm surgery. *Surg Today. 2004;34(8):648-51.*	III	(N=51) Early SBO was lower with Seprafilm evident by earlier diet intake and less abdominal complaints. No reoperations were required in either group.
Meissner K	2001	Small bowel obstruction following extended right hemicolectomy and subtotal colectomy: assessing the benefit of prophylactic tube splinting. *Dig Surg. 2001;18(5):388-92.*	III	(N=34) Intestinal tube splinting showed non-statistical fewer early and late SBO
Mohri Y	2005	Hyaluronic acid-carboxycellulose membrane (Seprafilm) reduces early	III	(N=184) Incidence of early SBO lower with Seprfilm. No

		postoperative small bowel obstruction in gastrointestinal surgery. *Am Surg. 2005 Oct;71(10):861-3.*		difference in surgical site infection.
Sprouse LR 2nd	2001	Twelve-year experience with the Thow long intestinal tube: a means of preventing postoperative bowel obstruction. *Am Surg. 2001 Apr;67(4):357-60.*	III	(N=34) Transgastric Thow tube had no long term (>4y) with pts who had operative intervention for adhesion SBO. Follow-up recorded via phone calls to patients (25 of 34). Complications all related to gastrostomy (25%)
Rodriguez-Ruesga R	1995	Twelve-year experience with the long intestinal tube. *World J Surg. 1995 Jul-Aug;19(4):627-30; discussion 630-1.*	III	(N=47) Complex surgical patient with median 4 previous laparotomies. 23.4% recurrent SBO, only 2 required reoperation.
Korenaga D	2001	Factors influencing the development of small intestinal obstruction following total gastrectomy for gastric cancer: the impact of reconstructive route in the Roux-en-Y procedure. *Hepatogastroenterology. 2001 Sep-Oct;48(41):1389-92.*	III	(N=48) 22.9% presented with mechanical obstruction and antecolic anastomosis found to be predictive factor. 45% required reoperation.
Poon JT	2004	Small bowel obstruction following low anterior resection: the impact of diversion ileostomy. *Langenbecks Arch Surg. 2004 Aug;389(4):250-5.*	II	(N=214) SBO following LAR is 10.3%, the majority benign and not malignant recurrence. Diverting ileostomy increases incidence of early SBO.
Holmdahl L	1997	Adhesions: prevention and complications in general surgery. *Eur J Surg. 1997 Mar;163(3):169-74.*	III	Survey sent out to surgical department heads in Sweden. 84% (87units) response rate. >4700 admissions for adhesion SBO, 47% operative rate. Over 1500 operations/y complicated by previously formed adhesions. Author suggests washing gloves and suturing peritoneum could help but no evidence provided.
SBO in Pregnancy				
Meyerson S	1995	Small bowel obstruction in pregnancy. *Am J Gastroenterol. 1995 Feb;90(2):299-302.*	III	9 cases over 15 years and 150,386 deliveries. Previous surgery 8 of 9 cases. Operation required in 8 of 9 patients. No maternal deaths. 3 of 9 fetal deaths (22-30 wks)