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GUIDELINE

Self-expandable metal stents for obstructing colonic and extracolonic cancer: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline

This Guideline is an official statement of the European Society of Gastrointestinal Endoscopy (ESGE). This Guideline was also reviewed and endorsed by the Governing Board of the American Society for Gastrointestinal Endoscopy (ASGE). The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system was adopted to define the strength of recommendations and the quality of evidence.

ESGE guidelines represent a consensus of best practice based on the available evidence at the time of preparation. They may not apply in all situations and should be interpreted in the light of specific clinical situations and resource availability. Further controlled clinical studies may be needed to clarify aspects of these statements, and revision may be necessary as new data appear. Clinical consideration may justify a course of action at variance to these recommendations. ESGE guidelines are intended to be an educational device to provide information that may assist endoscopists in providing care to patients. They are not rules and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment.

MAIN RECOMMENDATIONS

The following recommendations should only be applied after a thorough diagnostic evaluation including a contrast-enhanced computed tomography (CT) scan.

1. Prophylactic colonic stent placement is not recommended. Colonic stenting should be reserved for patients with clinical symptoms and imaging evidence of malignant large-bowel obstruction, without signs of perforation (strong recommendation, low quality evidence).
2. Colonic self-expandable metal stent (SEMS) placement as a bridge to elective surgery is not recommended as a standard treatment of symptomatic left-sided malignant colonic obstruction (strong recommendation, high quality evidence).
3. For patients with potentially curable but obstructing left-sided colonic cancer, stent placement may be considered as an alternative to emergency surgery in those who have an increased risk of postoperative mortality, i.e. American Society of Anesthesiologists (ASA) Physical Status $\geq$III and/or age $>$70 years (weak recommendation, low quality evidence).
4. SEMS placement is recommended as the preferred treatment for palliation of malignant colonic obstruction (strong recommendation, high quality evidence), except in patients treated or considered for treatment with antiangiogenic drugs (e.g. bevacizumab) (strong recommendation, low quality evidence).

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INTRODUCTION

Colorectal cancer is one of the most common cancers worldwide, particularly in the economically developed world.[1] Large-bowel obstruction caused by advanced colonic cancer occurs in 8%–13% of colonic cancer patients.[2–4] The management of this severe clinical condition remains controversial.[5] Over the last decade many articles have been published on the subject of colonic stenting for malignant colonic obstruction, including randomized controlled trials (RCTs) and systematic reviews. However, the definitive role of self-expandable metal stents (SEMSs) in the treatment of malignant colonic obstruction has not yet been clarified. This evidence- and consensus-based clinical guideline has been developed by the European Society of Gastrointestinal Endoscopy (ESGE) and endorsed by the American Society for Gastrointestinal Endoscopy (ASGE) to provide practical guidance regarding the use of SEMS in the treatment of malignant colonic obstruction.

With the exception of one trial,[6] all published RCTs on colonic stenting for malignant obstruction excluded rectal cancers, which were usually defined as within 8 to 10 cm of the anal verge, and colonic cancers proximal to the splenic flexure. Rectal stenting is often avoided because of the presumed association with complications such as pain, tenesmus, incontinence, and stent migration. Proximal colonic obstruction is generally managed with primary surgery, although there are no RCTs to support this assumption. Because of the aforementioned limitations, unless indicated otherwise the recommendations in this Guideline only apply to left-sided colon cancer arising from the rectosigmoid colon, sigmoid colon, descending

colon, and splenic flexure, while excluding rectal cancers and those proximal to the splenic flexure, and other causes of colonic obstruction including extracolonic obstruction.

METHODS

The ESGE commissioned this Guideline (chairs C.H. and J.-M.D.) and appointed a guideline leader (J.v.H.) who invited the listed authors to participate in the project development. The key questions were prepared by the coordinating team (E.v.H. and J.v.H.) and then approved by the other members. The coordinating team formed task force subgroups, each with its own leader, and divided the key topics among these task forces (see **Appendix e1**, available online at www.giejournal.org).

Each task force performed a systematic literature search to prepare evidence-based and well-balanced statements on their assigned key questions. The coordinating team independently performed systematic literature searches with the assistance of a librarian. The Medline, EMBASE and Trip databases were searched including at minimum the following key words: colon, cancer, malignancy or neoplasm, obstruction and stents. All articles studying the use of SEMS for malignant large-bowel obstruction were selected by title or abstract. After further exploration of the content, the article was then included and summarized in the literature tables of the key topics when it contained relevant data (see **Appendix e2**, **Tables e1–e5**, available online at www.giejournal.org). All selected articles were graded by the level of evidence and strength of recommendation according to the GRADE system.[7] The literature searches were updated until January 2014.

Each task force proposed statements on their assigned key questions which were discussed and voted on during the plenary meeting held in February 2014, Düsseldorf, Germany. In March 2014, a draft prepared by the coordinating team was sent to all group members. After agreement on a final version, the manuscript was submitted to *Endoscopy* for publication. The journal subjected the manuscript to peer review and the manuscript was amended to take into account the reviewers' comments. All authors agreed on the final revised manuscript. The final revised manuscript was then reviewed and approved by the Governing Board of ASGE. This Guideline was issued in 2014 and will be considered for review in 2019 or sooner if new and relevant evidence becomes available. Any updates to the Guideline in the interim will be noted on the ESGE website: http://www.esge.com/esge-guidelines.html.

RECOMMENDATIONS AND STATEMENTS

Evidence statements and recommendations are stated in bold italics.

General considerations before stent placement (**Table e1**, available online at www.giejournal.org)

Prophylactic colonic stent placement is not recommended. Colonic stenting should be reserved for patients with clinical symptoms and imaging evidence of malignant large-bowel obstruction, without signs of perforation (strong recommendation, low quality evidence).

Colonic stenting is indicated only in those patients with both obstructive symptoms and radiological or endoscopic findings suspicious of malignant large-bowel obstruction. Prophylactic stenting for patients with colonic malignancy but no evidence of symptomatic obstruction is strongly discouraged because of the potential risks associated with colonic SEMS placement. The only absolute contraindication for colonic stenting is perforation. In addition, colonic stenting is less successful in patients with peritoneal carcinomatosis and tumors close to the anal verge (<5 cm).[8–10]

Increasing age and American Society of Anesthesiologists (ASA) classification ≥III do not affect stent outcome (i.e. clinical success and complications) in several observational studies,[11–16] although these are well-known risk factors for postoperative mortality after surgical treatment of large-bowel obstruction (**Table 6**).[17–19]

A contrast-enhanced computed tomography (CT) scan is recommended as the primary diagnostic tool when malignant colonic obstruction is suspected (strong recommendation, low quality evidence).

When malignant colonic obstruction is suspected, contrast-enhanced CT is recommended because it can diagnose obstruction (sensitivity 96%, specificity 93%), define the level of the stenosis in 94% of cases, accurately identify the etiology in 81% of cases, and provide correct local and distal staging in the majority of patients.[5,20] When CT is inconclusive about the etiology of the obstructing lesion, colonoscopy may be helpful to evaluate the exact cause of the stenosis.

Examination of the remaining colon with colonoscopy or CT colonography (CTC) is recommended in patients with potentially curable obstructing colonic cancer, preferably within 3 months after alleviation of the obstruction (strong recommendation, low quality evidence).

European studies, including three that are population-based, show that synchronous colorectal tumors occur in 3%–4% of patients diagnosed with colorectal cancer.[21–24] Therefore, imaging of the remaining colon after potentially curative resection is recommended in patients with malignant colonic obstruction. Current evidence does not justify routine preoperative assessment for synchronous tumors in obstructed patients by CTC or colonoscopy through the stent. However, preoperative CTC and colonoscopy through the stent appear feasible and safe in these patients and there are presently no data to discourage their use in this population.[25–28] The role of positron emission tomography (PET)/CT in the diagnosis of synchronous lesions remains to be elucidated.[29]

TABLE 6. Outcome of surgery according to age and American Society of Anesthesiologists (ASA) classification

First author, year	Study population	Results	Study design Level of evidence
Tekkis, 2004[18]	Patients undergoing surgery for acute colorectal cancer obstruction (n = 1046)	Multivariate analysis of in-hospital postoperative mortality: - Age <65 years: 5.4% - Age 65-67 years: 13.1%; OR 2.97 (95%CI 1.26-7.08) - Age 75-84 years: 21.9%; OR 4.31 (95%CI 1.83-10.05) - Age ≥ 85 years: 27.0%; OR 5.87 (95%CI 2.27-15.14) - ASA I: 2.6% - ASA II: 7.6%; OR 3.32 (95%CI 0.73-15.18) - ASA III: 23.9%; OR 11.73 (95%CI 2.58-53.36) - ASA IV-V: 42.9%; OR 22.33 (95%CI 4.58-109.68)	Nonrandomized prospective UK multicenter study High quality evidence
Biondo, 2004[17]	Patients undergoing emergency surgery for acute large-bowel obstruction (n = 234) Colorectal cancer 82.1% Extracolonic cancer 4.7% Benign lesions 13.2%	Univariate analysis of 30-day postoperative mortality: - Age ≤70 years: 10.7% (14/131) - Age >70 years: 29.1% (30/103); $P < 0.001$ - ASA I-II: 8.1% (9/111) - ASA III-IV: 28.5% (35/123); $P < 0.001$ Multivariate analysis of 30-day postoperative mortality: - Age >70 years: OR 2.05 (95%CI 0.92-4.60) - ASA III-IV: OR 2.86 (95%CI 1.15-7.11)	No description of study design, most likely retrospective Moderate quality evidence
Tan, 2010[19]	Patients who underwent operative intervention for acute obstruction from colorectal malignancy (n = 134)	Perioperative morbidity rate: 77.6% Perioperative mortality rate: 11.9% Multivariate analysis of worse outcome (grade III-V complications, including death): - Age >60 years: OR 4.67 (95%CI 1.78-12.25) - ASA III-IV: OR 8.36 (95%CI 3.58-19.48)	Retrospective analysis Low quality evidence

CI, Confidence interval; *OR*, odds ratio.

Colonic stenting should be avoided for diverticular strictures or when diverticular disease is suspected during endoscopy and/or CT scan (strong recommendation, low quality evidence). Pathological confirmation of malignancy by endoscopic biopsy and/or brush cytology is not necessary in an urgent setting, such as before stent placement. However, pathology results may help to modify further management of the stented patient (strong recommendation, low quality evidence).

When malignancy is suspected after diagnostic studies, a small number of patients will have a benign cause of obstruction. Two RCTs comparing SEMS as a bridge to surgery versus emergency surgery in patients with left-sided malignant obstruction reported benign obstructive lesions in 4.6% (3/65)[30] and 8.2% (8/98)[31] of the randomized patients. These benign colonic lesions that mimic malignancy are usually due to diverticular disease. Further evidence of the difficulty of this distinction is also reflected by a systematic review showing a 2.1% prevalence of underlying adenocarcinoma of the colon in 771 patients in whom acute diverticulitis was diagnosed via CT scan.[32] Stent placement in active diverticular inflammation is associated with a risk of perforation and should therefore be avoided.[33] Furthermore, pathological confirmation of malignancy before emergency stent placement is often not feasible and is not required prior to colonic stent placement. Endoscopic biopsy and/or brush cytology for confirmation of malignancy

should be obtained during the stent placement procedure, because it may be helpful in modifying the further management of the stented patient.[34–36]

Preparation of obstructed patients with an enema to clean the colon distal to the stenosis is suggested to facilitate the stent placement procedure (weak recommendation, low quality evidence). Antibiotic prophylaxis in obstructed patients undergoing colon stenting is not indicated because the risk of post-procedural infections is very low (strong recommendation, moderate quality evidence).

There are no studies to date that have focused on bowel preparation before stent placement in obstructed patients. Symptomatic bowel obstruction is a relative contraindication to oral bowel cleansing. An enema is advisable to facilitate the stent placement procedure by cleaning the bowel distal to the stenosis.

Antibiotic prophylaxis before stent placement in patients with malignant colonic obstruction is not indicated because the risk of fever and bacteremia after stent insertion is very low. One prospective study analyzed 64 patients with colorectal cancer who underwent a stent procedure. Four of 64 patients (6.3%) had a positive post-stenting blood culture and none of the patients developed symptoms of infection within 48 hours following stent placement. Prolonged procedure time was associated with transient bacteremia (36 vs. 16 minutes, $P < 0.01$).[37] One other retrospective series of 233 patients undergoing colonic stent placement for malignant obstruction described that blood cultures had been drawn for unspecified reasons in 30 patients within 2 weeks after stent placement, showing bacteremia/fever in 7 patients (3%), which was reported as a minor complication.[15]

Colonic stent placement should be performed or directly supervised by an experienced operator who has performed at least 20 colonic stent placement procedures (strong recommendation, low quality evidence).

Two noncomparative studies addressed the learning curve of a single endoscopist performing colonic stent placement. Both showed an increase in technical success and a decrease in the number of stents used per procedure after performance of at least 20 procedures.[38,39] Two other retrospective series have shown that operator experience affects stenting outcome. The first reported significantly higher technical and clinical success rates when the stent was inserted by an operator who had performed at least 10 SEMS procedures.[16] The second showed a significantly increased immediate perforation rate when colonic stent placement was performed by endoscopists inexperienced in pancreaticobiliary endoscopy.[15] The authors of the latter article explained the lower immediate perforation rate by the skills that therapeutic ERCP endoscopists have in traversing complex strictures, understanding fluoroscopy, and deploying stents.[15]

Technical considerations of stent placement (**Table e2**, available online at www.giejournal.org)

Colonic stent placement is recommended with the combined use of endoscopy and fluoroscopy (weak recommendation, low quality evidence).

SEMS placement can be performed by using either the through-the-scope (TTS) or the over-the-guidewire (OTW) technique. The majority of SEMS are inserted through the endoscope with the use of fluoroscopic guidance. The OTW technique is performed using fluoroscopic guidance with or without tandem endoscopic monitoring. Purely radiologic stent placement is performed by advancing the stent deployment system over a stiff guidewire, and technical and clinical success rates of 83%–100% and 77%–98%, respectively, have been reported in observational studies.[40–45] Retrospective studies that compared endoscopy combined with fluoroscopic guidance versus solely radiography for stent placement show comparable success rates, although with a trend towards higher technical success when the combined technique is used.[16,46–48]

Stricture dilation either before or after stent placement is discouraged in the setting of obstructing colorectal cancer (strong recommendation, low quality evidence).

Although based on low quality evidence with small patient numbers, there are strong indications to believe that stricture dilation either just before or after colonic stent placement adversely affects the clinical outcome of stenting and particularly increases the risk of colonic perforation.[8,12,15,49] Pooled analyses, mainly based on retrospective data, also show increased risk of perforation after stricture dilation.[47,50,51]

Covered and uncovered SEMS are equally effective and safe (high quality evidence). The stent should have a body diameter ≥24 mm (strong recommendation, low quality evidence) and a length suitable to extend at least 2 cm on each side of the lesion after stent deployment (weak recommendation, low quality evidence).

The clinician should be aware of specific features of the chosen stent that may affect the patient after insertion. Two meta-analyses comparing covered and uncovered SEMS for malignant colonic obstruction found similar technical success, clinical success, and overall complication rates. Uncovered SEMS showed significantly higher tumor ingrowth rates (11.4% vs. 0.9%) but were less prone to migrate than covered SEMS (5.5% vs. 21.3%).[52,53]

The diameter of the stent also seems to influence stent outcome. In mainly retrospective analyses, the use of small-diameter stents with a body diameter <24 mm was associated with the occurrence of complications, in particular stent migration.[15,54–56] Stent length was not identified in observational studies as a risk factor for adverse stent outcome.[8,11,16,45] It is recommended to use a stent that is long enough to bridge the stenosis and to extend at least

TABLE 7. Short-term outcomes of self-expandable metal stent (SEMS) placement as a bridge to elective surgery

First author, year	Study population	Results	Study design Level of evidence
Huang, 2014[81]	Patients with acute left-sided malignant colonic obstruction 7 RCTs Preoperative SEMS (n = 195) Emergency surgery (n = 187)	Mean success rate of colonic stent placement: 76.9% (46.7%-100%) Permanent stoma rate (P = 0.002): - SEMS as bridge to surgery: 9% (9/100) - Emergency surgery: 27.4% (26/95) - OR 0.28 (95%CI 0.12-0.62); I^2 = 36% Primary anastomosis rate (P = 0.007): - SEMS as bridge to surgery: 67.2% (131/195) - Emergency surgery: 55.1% (103/187) - OR 2.01 (95%CI 1.21-3.31); I^2 = 0% Mortality rate (P = 0.76): - SEMS as bridge to surgery: 10.7% (12/112) - Emergency surgery: 12.4% (14/113) - OR 0.88 (95%CI 0.40-1.96); I^2 = 17% Overall complication rate (P = 0.03): - SEMS as bridge to surgery: 33.1% (55/166) - Emergency surgery: 53.9% (90/167) - OR 0.30 (95%CI 0.11-0.86); I^2 = 77% Anastomotic leakage rate (P = 0.47): - SEMS as bridge to surgery: 4.1% (8/195) - Emergency surgery: 5.9% (11/187) - OR 0.74 (95%CI 0.33-1.67); I^2 = 27% Wound infection rate (P = 0.004): - SEMS as bridge to surgery: 6.7% (10/150) - Emergency surgery: 18.1% (26/144) - OR 0.31 (95%CI 0.14-0.68); I^2 = 0% Intra-abdominal infection rate (P = 0.57): - SEMS as bridge to surgery: 1.4% (1/73) - Emergency surgery: 3.2% (2/63) - OR 0.62 (95%CI 0.12-3.19); I^2 = 0%	Meta-analysis of RCTs High quality evidence
Guo, 2011[100]	Patients aged ≥70 years diagnosed with acute left-sided colonic obstruction SEMS (n = 34) Surgery (n = 58)	SEMS versus surgery Overall rate of successful bridging with SEMS: 79% Mean time to elective surgery: 9 days (range 4-16) Successful relief of obstruction: 91% vs. 100% (P = 0.09) Primary anastomosis rate: 79% vs. 47% (P = 0.002) Temporary stoma rate: 9% vs. 53% (P < 0.001) Permanent stoma rate: 6% vs. 12% (P = 0.34) Median length of hospital stay: 19 vs. 14 days (P = 0.06) Acute mortality rate: 3% vs. 19% (P = 0.03) Acute complication rate: 24% vs. 40% (P = 0.11)	Retrospective comparison Low quality evidence

CI, Confidence interval; *OR*, odds ratio; *RCT*, randomized controlled trial; *SEMS*, self-expandable metal stent.

2 cm on each side of the lesion, taking into account the degree of shortening after stent deployment.[57] Several studies, including one RCT, have shown no difference in outcomes (efficacy and safety) based on different stent designs.[8,43,58–61]

Surgical resection is suggested as the preferred treatment for malignant obstruction of the proximal colon in patients with potentially curable disease (weak recommendation, low quality evidence). In a palliative setting, SEMS can be an alternative to emergency surgery (weak recommendation, low quality evidence).

Retrospective series have shown that SEMS may be successfully placed in malignant strictures located in the proximal colon (i.e. proximal to the splenic flexure).[8,16,62–64] However, these data show conflicting results regarding SEMS outcome compared with stent placement in the left-sided colon.[8,11,15,16,45,62,65,66] Emergency resection is generally considered to be the treatment of choice for right-sided obstructing colon cancer. In this setting, primary ileocolonic anastomosis or ileostomy can be performed depending on the surgical risk of the patient.[5,67,68]

SEMS placement is a valid alternative to surgery for the palliation of malignant extracolonic

obstruction (weak recommendation, low quality evidence). The technical and clinical success rates of stenting for extracolonic malignancies are inferior to those reported in stenting of primary colonic cancer (low quality evidence).

Large-bowel obstruction caused by extracolonic malignancies is a different entity within colonic stenting and has been studied mainly retrospectively. Technical and clinical success rates of stenting extracolonic malignancies have been reported to range from 67% to 96% and from 20% to 96%, respectively,[65,69–75] and are considered inferior to those reported in stenting of primary colonic cancer.[8,55,70,74] One retrospective comparison of SEMS for extracolonic versus primary colonic malignancy showed an increased complication rate in the extracolonic malignancy group (33% vs. 9%, $P = 0.046$), although this finding was not statistically significant in the multivariate analysis.[74] However, several larger series did not identify obstruction by extrinsic compression as a risk factor for complications.[8,11,15,70] It is generally advisable to attempt palliative stenting of extracolonic malignancies in order to avoid surgery in these patients who have a relatively short survival (median survival 30–141 days).[69,70,72,73]

There is insufficient evidence to discourage colonic stenting based on the length of the stenosis (weak recommendation, low quality evidence) or the degree of obstruction (strong recommendation, low quality evidence).

Few studies investigated the "stentability" of long obstructed segments.[58,76,77] However, in two retrospective studies that included a total of 240 patients, a better outcome was observed when SEMS were inserted in short obstructed segments.[55,78] One identified statistically significantly more technical failures (odds ratio [OR] 5.33) and clinical failures (OR 2.40) in stenoses >4 cm.[55]

The outcomes of SEMS placement for complete obstruction compared with subtotal obstruction are reported inconsistently in the literature. One comparative prospective study that specifically focused on this topic found similar technical and clinical success rates between both groups.[79] This was confirmed by more recently published large retrospective series.[8,55] However, in two observational studies significantly more complications were observed in the complete occlusion group (35% and 38% vs. 20% and 22%).[13,15] Furthermore, multivariate analysis in one prospective multicenter study, which reported an 11% overall perforation rate, identified complete obstruction as a risk factor for perforation (OR 6.88).[80]

Clinical indication: SEMS placement as a bridge to elective surgery (**Table e3**, available online at www.giejournal.org)

Colonic SEMS placement as a bridge to elective surgery is not recommended as a standard treatment of symptomatic left-sided malignant colonic obstruction (strong recommendation, high quality evidence). For patients with potentially curable left-sided obstructing colonic cancer, stent placement may be considered as an alternative to emergency surgery in those who have an increased risk of postoperative mortality, i.e. ASA ≥III and/or age >70 years (weak recommendation, low quality evidence).

Eight systematic reviews with meta-analysis have been published in the last decade that compared preoperative stenting with emergency resection for acute malignant left-sided colonic obstruction.[81–88] Three of the seven RCTs published to date on this subject [30,31,89–93] were prematurely closed, including two because of adverse outcomes in the stent group [30,31] and one because of a high incidence of anastomotic leakage in the primary surgery group.[92]

The most recent systematic review and meta-analysis evaluated the efficacy and safety of colonic stenting as a bridge to surgery (n = 195) compared with emergency surgery (n = 187) and considered only RCTs for inclusion (**Table 7**).[81] All seven RCTs that focused on the postoperative outcome of SEMS and emergency surgery were included in this meta-analysis. The mean technical success rate of colonic stent placement was 76.9% (range 46.7%–100%).[81] There was no statistically significant difference in the postoperative mortality comparing SEMS as bridge to surgery (10.7%) and emergency surgery (12.4%).[81] The meta-analysis showed the SEMS group had lower overall morbidity (33.1% vs. 53.9%, $P = 0.03$), a higher successful primary anastomosis rate (67.2% vs. 55.1%, $P < 0.01$), and lower permanent stoma rate (9% vs. 27.4%, $P < 0.01$).[81]

No clear conclusions may be drawn about differences in costs between the two procedures. In the two RCTs that compared costs between SEMS as bridge to surgery and emergency surgery, stenting seems to be the more costly strategy.[91,92] Cost–effectiveness depends on the rate of stent complications, in particular perforation, and a greater benefit of stenting is expected in high risk surgical patients.[94]

From the above data, some advantages of SEMS as a bridge to surgery can be extracted. However, this has to be balanced with the oncological outcomes in patients with a curable colonic cancer. Potential concerns have been raised about impaired oncological outcome after SEMS placement in the patient with potentially curable colon cancer, particularly following stent perforation. Long-term oncological outcome comparing SEMS as a bridge to elective surgery versus acute resection was analyzed by three RCTs (**Table 8**).[90,92,95] Although the study groups were small, with 15 to 26 patients in the stent arms, all three report higher disease recurrence rates in the SEMS group. This did not translate into a worse overall survival in any of these RCTs, but this may be related to short follow-up and small sample sizes.[90,92,95] These results are further supported by a larger comparative prospective cohort study showing significantly more local disease recurrences in the stent group compared with the primary surgery group in patients ≤75 years of age.[96] However, no difference in survival was seen between the two groups. One retrospective analysis reported a significantly lower 5-

TABLE 8. Oncological outcome of self-expandable metal stent (SEMS) placement

First author, year	Study population	Results	Study design Level of evidence
Sloothaak, 2013[95,*]	Patients with acute left-sided colonic obstruction, proven malignancy, and curable disease Preoperative SEMS (n = 26) Emergency surgery (n = 32)	Median follow-up: - SEMS as bridge to surgery: 36 months (IQR 34-49) - Emergency surgery: 38 months (IQR 18-44) 5-year overall recurrence rate ($P = 0.027$): - SEMS as bridge to surgery: 42% (11/26) - Emergency surgery: 25% (8/32) Locoregional recurrence rate ($P = 0.052$): - SEMS as bridge to surgery: 19% (5/26) - Surgery: 9% (3/32) Cumulative incidence of overall recurrences ($P < 0.01$): - Patients with stent-perforation: 83% (95%CI 58%-100%) - Non-perforated stent patients: 34% (95%CI 18%-65%) - Emergency surgery: 26% (95%CI 14%-47%) 5-year cumulative incidence of locoregional recurrences ($P = 0.053$): - Patients with stent perforation: 50% (95%CI 22%-100%) - Non-perforated stent patients: 10% (95%CI 3%-28%) - Emergency surgery: 11% (95%CI 3%-41%)	Follow-up data of RCT [31] Moderate quality evidence
Tung, 2013[90]	Patients with obstructing left-sided colon cancer Preoperative SEMS (n = 24) Emergency surgery (n = 24)	Median follow-up ($P = 0.083$): - SEMS as bridge to surgery: 65 months (range 18-139) - Emergency surgery: 32 months (range 4-118) Operation with curative intent ($P = 0.01$): - SEMS as bridge to surgery: 91% (22/24) - Emergency surgery: 54% (13/24) Lymph node harvest ($P = 0.005$): - SEMS as bridge to surgery: 23 lymph nodes - Emergency surgery: 11 lymph nodes Overall recurrent disease ($P = 0.4$): - SEMS as bridge to surgery: 50% (11/22) - Emergency surgery: 23% (3/13) 5-year overall survival rate ($P = 0.076$): - SEMS as bridge to surgery: 48% - Emergency surgery: 27% 5-year disease-free survival rate ($P = 0.63$): - SEMS as bridge to surgery: 52% - Emergency surgery: 48%	Follow-up data of RCT [93] Moderate quality evidence

year overall survival and significantly increased cancer-related mortality in the SEMS as bridge-to-surgery group.[97] The use of SEMS and the occurrence of tumor perforation were identified to correlate with worse overall survival. Follow-up data of the Stent-in 2 trial also showed a significantly higher overall recurrence rate in the SEMS group compared with the surgery group (42% vs. 25%), which was even higher in the subgroup of patients who experienced stent-related perforation (83%).[95]

The oncological risks of SEMS should be balanced against the operative risks of emergency surgery. Because there is no reduction in postoperative mortality and stenting seems to impact on the oncological safety, the use of SEMS as a bridge to elective surgery is not recommended as a standard treatment for potentially curable patients with left-sided malignant colonic obstruction. However, placement of SEMS may be considered an alternative option in patients at high surgical risk. The known risk factors

TABLE 8. Continued

First author, year	Study population	Results	Study design Level of evidence
Alcantara, 2011[92]	Patients with complete intestinal obstruction due to tumor in the left colon SEMS as bridge to surgery (n = 15) Intraoperative colonic lavage with primary anastomosis (n = 13)	Overall mean follow-up: 37.6 months No difference in overall survival ($P = 0.843$) Disease-free period ($P = 0.096$): - SEMS as bridge to surgery: 25.5 months - Emergency surgery: 27.1 months Tumor reappearance ($P = 0.055$): - SEMS as bridge to surgery: 53% (8/15) - Emergency surgery: 15% (2/13)	RCT Moderate quality evidence
Gorissen, 2013[96]	Patients with obstructing left-sided colonic cancer Preoperative SEMS (n = 62) Emergency surgery (n = 43)	Median follow-up ($P = 0.294$) - SEMS as bridge to surgery: 2.7 years - Emergency surgery: 2.8 years Local recurrence rate ($P = 0.443$): - SEMS as bridge to surgery: 23% (14/60) - Emergency surgery: 15% (6/39) Distant metastasis ($P = 1.000$): - SEMS as bridge to surgery: 27% (16/60) - Emergency surgery: 26% (10/39) Overall recurrence ($P = 0.824$): - SEMS as bridge to surgery: 32% (19/60) - Emergency surgery: 28% (11/39) Overall mortality ($P = 0.215$): - SEMS as bridge to surgery: 29% (18/62) - Emergency surgery: 44% (19/43) Cancer-specific mortality ($P = 0.180$): - SEMS as bridge to surgery: 24% (15/62) - Emergency surgery: 37% (16/43) Local recurrence rate in patients $\leq$ 75 years ($P = 0.038$): - SEMS as bridge to surgery: 32% - Emergency surgery: 8%	Prospective cohort study Moderate quality evidence
Sabbagh, 2013[97]	Patients operated on for left-sided malignant colonic obstruction with curative intent Preoperative SEMS (n = 48) Emergency surgery (n = 39)	Mean follow-up ($P = 0.21$): - SEMS as bridge to surgery: 28 months - Emergency surgery: 32 months 5-year overall survival rate ($P < 0.001$): - SEMS as bridge to surgery: 25% - Emergency surgery: 62% 5-year cancer-specific mortality ($P = 0.02$): - SEMS as bridge to surgery: 48% - Emergency surgery: 21% 5-year disease-free survival ($P = 0.24$): - SEMS as bridge to surgery: 22% - Emergency surgery: 32% Overall recurrence rate ($P = 0.18$): - SEMS as bridge to surgery: 33% - Emergency surgery: 20% Mean time to recurrence ($P = 0.92$): - SEMS as bridge to surgery: 16 months - Emergency surgery: 23 months In multivariate analysis SEMS (HR 2.42, 95%CI 1.13-5.18) and tumor perforation (HR 5.96, 95%CI 1.70-20.95) were associated with overall survival	Retrospective intention-to-treat analysis Low quality evidence

CI, Confidence interval; *HR*, hazard ratio; *IQR*, interquartile range; *RCT*, randomized controlled trial.
*Published in abstract form.

TABLE 9. Meta-analyses of palliative self-expandable metal stent (SEMS) placement

First author, year	Study population	Results	Study type Level of evidence
Liang, 2014[104]	Patients with malignant colorectal obstruction caused by advanced malignancy 3 RCTs 2 Prospective 4 Retrospective Palliative SEMS (n = 195) Emergency surgery (n = 215)	Major stent-related complications: - Short-term (<30 days) perforation rate: 3.7% - Long-term (≥30 days) perforation rate: 7.6% - Overall stent migration rate: 8.9% - Re-obstruction: not analyzed. Successful relief of obstruction: - Palliative SEMS: 94% - Surgery: 100% Short-term (<30 days) complication rate (P = 0.22): - Palliative SEMS: 26.2% (51/195) - Surgery: 34.5% (74/215) - OR 0.83 (95%CI 0.39-1.79) Long-term (≥30 days) complication rate (P = 0.03): - Palliative SEMS: 16.1% (25/155) - Surgery: 8.1% (14/173) - OR 2.34 (95%CI 1.07-5.14) Overall complication rate (P = 0.56): - Palliative SEMS: 43.9% (68/155) - Surgery: 45.1% (78/173) - OR 1.27 (95%CI 0.58-2.77) Overall mortality rate (P = 0.22): - Palliative SEMS: 7.1% (12/169) - Surgery: 11.6% (22/189) - OR 0.60 (95%CI 0.27-1.34) SEMS required significantly shorter hospitalization: weighted mean difference -6.07 days (95%CL -8.40, -3.74); P < 0.01	Systematic reviews and meta-analysis of comparative studies High quality evidence

associated with adverse outcomes following elective as well as emergency surgery in colorectal cancer are increasing age and an ASA score ≥III.[3,17–19,98,99] Therefore, the use of SEMS as a bridge to elective surgery may be considered an acceptable alternative treatment option in patients older than 70 years and/or with an ASA score ≥III.[100]

A time interval to operation of 5–10 days is suggested when SEMS is used as a bridge to elective surgery in patients with potentially curable left-sided colon cancer (weak recommendation, low quality evidence).

There are limited data to determine an optimal time interval to operation following stent placement as a bridge to surgery. Theoretically, a longer interval (>1 week) will allow for better recovery and more nearly optimal nutritional status, but this may increase the risk of stent-related complications and may compromise surgery by more local tumor infiltration and fibrosis. Therefore we suggest a 5- to 10-day interval between SEMS and elective resection. Data from the abstract of one RCT (n = 49) published in Chinese, which compared laparoscopic resection 3 and 10 days after stent placement, reported a significantly higher primary anastomosis rate and a lower conversion rate to open procedure when surgery was deferred until 10 days after stenting.[101] A retrospective analysis revealed an anastomotic leakage rate of 20% (3/15) for an interval of 1 to 9 days and 0% (0/28) when surgery was delayed for 10 days or longer (P = 0.037).[102] A published abstract comparing resection within 7 days (n = 26) and after 7 days (n = 30) of stent placement, found no differences in the postoperative morbidity and mortality.[103] In the literature, a median time interval to surgery of 10 days is a common practice considering the patient's clinical condition, potential risk of stent-related complications, and impact on oncological outcomes.[84]

Clinical indication: palliative SEMS placement (**Table e4**, available online at www.giejournal.org)

SEMS placement is the preferred treatment for palliation of malignant colonic obstruction (strong recommendation, high quality evidence).

Two meta-analyses, including randomized and non-randomized comparative studies, have compared SEMS (n = 195 and n = 404) and surgery (n = 215 and n = 433) for palliation of malignant colonic obstruction

TABLE 9. Continued

First author, year	Study population	Results	Study type Level of evidence
Zhao, 2013[105]	Patients with malignant colorectal obstruction that was unresectable 3 RCTs 5 Prospective 4 Retrospective 1 Case-matched Palliative SEMS (n = 404) Palliative surgery (n = 433)	Mean length of hospital stay ($P < 0.001$): - Palliative SEMS: 9.6 days - Surgery: 18.8 days, ICU admission rate ($P = 0.001$): - Palliative SEMS: 0.8% (1/119) - Surgery: 18.0% (22/122) - RR 0.09 (95%CI 0.02-0.38); $I^2 = 0\%$ Mean interval to chemotherapy: - Palliative SEMS: 15.5 days - Surgery: 33.4 days Clinical relief of obstruction ($P < 0.001$): - Palliative SEMS: 93.1% (375/403) - Surgery: 99.8% (433/434) - RR 0.96 (95%CI 0.93-0.98); $I^2 = 3\%$ In-hospital mortality rate ($P = 0.01$): - Palliative SEMS: 4.2% (14/334) - Surgery: 10.5% (37/354) - RR 0.46 (95%CI 0.25-0.85); $I^2 = 0\%$ Overall complication rate ($P = 0.60$): - Palliative SEMS: 34.0% (137/403) - Surgery: 38.1% (172/452) - RR 0.91 (95%CI 0.64-1.29); $I^2 = 66\%$ Early complication rate ($P = 0.03$): - Palliative SEMS: 13.7% (41/300) - Surgery: 33.7% (110/326) - RR 0.45 (95%CI 0.22-0.92); $I^2 = 66\%$ Late complication rate ($P < 0.001$): - Palliative SEMS: 32.3% (60/186) - Surgery: 12.7% (27/213) - RR 2.33 (95%CI 1.55-3.50); $I^2 = 0\%$ Stent complications: - Perforation rate: 10.1% - Stent migration: 9.2% - Stent obstruction: 18.3% Overall survival time (P = n.s.): - Palliative SEMS: 7.6 months - Surgery: 7.9 months Stoma formation rate ($P < 0.001$): - Palliative SEMS: 12.7% (38/299) - Surgery: 54.0% (170/315) - RR 0.26 (95%CI 0.18-0.37); $I^2 = 18\%$	Systematic review and meta-analysis of comparative studies High quality evidence

CI, Confidence interval; *CL*, confidence limits; *ICU*, intensive care unit; *n.s.*, not significant; *OR*, odds ratio; *RCT*, randomized controlled trial; *RR*, risk ratio.

(**Table 9**).[104,105] The technical success of stent placement in the studies included ranged from 88% to 100%,[6,106] while the initial clinical relief of obstruction was significantly higher after palliative surgery (100%) compared with stent placement (93%; $P < 0.001$).[104,105]

Both meta-analyses showed a lower 30-day mortality rate for SEMS, but it was significant only in the larger meta-analysis (4% vs. 11%, SEMS vs. surgery, respectively).[105] Placement of a SEMS was significantly associated with a shorter hospitalization (10 vs. 19 days) and a lower intensive care unit (ICU) admission rate (0.8% vs. 18.0%),[104,105] while permitting a shorter time to initiation of chemotherapy (16 vs. 33 days).[105,107] Surgical stoma formation was significantly lower after palliative SEMS compared with emergency surgery (13% vs. 54%).[105]

The larger meta-analysis showed no significant difference in overall morbidity between the stent group (34%) and the surgery group (38%).[105] Short-term complications did occur more often in the palliative surgery group, while late complications were more frequent in the SEMS group. Stent-related complications mainly included colonic perforation (10%), stent migration (9%) and re-obstruction (18%).[105]

The aforementioned results are supported by other recently published literature, including one RCT that was not included in the meta-analyses.[11,55,108–114]

There are insufficient data regarding the outcome of stent placement in patients with peritoneal carcinomatosis (**Table e1(a)**, available online at www.giejournal.org). One large retrospective study showed a significantly lower technical success rate in patients with carcinomatosis compared with patients without carcinomatosis (83% vs. 93%).[8] Another series, that focused on the outcomes of secondary SEMS insertion after initial stent failure, reported a significantly decreased stent patency in the setting of carcinomatosis (118 days vs. 361 days).[115] Despite the lower probability of success, SEMS placement may be an alternative to surgical decompression in the setting of peritoneal carcinomatosis. However, there is a lack of evidence to underpin a definite recommendation on this topic.

Patients who have undergone palliative stenting can be safely treated with chemotherapy without antiangiogenic agents (strong recommendation, low quality evidence). Given the high risk of colonic perforation, it is not recommended to use SEMS as palliative decompression if a patient is being treated or considered for treatment with antiangiogenic therapy (e.g. bevacizumab) (strong recommendation, low quality evidence).

It has been speculated that chemotherapy during stenting might induce stent-related complications, in particular perforation. Several retrospective series reported an increased risk of stent perforation (17%–50%) in patients treated with bevacizumab, an angiogenesis inhibitor.[15,55,116] A meta-analysis, searching for risk factors of stent perforation in a heterogeneous population, found a significantly increased perforation rate in patients receiving bevacizumab (12.5%) compared with patients who received no concomitant therapy during colorectal stenting (9.0%), while chemotherapy without bevacizumab was not associated with an increased risk of stent perforation (7.0%).[51] Despite the lack of evidence, an increased perforation risk can reasonably be extrapolated to the newer antiangiogenic agents, aflibercept and regorafenib, because of the similar therapeutic mechanism. Therefore, SEMS placement is strongly discouraged for patients who are being treated or considered for further treatment with antiangiogenic drugs.

Low quality published evidence showed contradictory results regarding the outcome of stenting during chemotherapy.[8,11,117] Nevertheless, no clear increase in adverse events has been observed with colonic stenting. Palliative chemotherapy in patients with a colonic stent is associated with prolonged survival,[76,118] and might therefore result in more patients being exposed to the risk of late stent complications. Suspicion of an association between chemotherapy and the occurrence of stent migration due to tumor shrinkage is prompted by several retrospective series.[43,119,120]

Long-term stent complications are not automatically an argument in favor of palliative surgery. The lower short-term mortality and the early start of chemotherapy because of SEMS should not be disregarded.

Adverse events related to colonic stenting (**Table e5**, available online at www.giejournal.org)

When stent obstruction or migration occurs in the palliative setting, endoscopic re-intervention by stent-in-stent placement or SEMS replacement is suggested (weak recommendation, low quality evidence). Surgery should always be considered in patients with stent-related perforation (strong recommendation, low quality evidence).

Colonic SEMS placement in patients with malignant large-bowel obstruction is associated with potential adverse events. However, the 30-day stent-related mortality rate is less than 4%.[11,12,105] Median stent patency in the palliative setting ranges widely between 55 days and 343 days.[58,59] One systematic review published in 2007 found a median stent patency of 106 days (range 68–288 days) in the palliative stent population.[121] Around 80% (range 53%–90%) of patients maintain stent patency until death or end of follow-up.[48,55,109,113,117,122] In the bridge-to-surgery setting, stent patency is maintained until surgery in the large majority of patients.

Adverse events related to colonic stent placement are usually divided into early ($\leq$30 days) and late ($>$30 days). The main early complications are perforation (range 0%–12.8%), stent failure after technically successful stent deployment (range 0%–11.7%), stent migration (range 0%–4.9%), re-obstruction (range 0%–4.9%), pain (range 0%–7.4%), and bleeding (range 0%–3.7%).[8,12,31,109] Late adverse events related to SEMS mainly include re-obstruction (range 4.0%–22.9%) and stent migration (range 1.0%–12.5%), and more rarely perforation (range 0%–4.0%),[8,11,105,109,113,117,122] although one RCT reported late perforations in 4 out of 10 stent patients.[123] Other SEMS complications reported less frequently in the literature are tenesmus (up to 22%, related to rectal SEMS), incontinence, and fistula.[16,109,112,122]

Stent-related perforation may result from different causes which can be classified as proposed by Baron et al.: (i) guidewire or catheter malpositioning; (ii) dilation of the stricture before or after stent placement; (iii) stent-induced perforation (tumor and nontumor local perforation); and (iv) proximal colonic distension because of inadequate colonic decompression or excessive air insufflation.[57] The final outcome of stent perforation has been inconsistently reported in the literature, although a perforation-related mortality rate of 50% is observed in a number of prospective and retrospective studies.[11,55,120,123] Furthermore, there are strong indications that perforation compromises the oncological outcome in patients with colorectal cancer.[95,97,124] Concurrent bevacizumab therapy, intraprocedural and post-stenting stricture dilation, and diverticular strictures were identified by several studies as risk factors for stent-related perforation.[12,15,33,47,51,55]

Stent migration can occur at any time following colonic stenting. Factors that have been identified to correlate with the occurrence of migration are use of covered SEMS and of small-diameter (<24 mm) stents,[15,52,54,55] and there is some evidence that chemotherapy may also be associated with stent migration by the mechanism of tumor shrinkage.[43,119,120]

Tumor ingrowth/overgrowth is the main cause of stent re-obstruction and usually occurs during the long-term course of stent therapy. The use of uncovered SEMS is a risk factor for tumor ingrowth.[52] One retrospective series focusing on predictive factors of stent occlusion found that <70% stent expansion within the first 48 hours is also predictive for the occurrence of re-obstruction.[125]

Both migration and re-obstruction can be managed endoscopically. Stent replacement and stent reopening by a stent-in-stent have been reported as first choice in the majority of papers, with satisfactory results (clinical success 75%–86%),[114,115] even though the long-term outcome of second stenting or other endoscopic maneuvers is rarely and poorly reported.[11,15,48,76,109,110,112]

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Abbreviations: ASA, American Society of Anesthesiologists; ASGE, American Society for Gastrointestinal Endoscopy; CT, computed tomography; CTC, computed tomography colonoscopy; ESGE, European Society of Gastrointestinal Endoscopy; GRADE, Grading of Recommendations Assessment, Development, and Evaluation system; ICU, intensive care unit; OR, odds ratio; OTW, over-the-guidewire technique; RCT, randomized controlled trial; SEMS, self-expandable metal stents..

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Jeanin E. van Hooft[1]
Emo E. van Halsema[1]
Geoffroy Vanbiervliet[2]
Regina G. H. Beets-Tan[3]
John M. DeWitt[4]
Fergal Donnellan[5]
Jean-Marc Dumonceau[6]
Robert G. T. Glynne-Jones[7]
Cesare Hassan[8]
Javier Jiménez-Perez[9]
Søren Meisner[10]
V. Raman Muthusamy[11]
Michael C. Parker[12]
Jean-Marc Regimbeau[13]
Charles Sabbagh[13]
Jayesh Sagar[14]
Pieter J. Tanis[15]
Jo Vandervoort[16]
George J. Webster[17]
Gianpiero Manes[18]
Marc A. Barthet[19]
Alessandro Repici[20]

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Current affiliations: Department of Gastroenterology and Hepatology, Academic Medical Center, Amsterdam, The Netherlands (1), Centre Hospitalier Universitaire de l'Archet, Pôle digestif, Nice, France (2), Department of Radiology, Maastricht University Medical Center, The Netherlands (3), Department of Gastroenterology and Hepatology, Indiana University Medical Center, Indianapolis, Indiana, USA (4), UBC Division of Gastroenterology, Vancouver General Hospital, Vancouver, Canada (5), Gedyt Endoscopy Center, Buenos Aires, Argentina (6), Mount Vernon Cancer Centre, Northwood, Middlesex, United Kingdom (7), Digestive Endoscopy Unit, Catholic University, Rome, Italy (8), Endoscopy Unit, Gastroenterology Department, Complejo Hospitalario de Navarra, Pamplona, Spain (9), Endoscopy Unit, Digestive Disease Center, Bispebjerg University Hospital, Copenhagen, Denmark (10), Division of Gastroenterology and Hepatology, David Geffen School of Medicine at University of California Los Angeles, Los Angeles, California, USA (11), Royal College of Surgeons of England, London, United Kingdom (12), Department of Digestive and Oncological Surgery, University Hospital of Amiens, France (13), Department of Colorectal Surgery, Royal Surrey County Hospital, Guildford, United Kingdom (14), Department of Surgery, Academic Medical Center, Amsterdam, The Netherlands (15), Department of Gastroenterology, Onze-Lieve-Vrouwziekenhuis, Aalst, Belgium (16), Department of Gastroenterology, University College Hospital, London, United Kingdom (17), Department of Gastroenterology and Endoscopy, Guido Salvini Hospital, Garbagnate Milanese/Rho, Milan, Italy (18), Department of Gastroenterology, Hôpital Nord, Aix Marseille Université, Marseille, France (19), Digestive Endoscopy Unit, Istituto Clinico Humanitas, Milan, Italy (20).

Reprint requests: Jeanin E. van Hooft, MD, PhD, Department of Gastroenterology and Hepatology, C2-116, Academic Medical Center, Meibergdreef 9, 1105 AZ, Amsterdam, The Netherlands.

Appendix e1 Self-expandable metal stents (SEMSs) for obstructing colonic and extracolonic cancer: key questions and task force subgroups.

Topics and key questions	Task forces (leads in bold)
1. The stent placement procedure: general considerations	
1a What are the radiographic, endoscopic, and clinical criteria of a colorectal obstruction suitable for stent placement? 1b Pathological confirmation required? – Is there a difference in safety and efficacy between colorectal stent placement in malignant versus benign strictures? – How many patients presenting with acute colorectal obstruction have a benign disease? – How to diagnose a malignancy in patients presenting with acute colorectal obstruction?	Regina Beets-Tan Fergal Donnellan **Gianpiero Manes** Michael Parker Jo Vandervoort
1c Patient characteristics – Is stent placement in the elderly associated with a worse outcome? Is there a difference in outcome between a palliative or curative intent in the elderly? – Does patient's performance status (WHO) influence the outcome of stent therapy? Is there a difference in outcome between a palliative or curative intent with regard to performance status?	
1d Preferred preparation? – What is the optimal workup of patients undergoing colorectal stent placement: radiographic imaging, bowel preparation? – Is antiobiotic prophylaxis indicated? In other words, what is the risk of post-procedural infections?	
1e By whom? – Is there a difference in technical and clinical success rate between purely fluoroscopic, purely endoscopic, or combined stent placement? – Does operator experience influence the success rate of stent placement? If relevant, what should be the level of experience of an operator for performing colorectal stent placement? – Can the effect of a learning curve be observed in terms of a better technical and clinical outcome of stent placement? – Should a training be followed before an operator is allowed to perform colorectal stent placement? What should this training look like?	Regina Beets-Tan **Fergal Donnellan** Gianpiero Manes Michael Parker Alessandro Repici
1f Patient monitoring? – How should patients be monitored during and post stent placement? – Is there an increased risk of aspiration in patients presenting with an ileus?	
1g Synchronous strictures? – What is the incidence of a synchronous, second stricture which causes the primary stent placement to be ineffective? – How to check for synchronous lesions?	
2. The stent placement procedure: technical considerations	
2a Stent choice? – Is there a difference in technical and clinical success rate between stent placement over the wire or through the scope? – How to determine optimal stent length and diameter? – Are there stents specifically designed for certain characteristics of the stenosis: tortuous anatomy, proximal colon? – Is there a difference in technical and clinical outcome between the use of covered vs. uncovered stents? – Is there a difference in outcome (safety and efficacy) between the available stent designs?	**Marc Barthet** Gianpiero Manes Søren Meisner **Geoffroy Vanbiervliet** George Webster
2b Stricture dilation? – Is stricture dilation during the stent placement procedure contraindicated? – When to consider stricture dilation?	
2c Stricture characteristics – Is there a difference in safety and efficacy between colorectal stent placement in malignant versus benign strictures? – Is there a difference in outcome (safety and efficacy) between stenting the right versus left colon? – Does an extracolonic malignancy influence the outcome (safety and efficacy) of stent placement? – Does stricture length influence the technical and clinical outcome of stent placement? – Is stenting of incomplete strictures as effective as stenting complete obstructions?	**Marc Barthet** Gianpiero Manes Søren Meisner Jean-Marc Regimbeau Charles Sabbagh **Geoffroy Vanbiervliet**

Topics and key questions	Task forces (leads in bold)
3. Clinical indications	
3a Does stent placement followed by elective surgery (stent as bridge to surgery) improve clinical outcome measurements compared with emergency surgery: – clinical and technical success? – morbidity (including anastomotic leaks, wound infections) and mortality? – survival? – hospital stay? – one-stage surgery/stoma rate? – quality of life? – costs? – What should be the interval between stent placement and resection regarding patient's clinical condition or oncological outcome? – Are there advantages for a subgroup of patients, e.g. poor performance status, high age?	Robert Glynne-Jones Javier Jiménez-Pérez Gianpiero Manes **Jayesh Sagar** Pieter Tanis
3b Does colonic stenting in palliation of malignant colonic obstruction improve clinical outcome measurements compared with palliative surgery: – clinical and technical success? – morbidity (including anastomotic leaks, wound infections) and mortality? – survival? – hospital stay? – one-stage surgery/stoma rate? – quality of life? – costs? – Are there advantages for a subgroup of patients, e.g. poor performance status, high age?	Marc Barthet Robert Glynne-Jones **Michael Parker** Jayesh Sagar Geoffroy Vanbiervliet Jo Vandervoort
4. Oncological perspective	
4a Do stents influence the oncological outcome (local recurrence rate, metastatic disease) in a curative setting? 4b Does stent perforation influence the oncological outcome (local recurrence rate, metastatic disease)? – Are these consequences different for guidewire perforations, clinical perforations during stent placement, clinical perforations after stent placement, and occult perforations? 4c What is the safety of chemotherapy during stent therapy? 4d What is the safety of bevacizumab-based chemotherapy during stent therapy?	Robert Glynne-Jones Jean-Marc Regimbeau Charles Sabbagh **Pieter Tanis** Jo Vandervoort George Webster
5. Adverse events related to colonic stenting	
5a What are the adverse events related to colorectal stenting and what is their incidence? 5b What is the mean/median stent patency? 5c How should adverse events (migration, occlusion, malfunction, perforation) be treated? 5d What factors influence the occurrence of adverse events?	Fergal Donnellan Jean-Marc Regimbeau **Alessandro Repici** Charles Sabbagh George Webster

WHO, World Health Organization

Appendix e2 Evidence tables. Self-expandable metal stents (SEMSs) for obstructing colonic and extracolonic cancer: European Society of Gastrointestinal Endoscopy (ESGE) Guideline

TABLE E1. (a–h) General considerations before stent placement

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(a) Outcomes of SEMS placement in patients with peritoneal carcinomatosis and in the rectum.						
Choi, 2013 [13]	Retrospective	Colorectal SEMS placement Niti-S, Hanarostent, Choostent, Bonastent Covered 27% Uncovered 73%	Patients with malignant colorectal obstruction (n = 152) – Palliative SEMS placement (n = 83) – SEMS as bridge to surgery (n = 69)	Clinical effectiveness, complications, and risk factors associated with the complications of SEMS placement	Univariate analysis of risk factors for complications: – Carcinomatosis peritonei (P = 0.009):Yes: 56.5%No: 27.9% Multivariate analysis of risk factors for complications: – Carcinomatosis peritonei: OR 2.0 (95%CI 0.70–5.72); P = 0.198	Low
Kim JH, 2013 [9]	Retrospective	Palliative SEMS placement Comvi stent, Niti-S stent	Patients with malignant colorectal obstruction by a noncolonic malignancy with peritoneal carcinomatosis (n = 20)	Survival and long-term clinical outcome of SEMS	Technical success rate: 90% Clinical success rate: 85% Overall clinical success: 50% Surgical intervention: 45% Mean event-free survival: 119 days Overall survival: 156 days	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered, Comvi stent, WallFlex, Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS placement (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Technical success rate for: – Carcinomatosis, no vs. yes: 93% vs. 83% (OR 2.83; P = 0.019) – Age, <70 vs. ≥70 years: 86% vs. 89.2% (P = 0.477) Immediate clinical success rate for: – Carcinomatosis, no vs. yes: 84.5% vs. 83.2% (P = 0.986) – Age, <60 vs. ≥60 years: 83% vs. 84.3% (P = 0.790)	Low
Yoon, 2011 [115]	Retrospective	Secondary SEMS placement as stent-in-stent Niti-S covered, Comvi covered, WallFlex uncovered, Niti-S D-type uncovered	Patients who underwent secondary SEMS because of the recurrence of obstructive symptoms (n = 36)	Immediate and long-term clinical success and complications	Immediate clinical success rate for: – Carcinomatosis (P = 0.062):Presence: 63.6% Absence: 92.9% Median duration of stent patency for: – Carcinomatosis (P = 0.004):Presence: 118 day-sAbsence: 361 days Predictive factors for complications: – Carcinomatosis (P = 0.467):Presence: 21.4% Absence: 36.4%	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Song, 2008 [10]	Retrospective	SEMS placement Fully covered Stentech, Fully covered Taewoong, Dual stent	Patients with malignant rectal obstruction – <5 cm from anal verge (n = 16) – >5 cm from anal verge (n = 14)	Technical feasibility, clinical effectiveness and safety of SEMS	Overall technical success rate: 100% Complications of SEMS <5 cm vs. >5 cm of the anal verge: – Pain: 63% vs. 14% ($P = 0.011$) – Incontinence: 13% vs. 0% ($P = 0.485$) – Migration: 6% vs. 21% ($P = 0.315$) – Incomplete stent expansion: 13% vs. 7% ($P = 1.0$) – Perforation: 6% vs. 7% ($P = 1.0$) – Tumor ingrowth: 0% vs. 7% ($P = 0.467$) – Hematochezia: 6% vs. 0% ($P = 1.0$) Multivariate analysis: – Clinical success of SEMS <5 cm of anal verge: OR 0.54; $P = 0.641$ – Pain of SEMS <5 cm: OR 24.30; $P = 0.008$	Low
(b) Outcome of SEMS placement according to age and American Society of Anesthesiologists (ASA) classification.						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent, Taewoong, Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Technical success rate: 97.3% Clinical success rate: 95.8% Overall complication rate: 39.7% Overall re-intervention rate: 30.8% – Endoscopic: 18.5% – Surgical: 14.4% Predictors of early complications: – Age: OR 1.03; $P = 0.545$ – ASA III–IV: OR 0.88; $P = 0.834$ Predictors of late complications: – Age: OR 1.01; $P = 0.972$ – ASA III–IV: OR 0.94; $P = 0.906$ Predictors of endoscopic re-intervention: – Age: OR 1.02; $P = 0.075$ – ASA III–IV: OR 1.29; $P = 0.628$ Predictors of surgical treatment: – Age: OR 0.98; $P = 0.543$ – ASA III–IV: OR 1.13; $P = 0.847$	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Geraghty, 2014 [16]	Retrospective	Colonic stenting for large-bowel obstruction	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264) – CRC bridge to surgery (n = 52) – Benign (n = 9) – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Factors related to technical success: – Age <70 vs. ≥70 years: 89.2% vs. 86.3% (P = 0.428) – ASA I–II vs. ASA III–V: 85% vs. 87.8% (P = 0.491) Factors related to clinical success: – Age <70 vs. ≥70 years: 88.9% vs. 82.7% (OR 1.83; P = 0.098) – ASA III–V vs. ASA I–II: 80% vs. 90.3% (OR 0.43; P = 0.041)	Low
Choi, 2013 [13]	Retrospective	Colorectal SEMS placement Niti-S Hanarostent Choostent Bonastent Covered 27% Uncovered 73%	Patients with malignant colorectal obstruction (n = 152) – Palliative SEMS placement (n = 83) – SEMS as bridge to surgery (n = 69)	Clinical effectiveness, complications and risk factors associated with the complications of SEMS placement	Univariate analysis of risk factors for complications: – Mean age for complications vs. no complications: 66 vs. 70 years (P = 0.235) – Complication rate for ASA I, II and III: 24.2%, 34.3% and 34.8%, respectively (P = 0.556)	Low
Meisner, 2011 [12]	Prospective cohort	WallFlex Colonic stent placement	Patients with malignant colonic obstruction (n = 463) – Palliative SEMS placement (n = 255) – SEMS as bridge to surgery (n = 182) – Indication not specified (n = 10)	Performance, safety and effectiveness of colorectal stents	Procedural success rate for ASA I–II vs. ASA ≥III: 98.1% vs. 98.1% (P = 1.000) 30-day clinical success rate for ASA I–II vs. ASA ≥III: 92.1% vs. 87.4% (P = 0.162) Overall complication rate for ASA I–II vs. ASA ≥III: 11.4% vs. 11.5% (P = 0.987)	Moderate
Donnellan, 2010 [14]	Retrospective	Uncovered Wallstent insertion	Patients with malignant colorectal obstruction – ≥70 years (n = 24) – <70 years (n = 19)	Success rate, complications and mortality of SEMS insertion	Older versus younger group – Successful stent placement: 88% vs. 100% (P = n.s.) – Overall complications: 12.5% vs. 26% (P = n.s.) – 30-day mortality: 22% vs. 13% (P = n.s.) – Median survival: 112.5 vs. 134.5 days (P = 0.09)	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex, Wallstent, WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Major complication rate for age ≤65 vs. >65 years: 25.9% vs. 22.2% (P = 0.259)	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(c) Computed tomography (CT) scan for the diagnosis of colonic obstruction.						
Frager, 1998 [20]	Prospective	CT scan with oral contrast; Dynamic/spiral technique (n = 40) Intravenous contrast (n = 56) Rectal air insufflation (n = 2)	Patients with suspected colonic obstruction (n = 75) Outcomes of CT were compared with: – Surgery/endoscopy (n = 65) – Clinical course (n = 9) – Contrast enema (n = 1)	Diagnostic capabilities and limitations of CT in diagnosing colonic obstruction	Sensitivity: 96% (45/47) Specificity: 93% (26/28) Correct pathologic diagnosis: 81% (38/47) Correct localization of obstruction: 94% (44/47) CT was more sensitive ($P = 0.045$), more accurate ($P = 0.047$), and had a better negative predictive value ($P = 0.0004$) than contrast enema	Low
(d) Preoperative detection of synchronous colorectal cancer.						
Lim, 2013 [27]	Prospective	Preoperative colonoscopy after SEMS insertion in patients with a resectable cancer Bonastent covered, Niti-S uncovered	Patients with malignant colorectal obstruction (n = 73) SEMS as bridge to surgery (n = 45)	Success rate of complete colonoscopy after stent placement	Complete preoperative colonoscopy: 88.9% (40/45) Complete colonoscopy for uncovered vs. covered SEMS: 96% vs. 80% ($P = 0.154$) The colonoscope was not damaged mechanically by passage through the stent Bowel preparation: – Excellent 17.8% – Good 55.5% – Fair 26.7% Synchronous lesions: – Adenomas 42.2% – Intramucosal carcinoma 2.2% Stent migration due to: – Colonoscopy 7% (3/45) – Bowel preparation 2% (1/45)	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Park SH, 2012 [25]	Retrospective	CT colonography (CTC) with intravenous contrast after failed colonoscopy of the proximal colon past a newly diagnosed advanced colorectal cancer	Patients with advanced colorectal cancer without an acutely severe colonic obstruction requiring immediate colonic decompression (n = 411) Pathological specimen and/or postoperative colonoscopy with pathological confirmation of proximal lesions as reference (n = 284)	Performance measures of CTC for detecting and characterizing synchronous lesions proximal to a stenosing colorectal cancer	Patients with positive findings on CTC (lesion ≥6 mm in proximal colon): 31.7% Per-patient sensitivity for detection in the proximal colon: – Cancer 100% (6/6) – Advanced neoplasia 88.6% (39/44) Per-patient negative predictive value (NPV) – Cancer 100% (194/194) and – Advanced neoplasia 97.4% (189/194) Per-lesion sensitivity for detecting cancer 100% (8/8) CTC missed: – Advanced adenomas 22.8% (13/57) – Non-advanced adenomas 34.2% (25/73) – Non-neoplastic lesions 57.1% (8/14) False-positive lesions found by CTC: 32.5% (51/157) Per-lesion positive predictive value (PPV) for all histological types of lesion: 67.5% (106/157) Per-lesion, for cancer with lesion size criterion of ≥15 mm on CTC: – Sensitivity 87.5% (7/8) – PPV 70% (7/10)	Moderate

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Cha, 2010 [26]	Retrospective	CT colonography (CTC) after SEMS placement Hercules SP colorectal stent, Niti-S D-type, WallFlex, Comvi stent, Bonastent	Patients successfully treated with SEMS placement for acute colon obstruction caused by pathologically proven colorectal cancer (n = 50) Surgical specimen findings and/or postoperative colonoscopy as a reference standard (n = 31)	Diagnostic performance of CTC for preoperative examination of the proximal colon after metallic stent placement	Examination quality inadequate: 6% 14 lesions ≥6 mm were found proximal to the stent in 10 patients Synchronous lesions: – Cancers 6.5% (2/31) – Adenomatous lesions 29% (9/31) Per-lesion sensitivity for lesions ≥6 mm proximal to stent: 85.7% (12/14) CTC detection of synchronous lesions: – Cancers 100% (2/2) – Advanced adenomas 100% (5/5) CTC missed two sessile tubular adenomas Per-patient sensitivity for lesions ≥6 mm: 90% (9/10) Per-patient specificity for lesions ≥6 mm: 85.7% (18/21); false positive findings n = 3 CTC did not generate any false diagnosis of synchronous cancer No perforation or stent migration was noted in any of the 50 patients	Low
Vitale, 2006 [28]	Prospective	Preoperative colonoscopy after effective stent placement Enteral Wallstent, Ultraflex Precision	Patients with acute neoplastic colon obstruction (n = 57) SEMS as bridge to surgery (n = 31)	Feasibility of a preoperative colonoscopy after stent placement	Complete colonoscopy in resectable patients: 93.5% (29/31) Complications related to colonoscopy: – Minor bleeding at stent site: 16% (5/31) No endoscope mechanical damage was detected Bowel preparation: – Excellent: 35.5% – Good: 48.4% – Fair: 16.1% Results of preoperative colonoscopy: – Synchronous cancer 9.6% (3/31) – Adenomas 25.8% (8/31)	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(e) Stenting for benign colorectal obstruction.						
Currie, 2014 [33]	Systematic review	Endoscopic or fluoroscopic placement of a self-expanding stent	Patients with benign colorectal obstruction (n = 122) 21 case series Diverticulitis 54% Anastomotic stricture 33%	Efficacy and safety of self-expandable stents	Overall success rate: – Technical 94% – Clinical 80% Perforation rate: 12% – In case of diverticulitis: 17% Re-obstruction rate 14% – Stent collapse (n = 10) – Stool impaction (n = 5) Stent migration rate: 20% Diverticulitis patients: – Bridge to surgery: 61% – Stoma avoidance: 42% – Complications: 52%	Moderate
(f) Brush cytology and biopsy for the diagnosis of colorectal cancer.						
Brouwer, 2009 [34]	Retrospective	Brush cytology, endoscopic biopsy, and definitive resection of the colorectal lesion	Patients who had both cytology and biopsy of a colorectal lesion that was then resected and submitted to formal histologic analysis (n = 918)	Results of brush cytology for the diagnosis of colorectal cancer	Brush cytology versus biopsy: – Sensitivity: 88.2% vs. 86.9% (P = 0.485) – Specificity: 94.1% vs. 98.1% (P = 0.065) – PPV: 98.6% vs. 99.5% (P = 0.159) – NPV: 61.9% vs. 60.3% (P = 0.797) – False-positive rate: 0.06% vs. 0.02% (P = 0.160) – False-negative rate: 0.12% vs. 0.13% (P = 0.543) Histology versus combined cytology/biopsy: – Sensitivity: 86.9% vs. 97.4% (P < 0.001) – Specificity: 98.1% vs. 98.7% (P = 1.000) – PPV: 99.5% vs. 99.7% (P = 0.900) – NPV: 60.3% vs. 88.4% (P<0.001) – False-positive rate: 0.02% vs. 0.01% (P = 1.000) – False-negative rate: 0.13% vs. 0.03% (P < 0.001)	Moderate

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Geramizadeh, 2003 [35] *	Description of design missing	Brush cytology and biopsy at the same time	Patients with any colorectal lesion on colonoscopy (n = 72)	Specificity and sensitivity of brush cytology and biopsy	Sensitivity and specificity: Brush cytology: 88% and 98% Biopsy: 96% and 100% Combined cytology and biopsy: sensitivity 100%	Low
Farouk, 1996 [36]	Prospective	Brush biopsy with a cervical smear brush followed by conventional forceps biopsy	Patients seen at rectal outpatient clinic with rectal lesions suspicious of carcinoma (n = 289) Subsequent surgical resection (n = 249)	Assessment of brush cytology as an aid for the diagnosis of rectal cancer	Biopsy versus brush cytology: – True-positive: 88.1% vs. 90.6% – True-negative: 100% vs. 97.8% – False-positive: 0% vs. 0.3% – False-negative: 13.9% vs. 9.4% – Sensitivity: 81% vs. 83% (combined 98%) – Specificity: 100% vs. 90%	Moderate
(g) Risk of bacteremia following colorectal stent placement.						
Chun, 2012 [37]	Prospective	Colorectal stent placement Hanarostent, Bonastent	Patients who underwent colorectal stent insertion (n = 125) Patients analyzed (n = 64) – Colorectal cancer (n = 62) – Metastatic origin (n = 2)	Risk of bacteremia and infectious complications within 48 h after stent insertion	Blood cultures at baseline: all negative Post-procedural positive blood cultures: 6.3% Considered contaminants: 3.1% – Bacteroides fragilis: 1.6% – Escherichia coli: 3.1% – *Klebsiella* spp 1.6% None of the study subjects developed fever in the 48 h after stent placement Median time required for stent placement in patients with transient bacteremia vs. negative blood cultures: 35.5 vs. 16.0 min (P = 0.006)	Moderate

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex, Wallstent, WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Blood cultures drawn ≤2 weeks after stent placement: 13% (30/224) Positive cultures: 3% (7/224) – *Escherichia coli* (n = 4) – *Bacteroides fragilis (n = 1)* – *Clostridium sordellii* (n = 1) – *Staphylococcus aureus* (n = 2) Bacteremia incidence for degree of obstruction (P = 0.38): – Complete obstruction: 20% (2/10) – Subtotal obstruction: 25% (5/20) Minor complications: – Hematochezia: 0.9% (2/224) – Bacteremia/fever: 3.1% (7/224) – Tenesmus: 2.2% (5/224)	Low
(h) Operator experience in colorectal stenting.						
Geraghty, 2014 [16]	Retrospective	Colonic stenting for large-bowel obstruction	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264) – CRC bridge to surgery (n = 52) – Benign (n = 9) – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Multivariate analysis of factors related to technical success: – Experience >10 vs. ≤10 procedures: 88.2% vs. 85.8%; OR 3.34 (95%CI 1.24–9.02); P = 0.001 Multivariate analysis of factors related to clinical success: – Experience >10 vs. ≤10 procedures: 85.7% vs. 83.8%; OR 5.95 (95%CI 1.66–21.28); P = 0.006	Low

TABLE E1. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Lee JH, 2012 [39]	Retrospective	SEMS insertion by one experienced colonoscopist with no experience in ERCP Niti-S covered, Comvi stent, WallFlex, Niti-S D-type	Patients with malignant colorectal obstruction (n = 120)	Assessment of the effectiveness of SEMS insertion by evaluating the learning curve an endoscopist	Outcomes from first to last quartile Technical success rate: 90.0%, 96.7%, 96.7%, and 96.7% (P = 0.263) Clinical success rate: 90.0%, 90.0%, 96.7%, and 83.3% (P = 0.588) Complication rate: 26.7%, 23.3%, 10.0%, and 33.3% (P = 0.184) Number of stents per procedure: 1.13, 1.03, 1.00, and 1.00 (P = 0.029) Median procedure duration significantly decreased from 20.9 to 14.8 minutes after the first 30 procedures (P = 0.005)	Low
Williams, 2011 [38]	Prospective	SEMS placement performed by a single surgeon endoscopist and a consultant radiographer	Patients with acute or subacute large-bowel obstruction (n = 37)	Change in practice over time and the learning curve of a single surgeon endoscopist	Chronological outcome of stenting procedures: Technical success rate: – Procedure 1–11: 82% – Procedure 12–21: 90% – Procedure 22–37: 94% Number of stents per procedure: – Procedure 1–11: 1.7 stents – Procedure 12–21: 1.1 stents – Procedure 22–37: 1.0 stents	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex, Wallstent, WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Major complication rate for ERCPist vs. non-ERCPist: 21.0% vs. 33.3% (P = 0.030) Immediate perforation rate for ERCPist vs. non-ERCPist: 1.7% (3/176) vs. 7.0% (4/57) (P = 0.021)	Low

ASA, American Society of Anesthesiologists; *CRC*, colorectal cancer; *CTC*, CT colonography; *CI*, confidence interval; *ERCP*, endoscopic retrograde cholangiopancreatography; *n.s.*, not significant; *NPV*, negative predictive value; *PPV*, positive predictive value; *OR*, odds ratio; *SEMS*, self-expandable metal stent.
*Data extracted from abstract because of no access to the journal.

TABLE E2. (a–i) Technical considerations of stent placement.

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(a) Method of self-expandable metal stent (SEMS) placement.						
Geraghty, 2014 [16]	Retrospective	Radiologic over-the-wire (OTW) or endoscopic through-the-scope (TTS) colonic stent placement	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264) – CRC bridge to surgery (n = 52) – Benign (n = 9) – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Overall success rate: – Technical 87.4% – Clinical 83.5% Multivariate analysis of factors related to technical success: – TTS vs. OTW technique: 90.9% vs. 80.8%; OR 4.87 (95%CI 1.89–12.78); $P = 0.017$ Multivariate analysis of factors related to clinical success: – TTS vs. OTW technique: 90.3% vs. 74.8%; OR 7.93 (95%CI 2.25–27.97); $P = 0.001$	Low
Kim JW, 2013 [46]	Retrospective	Colorectal SEMS placement Niti-S D-type uncovered Niti-S covered Covered Comvi stent	Patients with malignant colorectal obstruction Combined endoscopic and fluoroscopic TTS stent placement (n = 73) Radiologic OTW stent placement (n = 38)	Clinical outcomes of endoscopic and radiologic SEMS placement	Endoscopic versus radiologic stent placement – Technical success rate: 100% vs. 92.1% ($P = 0.038$) – Clinical success rate: 91.8% vs. 97.1% ($P = 0.424$) – Complication rate: 32.4% vs. 15.4% ($P = 0.303$) – Median stent patency: 70 days vs. 93 days ($P = 0.428$)	Low
de Gregorio, 2011 [48]	Retrospective	Colorectal stent placement Wallstent SX-ELLA intestinal stent	Patients with total or partial large-bowel obstruction secondary to malignancy Fluoroscopic OTW stent placement (n = 401) Combined endoscopic and fluoroscopic OTW stent placement (n = 66)	Radiation dose of fluoroscopic and combined endoscopic and fluoroscopic stent placement	Radiologic versus endoscopic stent placement Procedure time: 67.1 vs. 65.5 min ($P = 0.541$) Radiation dose: 3,439 vs. 3,010 dGy·cm^2 ($P < 0.001$) Technical success rate: 92.8% vs. 90.9% ($P = 0.595$) Clinical success rate: 90.5% vs. 74.2% ($P < 0.001$) Complication rate: 21.7% vs. 18.2% ($P = 0.517$)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Selinger, 2011 [45]	Retrospective	Radiologic colonic stent insertion Hanarostent Wallstent Choo stent Niti-S Others	Patients who underwent colonic SEMS insertion (n = 96) – Colonic malignancy 80.2% – Extracolonic malignancy 14.6% – Benign 5.2%	Factors associated with technical and clinical outcomes of SEMS placement	Technical success rate 83.3% Clinical success rate 77.1% Early complications: – Death 2.5% – Stent migration 3.8% – Severe bleeding 2.5% – Perforation 1.3% – Stent obstruction 1.3%	Low
Kim SY, 2010 [40]	Retrospective	Radiologic uncovered SEMS placement Hanarostent EGIS stent	Patients with malignant colorectal obstruction (n = 99) – Palliative SEMS placement (n = 47) – SEMS as bridge to surgery (n = 52)	Effectiveness of radiologic uncovered stent placement	Overall success rate: – Technical 94.8% – Clinical 89.1% There were no procedure-related major complications such as major bleeding or colonic perforation	Low
Kim JH, 2009 [43]	Prospective	Radiologic dual-design SEMS insertion Flared ends (n = 69) Bent ends (n = 53)	Patients with malignant colorectal obstruction (n = 122) – Palliative SEMS placement (n = 80) – SEMS as bridge to surgery (n = 42)	Clinical safety and efficacy of dual-design stents	Flared-ends versus bent-ends – Technical success rate: 94.2% vs. 96.2% – Clinical success rate: 93.8% vs. 90.2% – Overall complication rate: 18.5% vs. 25.5% – Perforation rate: 6.2% vs. 5.9% – Stent migration rate: 6.2% vs. 5.9%	Moderate
Kim H, 2008 [41]	Retrospective	Fluoroscopically guided colorectal stent insertion without endoscopic assistance Hanarostent Dual stent	Patients with acute malignant colorectal obstruction (n = 42) – Palliative SEMS placement (n = 24) – SEMS as bridge to surgery (n = 18)	Technical feasibility and clinical effectiveness of SEMS	Technical success rate 100% Clinical success rate 98% There were no procedure-related major complications Procedure-related minor complications: – Hematochezia: 14% – Tenesmus: 2% – Anal pain: 2%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Shrivastava, 2008 [42]	Retrospective	Radiologic colorectal SEMS insertion Memotherm WallFlex	Patients with an advanced obstructing colorectal tumor (n = 91)	Efficacy, risks and survival after palliative colorectal stenting	Technical success rate 89% Clinical success rate 99% Overall immediate success of SEMS: 88% Early complications (<30 days): – Pain: 8.6% – Minor rectal bleeding: 3.7% – Stent migration: 8.6% – Perforation: 6.2%	Low
Alcantara, 2007 [44]	Prospective	Radiologic SEMS placement Enteral Wallstent Esophacoil Hanarostent WallFlex	Patients with large-bowel obstruction due to colorectal cancer (n = 95) – Palliative SEMS placement (n = 28) – SEMS as bridge to surgery (n = 67)	Effectiveness of stenting	Clinical relief of obstruction: 95% Complications associated with stenting: – Perforation: 3.8% – Stent migration: 3.8% – Obstruction: 3.8% – Tenesmus: 1%	Moderate
Sebastian, 2004 [47]	Systematic review	Colorectal SEMS placement	Patients with malignant colorectal obstruction (n = 1198) 54 case series	Efficacy and safety of SEMS	Technical failure rates for combined radiologic/endoscopic stent placement and stent placement with fluoroscopic guidance only: 4.5% and 9.6%, respectively (P = 0.086)	Moderate
(b) Stricture dilation						
Van Halsema, 2014 [51]	Meta-analysis	Colorectal SEMS placement	All patients who underwent colorectal stent placement (n = 4086)	Risk factors for perforation from colonic stenting	Pooled perforation rate: – No dilation: 8.5% (95%CI 7.2%–10.0%) – Overall stricture dilation: 8.5% (95%CI 5.5%–12.8%) – Pre-stenting dilation: 8.2% (95%CI 4.0%–16.1%) – Re-intervention dilation: 20.4% (95%CI 6.5%–48.8%)	Moderate

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Meisner, 2011 [12]	Prospective cohort	WallFlex colonic stent placement	Patients with malignant colonic obstruction (n = 463) – Palliative SEMS placement (n = 255) – SEMS as bridge to surgery (n = 182) – Indication not specified (n = 10)	Performance, safety and effectiveness of colorectal stents	Pre-stenting dilation: 3.2% 30-day cumulative perforation rate: 3.9% Post hoc analysis: Odds of perforation after pre-stenting dilation 9.41 times higher than without dilation ($P = 0.0017$)	Moderate
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Immediate clinical success rate for: – Balloon dilation to expand the stent, yes vs. no: 85% vs. 84% ($P = 1.000$) Multivariate analysis of long-term clinical failure: – Balloon dilation to expand the stent: OR 3.58 ($P < 0.001$)	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex Wallstent WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Univariate analysis of factors associated with major complications: Stricture dilation ($P = 0.026$): – Pre-stenting dilation: 40.9% (9/22) – No dilation: 22.3% (47/211) Perforation rate ($P = 0.027$): – Pre-stenting dilation: 18.2% (4/22) – No dilation: 6.6% (14/211)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Tanaka, 2010 [49]	Experimental	Immediately after surgical resection, an 18 mm balloon was placed in the stricture and slowly inflated with hydrostatic pressure over 1 minute and kept at maximum diameter for 1 minute	Patients with strictured colorectal cancers of <15 mm in internal diameter (n = 47)	Risk factors associated with perforation in excised colorectal cancer specimens	Perforation rate: 17.0% (8/47) Univariate analysis for risk factors associated with perforation: – Annular vs. half-annular/subannular strictures: 34.8% vs. 0% ($P = 0.020$) – Mean internal diameter of perforated vs. nonperforated cases: 4.9 mm vs. 8.3 mm ($P = 0.001$) – Collagen fibers per visual field of perforated vs. nonperforated cases: 30.8% vs. 12.0% ($P < 0.0001$)	Low
Sebastian, 2004 [47]	Systematic review and pooled analysis	Colorectal SEMS placement	Patients with malignant colorectal obstruction (n = 1198) 54 case series	Efficacy and safety of SEMS	Pre-dilation to allow passage of guidewire (n = 96) Perforation rate: 3.8% Pre-dilation was significantly associated with perforation and was thought to be responsible in 16 cases (17.7%) Stent migration rate: 11.8% Risks for increased rate of stent migration: laser treatment, dilation prior to stent insertion and chemotherapy and radiotherapy	Moderate

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Khot, 2002 [50]	Systematic review and pooled analysis	Colorectal SEMS placement	Patients with colorectal obstruction (n = 598) 29 case series Malignant strictures: 97% Benign strictures: 3%	Safety and efficacy of colorectal SEMS	Perforation rate: 3.7% Perforation incidence in non-balloon dilation group 2.4% (12/493) vs. 9.5% (10/105) in balloon dilation group ($P < 0.05$)	Moderate
(c) Stent covering.						
Yang, 2013 [53]	Systematic review and meta-analysis	Covered and uncovered SEMS placement for palliative treatment	Patients with cancerous obstruction in any position of the digestive tract 1 RCT and 2 nonrandomized prospective studies Covered SEMS (n = 147) Uncovered SEMS (n = 152)	Clinical outcomes of covered and uncovered SEMS	Covered versus uncovered SEMS for colorectal obstruction Time to recurrence of obstruction: HR = 0.89 (95%CI 0.18–4.45) No differences in technical and clinical success Significantly lower tumor ingrowth using covered SEMS Tumor overgrowth: RR = 2.68 (95%CI 0.54–13.33) Stent migration: RR = 11.70 (95%CI 2.84–48.27)	High

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Zhang, 2012 [52]	Systematic review and meta-analysis	Uncovered and covered SEMS placement	Patients with malignant colorectal obstruction 1 RCT 3 prospective and 2 retrospective comparative studies Covered SEMS (n = 218) Uncovered SEMS (n = 246)	Efficacy of uncovered and covered SEMS	Uncovered versus covered SEMS: Technical success rate: 99.6% vs. 97.2%; RR 1.01 (95%CI 0.98–1.04); $P = 0.48$ Clinical success rate: 96.4% vs. 93.8%; RR 1.03 (95%CI 0.98–1.09); $P = 0.26$ Tumor ingrowth rate: 11.4% vs. 0.9%; RR 5.99 (95%CI 2.23–16.10); $P = 0.0004$ Early ($\leq$7 days) migration rate: 2.9% vs. 6.9%; RR 0.73 (95%CI 0.27–2.00); $P = 0.54$ Late (>7 days) migration rate: 5.5% vs. 21.3%; RR 0.25 (95%CI 0.08–0.80); $P = 0.02$ Perforation rate: 0.4% vs. 0.9%; RR 0.50 (95%CI 0.08–3.11); $P = 0.46$ Overall complication rate: 21.5% vs. 32.1%; RR 0.79 (95% CI 0.58–1.09); $P = 0.16$ Stent patency was significantly longer for uncovered SEMS, weighted mean difference 15.3 days (95%CI 4.31–26.37); $P = 0.006$. However, this was nonsignificant in sensitivity analysis ($P = 0.22$)	High

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(d) Stent size.						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent Taewoong Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Technical success rate: 97.3% Clinical success rate: 95.8% Overall complication rate: 39.7% Overall re-intervention rate: 30.8% – Endoscopic: 18.5% – Surgical: 14.4% Predictors of early complications: – Length of stent: OR 1.02; $P = 0.736$ Predictors of late complications: – Length of stent: OR 0.98; $P = 0.341$ Predictors of endoscopic re-intervention: – Length of stent: OR 0.96; $P = 0.032$ Predictors of surgical treatment: – Length of stent: OR 1.00; $P = 0.918$	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Geraghty, 2014 [16]	Retrospective	Colonic stenting for large-bowel obstruction	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264) – CRC bridge to surgery (n = 52) – Benign (n = 9) – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Univariate analysis of factors related to technical success: Stent length (P = 0.521): – Length ≥10 cm: 88.6% – Length <10 cm: 91.2% Stent diameter (P = n.s.): – Diameter ≥25 mm: 95.2% – Diameter <25 mm: 88.0% Univariate analysis of factors related to clinical success: Stent length (P = 0.907): – Length ≥10 cm: 91.1% – Length <10 cm: 91.6% Stent diameter (P = 0.161): – Diameter ≥25 mm: 95.2% – Diameter <25 mm: 87.4%	Low
Kim BC, 2012 [54]	Retrospective	Colorectal SEMS insertion WallFlex Enteral Niti-S D-type uncovered Niti-S Comvi covered	Patients with malignant colorectal obstruction Palliative SEMS placement (n = 54) SEMS as bridge to surgery (n = 48)	Clinical outcomes of palliative SEMS placement	Risk factors for complications: SEMS diameter (P = n.s.): – Diameter <24 mm: 71.4% – Diameter ≥24 mm: 42.6% SEMS length (P = n.s.): – Length <100 mm: 48.8% – Length ≥100 mm: 38.5% Risk factors for stent migration: SEMS diameter (P < 0.05): – Diameter <24 mm: 71.4% – Diameter ≥24 mm: 12.8% SEMS length (P = n.s.): – Length <100 mm: 22.0% – Length ≥100 mm: 15.4% Risk factors for stent re-obstruction: SEMS diameter (P = n.s.): – Diameter <24 mm: 0% – Diameter ≥24 mm: 8.5% SEMS length (P = n.s.): – Length <100 mm: 7.3% – Length ≥100 mm: 7.7%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex Wallstent Ultraflex Hanarostent Bonastent Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short- and long-term efficacy of SEMS	Overall major complication rate: 11.9% – Perforation rate: 6.0% – Stent migration rate: 5.5% – Stent re-obstruction rate: 0.5% Small-caliber SEMS (<25 mm) were associated with stent migration: OR 7.0 (95%CI 1.9–24.6); $P = 0.002$	Low
Selinger, 2011 [45]	Retrospective	Radiologic colonic stent insertion Hanarostent Wallstent Choo stent Niti-S Others	Patients who underwent colonic SEMS insertion (n = 96) – Colonic malignancy 80.2% – Extracolonic malignancy 14.6% – Benign 5.2%	Factors associated with technical and clinical outcomes of SEMS placement	Clinical long-term success: – Overall: 77% (44/57) – Colorectal malignancy: 81% (38/47) Factors influencing long-term clinical success: – Length of stent ($P = 0.81$)	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Immediate clinical success rate for: Stent length ($P = 0.992$): – Length <10 cm: 83.7% – Length ≥10 cm: 83.8%	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex Wallstent WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Univariate analysis of factors associated with major complications: Stent diameter ($P = 0.001$) – Diameter ≤22 mm: 31.9% – Diameter 25 mm: 13.3%	Low
Im, 2008 [56]	Prospective	Palliative colorectal uncovered SEMS placement	Palliative endoscopic SEMS placement for a malignant colorectal obstruction (n = 49)	Clinical outcomes and factors associated with long-term complications and patency of SEMS	Univariate analysis of long-term complications: Stent diameter ($P = 0.48$): – Diameter ≤22 mm: 27% – Diameter 24 mm: 15.4%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(e) Stent model.						
Cheung, 2012 [58]	RCT	Colonic SEMS placement Taewoong D-type uncovered stent (n = 52) Boston Scientific WallFlex stent (n = 71)	Patients with acute malignant colonic obstruction – Palliative SEMS placement (n = 58) – SEMS as bridge to surgery (n = 65)	Clinical outcome and safety of the D-type stent and the WallFlex stent	WallFlex versus Taewoong D-Type Palliative group: – Technical success rate: 100% vs. 100% – Clinical success rate: 100% vs. 100% – Perforation rate: 3.6% vs. 0% ($P = 0.296$) – Migration rate: 3.6% vs. 3.3% ($P = 0.296$) – Re-stenosis rate: 3.6% vs. 0% ($P = 0.296$) Bridge-to-surgery group: – Technical success rate: 93% vs. 95.5% ($P = 0.700$) – Clinical success rate: 86% vs. 90.1% ($P = 0.681$) – Perforation rate: 7% vs. 4.5% ($P = 0.683$) – Migration rate: 0% vs. 0% – Re-stenosis rate: 2.3% vs. 0% ($P = 0.465$) Mean length of stenosis for perforation vs. no perforation: 60 mm vs. 50 mm ($P = 0.249$)	Moderate

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Park JK, 2011 [59]	Retrospective	Through-the-scope palliative SEMS insertion Uncovered: – Wallstent – Niti-S – Bonastent – Hanarostent Covered: – Niti-S – Bonastent	Patients with incurable malignant colorectal obstruction (n = 103)	Success rates and complication rates according to stent type	Uncovered SEMS group (n = 73) Technical success rates: Wallstent 100%, Niti-S 100%, and Bonastent 100% (P = n.s.) Clinical success rates: Wallstent 100%, Niti-S 100%, and Bonastent 100% (P = n.s.) Overall complication rate: Wallstent 37%, Niti-S 20%, Bonastent 9% (P = 0.065) Occlusion rates: Wallstent 11.1%, Niti-S 5%, and Bonastent 9% (P = 0.761) Migration rates: Wallstent 25.9%, Niti-S 15%, and Bonastent 0% (P = 0.037) Stent patency up to death: Wallstent 63%, Niti-S 80%, and Bonastent 91% (P = 0.065)	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Immediate clinical success rate for stent manufacturer (P = 0.354): – Covered Niti-S stent: 87.2% – Covered Comvi stent: 70% – Uncovered WallFlex stent: 84.3% – Uncovered Niti-S D-type stent: 84.5%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Kim JH, 2009 [43]	Prospective nonrandomized	Radiologic dual-design SEMS insertion Flared ends (n = 69) Bent ends (n = 53)	Patients with malignant colorectal obstruction (n = 122) – Palliative SEMS placement (n = 80) – SEMS as bridge to surgery (n = 42)	Clinical safety and efficacy of dual-design stents	Flared-ends versus bent-ends Technical success rate: 94.2% vs. 96.2% ($P = 0.696$) Clinical success rate: 93.8% vs. 90.2% ($P = 0.504$) Overall complication rate: 18.5% vs. 25.5% ($P = 0.361$) Perforation rate: 6.2% vs. 5.9% ($P > 0.999$) Stent migration rate: 6.2% vs. 5.9% ($P > 0.999$)	Moderate
Small, 2008 [60]	Retrospective	Through-the-scope (TTS) Enteral Wallstent or non-TTS Precision Colonic Ultraflex stent placement	Patients with malignant left-sided colon obstruction Wallstent TTS (n = 50) Ultraflex OTW (n = 35)	Outcomes after palliative placement of the Enteral Wallstent (EW) and the Precision Colonic Ultraflex (PCU) stent	Wallstent versus Ultraflex Technical success rate: 94% vs. 100% (P = n.s.) Technical difficulty: 16% vs. 9% (P = n.s.) Complication rate: 60% vs. 40% ($P = 0.035$) – Early (<7 days) complication rate: 30% vs. 34.3% (P = n.s.) – Late (>7d) complication rate: 38% vs. 20% ($P = 0.04$) Stent occlusion rate: 18% vs. 11% (P = n.s.) Median stent patency: 63 vs. 134 days Re-intervention rate: 62% vs. 40% ($P = 0.02$)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Garcia-Cano, 2006 [61]	Retrospective	Colorectal SEMS insertion Enteral Wallstent Hanarostent Ultraflex Precision	Patients with malignant colorectal obstruction (n = 175)	Technical and clinical success of SEMS	Technical success rate (P = n.s.): – Wallstent: 92.4% – Hanarostent: 88.5% – Ultraflex: 96.7% Clinical success rate (P = n.s.): – Wallstent: 83.6% – Hanarostent: 95.7% – Ultraflex: 82.8% Overall complication rate (P = n.s.): – Wallstent: 18.5% – Hanarostent: 15.3% – Ultraflex: 20%	Low
(f) SEMS placement for proximal colonic cancers						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent Taewoong Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Predictors of early complications: – Right-sided obstruction: OR 0.51; P = 0.541 Predictors of late complications: – Right-sided obstruction: OR 0.59; P = 0.541 Predictors of endoscopic re-intervention: – Right-sided obstruction: OR 1.74; P = 0.478 Predictors of surgical treatment: – Right-sided obstruction: OR 0.70; P = 0.750	Low
Geraghty, 2014 [16]	Retrospective	Colonic stenting for large-bowel obstruction	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264) – CRC bridge to surgery (n = 52) – Benign (n = 9) – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Univariate analysis of factors related to technical success: Obstruction site (P = 0.602): – Proximal colon: 90.0% – Distal colon: 87.1% Univariate analysis of factors related to clinical success: Obstruction site (P = 0.645): – Proximal colon: 87.5% – Distal colon: 84.7%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Kim JY, 2013 [65]	Retrospective	Endoscopic SEMS (M.I. Tech) placement	Patients with malignant colorectal obstruction (n = 209) – Right colon (n = 43) – Left colon (n = 166)	Clinical outcomes of SEMS in patients with colorectal cancer and those with extracolonic malignancy	Multivariate analysis of risk factors for complications: – Right colon: HR 1.17 (95%CI 1.25–8.24); $P = 0.015$	Low
Cho, 2011 [62]	Retrospective	Endoscopic stent insertion Hanarostent Bonastent	Patients with malignant colon obstruction Proximal to the splenic flexure (n = 37) Distal colon (n = 99)	Technical feasibility and clinical outcomes of SEMS insertion for proximal and distal colon obstruction	Proximal versus distal colon Technical success rate: 86% vs. 97% ($P = 0.06$) Clinical success rate: 78% vs. 91% ($P = 0.08$) Complication rate: 24% vs. 27% ($P = 0.89$) Perforation rate: 5% vs. 0% ($P = 0.15$) Re-occlusion rate: 11% vs. 18% ($P = 0.47$) Stent migration rate: 8% vs. 8% ($P = 0.73$) Median stent patency: 120 days vs. 186 days Median survival: 124 days vs. 348 days	Low
Selinger, 2011 [45]	Retrospective	Radiologic colonic stent insertion Hanarostent Wallstent Choo stent Niti-S Others	Patients who underwent colonic SEMS insertion (n = 96) – Colonic malignancy 80.2% – Extracolonic malignancy 14.6% – Benign 5.2%	Factors associated with technical and clinical outcomes of SEMS placement	Technical and clinical success rate: 83.3% and 77.1% Early and late complication rates: 10% and 26.3% Clinical long-term success: Overall: 77% (44/57) Colorectal malignancy: 81% (38/47) Factors influencing short-term clinical success: – Obstruction site ($P = 0.65$) Factors influencing long-term clinical success: – Obstruction site ($P = 0.31$)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Yao, 2011 [63]	Retrospective	Endoscopic decompression using SEMS as bridge to one-stage surgery	Patients with acute colon obstruction proximal to splenic flexure (n = 81)	Usefulness of SEMS as bridge to surgery in the management of acute proximal colon obstruction	Technical success rate: 96.3% Clinical success rate: 96.3% One-stage surgery: 92.3% (72/78) with 3.8% morbidity	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Multivariate analysis of factors associated with technical failure in the palliative group: Obstruction site (P = 0.034): – Right colon: 20.6% – Left colon: 10.6% – OR 2.25 (95%CI 1.06–4.75) Univariate analysis of factors associated with immediate clinical failure in palliative group: Obstruction site (P = 0.245): – Right colon: 11.1% – Left colon: 17.7%	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex Wallstent WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications and risk factors of SEMS placement	Univariate analysis of major complications: Site of obstruction (P = 0.138): – Right colon: 17.1% – Left colon: 25.8%	Low
Dronamraju, 2009 [66]	Retrospective	Colonic Enteral Wallstent insertion	Patients with malignant large-bowel obstruction (n = 97) Proximal to splenic flexure (n = 16) Distal colon (n = 81)	Outcomes following stenting for lesions proximal to the splenic flexure	Proximal versus distal colon Successful stenting: 87.5% vs. 78.9% (P = 0.6) Complication rate: 7.1% vs. 8.6% (P = 0.3) Hospital stay: 1.6 days vs. 2.0 days (P = 0.9)	Low
Repici, 2007 [64]	Retrospective	Colonic SEMS insertion Wallstent WallFlex	Patients with right-sided malignant colonic obstruction (n = 21)	Outcome after colonic stent placement into the proximal colon	Technical success rate: 95.2% Clinical success rate: 85% Complication rate: 4.8% Re-occlusion due to tumor ingrowth: 4.8% Median follow-up: 8 months (range 3–13)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(g) Colonic SEMS placement for obstruction caused by extracolonic malignancy (ECM).						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent Taewoong Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Predictors of early complications: – Extrinsic compression: OR 3.38; $P = 0.317$ Predictors of late complications: – Extrinsic compression: OR 1.00; $P = 0.905$ Predictors of endoscopic re-intervention: – Extrinsic compression: OR 0.68; $P = 0.633$ Predictors of surgical treatment: – Extrinsic compression: OR 1.47; $P = 0.643$	Low
Kim JY, 2013 [65]	Retrospective	Endoscopic SEMS (M.I. Tech) placement	Patients with malignant colorectal obstruction (n = 209) – Colorectal cancer (CRC) (n = 149) – Extracolonic malignancy (ECM)(n = 60)	Clinical outcomes of SEMS in patients with colorectal cancer and those with extracolonic malignancy	CRC versus ECM Technical success rate: 99.3% vs. 95.2% ($P = 0.079$) Clinical success rate: 92.6% vs. 86.7% ($P = 0.688$) Re-obstruction: 21.9% vs. 30% ($P = 0.288$) Stent migration: 5.5% vs. 1.7% ($P = 0.378$) Perforation: 4.1% vs. 8.3% ($P = 0.467$) 10-day mortality: 2.7% vs. 3.3% ($P = 1.000$) Median stent patency: 193 vs. 186 days ($P = 0.253$) Multivariate analysis of risk factors for complications: – Extracolonic malignancy: HR 0.11 (95%CI 0.47–2.68) ; $P = 0.800$	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Moon, 2013 [69]	Retrospective	Palliative uncovered SEMS placement Hanarostent Bonastent	Patients with malignant colonic obstruction (n = 97) – CRC (n = 53) – ECM (n = 44)	Success and complications of stent placement in patients with extracolonic malignancy	CRC versus ECM Technical success rate: 98.1% vs. 93.2% (P = 0.326) Clinical success rate: 84.9% vs. 77.3% (P = 0.433) Overall early complication rate: 5.8% vs. 9.6% (P = 0.343) – Perforation rate: 0% vs. 4.8% – Migration rate: 5.8% vs. 4.8% Median stent patency: 177 days vs. 117 days (P = 0.015) – Re-obstruction: 22.2% vs. 10.0% – Late migration: 13.9% vs. 10.0% (P = 0.498) Median overall survival: 402 vs. 141 days (P = 0.018)	Low
Keranen, 2012 [70]	Retrospective	Colorectal SEMS insertion Memotherm Ultraflex WallFlex Wallstent Choo stent Instent	Patients with malignant colorectal obstruction (n = 101) Palliation group: CRC (n = 66) ECM (n = 24)	Efficacy and safety of SEMS for colorectal cancer and extracolonic malignancies	CRC versus ECM Technical success rate: 100% vs. 96% (P = n.s.) Clinical success rate: 94% vs. 65% ($P < 0.001$) Overall complication rate: 20% vs. 29% (P = 0.497) Median survival: 158 vs. 49 days (P = 0.030)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Kim BK, 2012 [71]	Retrospective	SEMS placement compared with emergency surgery Wallflex uncovered Comvi covered stent Niti-s D-type uncovered	Patients with malignant colorectal obstruction due to advanced gastric cancer (n = 180) – Palliative SEMS placement (n = 111) – Emergency surgery (n = 69)	Clinical outcomes and complications	Outcomes of SEMS placement Technical success rate: 73.9% Clinical success rate: 54.1% Acute complication rate: 3.6% Overall complication rate: 62.4% – Re-obstruction: 40% – Stent migration: 9.4% – Perforation: 9.4% – Bleeding: 3.5% SEMS versus emergency surgery: Technical success rate: 74% vs. 94% ($P = 0.001$) Clinical success rate: 54% vs. 75% ($P = 0.005$) Early ($\leq$1 month) complication rate: 29% vs. 29% ($P = 1.000$) Late (>1 month) complication rate: 21% vs. 16% ($P = 0.557$) Procedure-related mortality: 4% vs. 9% ($P = 0.307$) Stoma formation: 27% vs. 46% ($P = 0.010$) Median patency: 117 vs. 183 days ($P = 0.105$) Overall survival: 8.5 vs. 9.5 months ($P = 0.217$)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Kim JH, 2011 [72]	Retrospective	Palliative Dual-design stent placement	Patients with inoperable malignant colonic obstruction (n = 108) – CRC (n = 58) – ECM (n = 50)	Clinical outcomes of SEMS for CRC and ECM	CRC versus ECM Technical success: 84% vs. 94% (P = 0.137) Clinical success rate: 98% vs. 96% (P = 0.533) Perforation rate: 2% vs. 11% (P = 0.082) Migration rate: 10% vs. 4% (P = 0.262) Bleeding: 6% vs. 9% (P = 0.653) Pain: 4% vs. 13% (P = 0.124) Tumor ingrowth: 6% vs. 2% (P = 0.328) Median overall survival: 4.6 vs. 4.1 months (P = 0.67) Median symptom-free survival: 4 vs. 3 months (P = 0.07)	Low
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex Wallstent Ultraflex Hanarostent Bonastent Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short- and long-term efficacy of SEMS	Technical success rate: 91.5% Immediate clinical success rate: 89.7% Univariate analysis of factors associated with technical failure: – Extrinsic tumor: OR 3.60 (95%CI 1.60–10.70); P = 0.02 Univariate analysis of factors associated with clinical failure: – Extrinsic tumor: OR 4.35 (95%CI 1.80–10.20); P = 0.001	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) Palliative SEMS (n = 276) SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Multivariate analysis of factors associated with technical failure in the palliative group: Origin of malignancy (P = 0.011): – Extrinsic: 19.3% – Intrinsic: 8.6% – OR 2.57 (95%CI 1.25–5.32) Univariate analysis of factors associated with immediate clinical failure in palliative group: Origin of malignancy (P = 0.986): – Extrinsic: 16.3% – Intrinsic: 16.2% Multivariate analysis of factors associated with long-term clinical failure in the palliative group: Extrinsic origin of malignancy: OR 1.13 (95%CI 0.51–2.54); P = 0.761	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex Wallstent WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications and risk factors of SEMS placement	Univariate analysis of major complications: Site of lesion (P = 0.237): – Extrinsic: 20.4% – Intrinsic: 25.1%	Low
Trompetas, 2010 [73]	Retrospective	Palliative colonic stenting	Patients with obstructing extracolonic cancer (n = 11)	Clinical outcomes after colonic stenting for extracolonic cancer	Technical success rate: 45% (5/11) Clinical success rate: 27% (3/11) Perforation rate: 9% (1/11) 30-day mortality rate: 36% (4/11) Median survival: 2 months	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Keswani, 2009 [74]	Retrospective	Placement of a colonic metal stent (Microvasive)	Patients with malignant colon obstruction (n = 49) – CRC (n = 34) – ECM (n = 15)	Success and complication rates of colorectal stenting in patients with colorectal cancer versus those with extracolonic malignancy	CRC versus ECM Technical success rate: 97.1% vs. 66.7% ($P = 0.008$) Clinical success rate: 88.6% vs. 20% ($P < 0.001$) Surgical therapy: 5.9% vs. 60% ($P < 0.001$) Clinical success after all therapy: 100% vs. 80% ($P = 0.03$) Complication rate: 8.8% vs. 33.3% ($P = 0.046$) Multivariate analysis of risk factors for endoscopic failure: – Extracolonic malignancy: HR 21.0 (95%CI 3.3–134.3); $P = 0.001$ Multivariate analysis of risk factors predictive of complications: – Extracolonic malignancy: HR 0.2 (95%CI 0.0–1.7); P = 0.15	Low
Shin, 2008 [75]	Retrospective	Colorectal Taewoong SEMS insertion	Patients with unresectable extrinsic tumors (n = 39)	Success rates and complications of SEMS for unresectable extrinsic tumors	Technical success rate: 87.2% Clinical success rate: 82.1% Complication rate: 38.6% – Re-obstruction: 24.6% – Migration: 8.8% – Stool incontinence: 5.2%	Low
(h) "Stentability" based on the length of the obstructed segment.						
Almadi, 2013 [77]	Retrospective	Uncovered WallFlex stent insertion	Patients with malignant colonic obstruction (n = 73) – Palliation: 35% – Bridge to surgery: 65%	Predictive factors for complications of colonic stenting	Technical success rate: 93.9% Complications: – Perforation: 4.1% – Stent migration: 8.2% – Re-occlusion: 2.7% Mean length of stenosis for complications vs. no complications: 5.43 vs. 5.09 cm ($P = 0.49$) Length of stenosis not associated with survival ($P = 0.95$)	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Cheung, 2012 [58]	RCT	Colonic SEMS placement Taewoong D-type uncovered stent (n = 52) Boston Scientific WallFlex stent (n = 71)	Patients with acute malignant colonic obstruction Palliative SEMS placement (n = 58) SEMS as bridge to surgery (n = 65)	Clinical outcome and safety of the D-type stent and the WallFlex stent	Mean length of stenosis for perforated cases (n = 5) versus nonperforated cases: 60 mm vs. 50 mm ($P = 0.249$)	Moderate
Luigiano, 2011 [76]	Prospective	Endoscopic WallFlex placement for palliation	Patients with malignant colorectal obstruction (n = 39)	Outcomes of through-the-scope large diameter SEMS placement for palliation	Technical success rate: 92.3% Clinical success rate: 89.7% Technical failure was related to extracolonic etiology ($P < 0.001$) No correlation between clinical failure and: – Length of stenosis – Type of malignancy – Stricture location – Degree of obstruction Complications: – Perforation: 5.6% – Tumor ingrowth: 17.1% – Stent migration: 2.8% No correlation between complications and: – Length of stenosis – Type of malignancy – Stricture location – Degree of occlusion Univariate and multivariate analyses did not show any factors related to long-term clinical success and survival	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex Wallstent Ultraflex Hanarostent Bonastent Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short- and long-term efficacy of SEMS	Technical success rate: 91.5% Immediate clinical success rate: 89.7% Univariate analysis of factors associated with technical failure: – Length of stenosis >4 cm: OR 5.33 (95%CI 1.40–20.10); $P = 0.008$ Univariate analysis of factors associated with clinical failure: – Length of stenosis >4 cm: OR 2.40 (95%CI 1.00–5.50); $P = 0.03$	Low
Jung, 2010 [78]	Retrospective	Palliative colorectal SEMS placement Niti-S covered Hanarostent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 39)	Clinical outcomes and risk factors associated with the long-term outcomes of palliative SEMS	Technical success rate: 100% Clinical success rate: 87.2% Complications: – Perforation: 5.1% – Stent migration: 10.3% – Tumor ingrowth: 2.9% Mean event-free survival for: – Stent length <10 cm vs. ≥10 cm: 151 vs. 60 days ($P = 0.008$) – Proximal vs. distal obstructions: 36 vs. 123 days ($P = 0.015$) – Stent diameter <22 mm vs. ≥22 mm: 87 vs. 121 days ($P = 0.502$) Multivariate analysis of risk factors for long-term efficacy: – Length of stent ≥10 cm: OR 0.33 (95%CI 0.15–0.70); $P = 0.004$ – Distal obstruction: OR 3.39 (95%CI 1.16–9.91); $P = 0.025$	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(i) "Stentability" based on the degree of obstruction.						
Choi, 2013 [13]	Retrospective	Colorectal SEMS placement Niti-S Hanarostent Choostent Bonastent Covered 27% Uncovered 73%	Patients with malignant colorectal obstruction (n = 152) – Palliative SEMS placement (n = 83) – SEMS as bridge to surgery (n = 69)	Clinical effectiveness, complications and risk factors associated with the complications of SEMS placement	Multivariate analysis of risk factors for complications: Degree of obstruction (P = 0.042) : – Occlusion: 38.3% – Subocclusion: 22.4% – OR 2.34 (95%CI 1.03–5.32)	Low
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex Wallstent Ultraflex Hanarostent Bonastent Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short- and long-term efficacy of SEMS	Technical success rate: 91.5% Immediate clinical success rate: 89.7% Univariate analysis of factors associated with technical failure: – Complete occlusion: OR 0.49 (95%CI 0.18–1.30); P = 0.17 Univariate analysis of factors associated with clinical failure: – Complete occlusion: OR 0.68 (95%CI 0.30–1.40); P = 0.30	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered Comvi stent WallFlex Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Univariate analysis of factors associated with technical success in the palliative group: Degree of obstruction (P = 0.214): – Total: 85.3% – Subtotal: 90.7% Univariate analysis of factors associated with immediate clinical success in palliative group: Degree of obstruction (P = 0.621): – Total: 84.6% – Subtotal: 82.1%	Low

TABLE E2. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex Wallstent WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168) – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications and risk factors of SEMS placement	Univariate analysis of major complications: Degree of obstruction (P = 0.010): – Complete: 35% – Subtotal: 20.2%	Low
Stenhouse, 2009 [79]	Prospective	Colorectal SEMS placement Wallstent Memotherm	Patients with malignant colorectal obstruction (n = 72) – Palliative SEMS placement (n = 56) – SEMS as bridge to surgery (n = 16)	Outcomes of SEMS placement in complete and subtotal obstruction	Complete (n = 32) versus subtotal obstruction (n = 36) Technical success rate: 84% vs. 92% (P = 0.46) Clinical success rate: 65% vs. 73% (P = 0.58) Overall stent migration rate: 23% – Complete (n = 5) vs. subtotal (n = 9)	Moderate
Song, 2007 [80]	Prospective	Colorectal Dual stent insertion	Patients with symptomatic malignant colorectal obstruction (n = 151) – Complete obstruction (n = 59) – Subtotal obstruction (n = 92) – Palliative SEMS placement (n = 101) – SEMS as bridge to surgery (n = 50)	Technical feasibility, clinical effectiveness, and safety of the dual colorectal stent	Complete versus subtotal obstruction Technical failure rate: 15.3% vs. 4.3% (P = 0.034) Overall perforation rate: 11.0% (16/145) Complete obstruction was a risk factor for perforation in multivariate analysis: OR 6.88 (95%CI 2.04–23.17); P = 0.002	Moderate

CI, confidence interval; *CRC*, colorectal cancer; *ECM*, extracolonic malignancy; *HR*, hazard ratio; *n.s.*, not significant; *OR*, odds ratio; *OTW*, over-the-wire; *RCT*, randomized controlled trial; *RR*, relative risk; *SEMS*, self-expandable metal stent; *TTS*, through-the-scope.

TABLE E3. **(a–c)** Self-expandable metal stent (SEMS) placement as a bridge to elective surgery.

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(a) Randomized controlled trials (RCTs) comparing SEMS as bridge to surgery and emergency surgery.						
Ghazal, 2013 [89]	RCT	Emergency stenting followed by elective resection versus total abdominal colectomy and ileorectal anastomosis	Patients with acute obstructed carcinoma of the left colon Preoperative stent (n = 30), Emergency surgery (n = 30)	Feasibility, safety, clinical outcomes	Outcomes of stent placement Technical and clinical success rate: 96.7% and 100% No complications encountered during the 7–10 days until surgery Preoperative SEMS vs. emergency surgery Operative details: – Mean time: 130 vs. 176 min ($P = 0.001$) – Mean blood loss: 250 vs. 500 ml ($P = 0.010$) – Patients requiring blood transfusion: 44.8% vs. 73.3% ($P = 0.035$) – Patients requiring fresh frozen plasma: 10.3% vs. 83.3% ($P = 0.010$) Overall postoperative complications: 13.8% vs. 50% ($P = 0.012$) - Anastomotic leakage: 0% vs. 3.3% ($P = 1.00$) - Wound infection: 10.3% vs. 30% ($P = 0.022$) - Chest infection: 3.4% vs. 16.7% ($P = 0.098$) Median hospital stay: 13 vs. 8 days ($P = 0.102$) Median bowel motions per day: 2 vs. 6 ($P = 0.013$) No operative mortality in both groups Overall median follow-up: 18 months (range 6–40) Recurrent disease: 17.2% vs. 13.3% ($P = 0.228$)	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Tung, 2013 [90]	Long-term follow-up of RCT	SEMS placement followed by laparoscopic resection versus conventional open surgery	Patients with obstructing left-sided colorectal cancer (n = 48) Endo-laparoscopic (n = 24), Open surgery (n = 24)	Pathological staging, number of lymph nodes harvested, administration of adjuvant therapy, survival and disease recurrence following curative surgery	Emergency surgery vs. preoperative SEMS Median lymph node harvest: 11 vs. 23 ($P = 0.005$) Permanent stoma: 25% vs. 0% ($P = 0.03$) Adjuvant chemotherapy: 54% vs. 75% ($P = 0.2$) Median follow-up: 32 vs. 65 months ($P = 0.083$) Curative intent: 54% (13/24) vs. 92% (22/24) ($P = 0.01$) Disease recurrence rate: 23% vs. 50% ($P = 0.4$) 5-year overall survival rate: 27% vs. 48% ($P = 0.076$) 5-year disease-free survival rate: 48% vs. 52% ($P = 0.63$) 5-year survival rate for patients with stage II/III disease: 42.8% vs. 57.1% ($P = 0.347$)	Moderate
Ho, 2012 [91]	RCT	Colonic stenting followed by elective surgery versus immediate emergency surgery WallFlex stent	Patients with acute left-sided malignant colonic obstruction with no evidence of peritonitis SEMS as bridge to surgery (n = 20), Emergency surgery (n = 19)	60-days postoperative morbidity rate, stoma, hospital stay, critical care stay, costs	Outcomes of SEMS placement Technical and clinical success rate: 75% and 93.3% No cases of stent-related perforation Preoperative SEMS vs. emergency surgery Median duration of surgery: 135 vs. 135 min ($P = 0.603$) Defunctioning stoma rate: 10% vs. 32% ($P = 0.127$) Postoperative mortality: 0% vs. 15.8% ($P = 0.106$) Overall complication rate: 35% vs. 58% ($P = 0.152$) Reoperation rate: 10% vs. 11% Wound infection: 15% vs. 21% Chest infection: 10% vs. 11% Resumption of bowel function: median 4 vs. 5 days ($P = 0.167$) Fit for discharge: median 6 vs. 8 days ($P = 0.028$) Median bowel frequency per day: 2 vs. 2 ($P = 0.653$) Total length of hospital stay: median 14 vs. 13 days ($P = 0.430$) Median length of stay in critical care: 2 vs. 3 days ($P = 0.057$) Median total costs: $18 132 vs. $13 301 ($P = 0.194$)	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Alcantara, 2011 [92]	RCT	Stent placement and deferred surgery versus emergency intraoperative colonic lavage with primary anastomosis	Patients with obstructive left-sided colonic cancer (n = 28) Preoperative stent (n = 15), Emergency surgery (n = 13)	Postoperative morbidity and mortality, staging, complications due to stent placement, surgical time, clinical follow-up, health costs, and follow-up of survival	No complications with stent placement were recorded Time to surgery after SEMS: 5–7 days Overall mean follow-up: 37.6 months Preoperative SEMS vs. emergency surgery Overall morbidity: 13.3% vs. 53.8% (P = 0.042) Anastomotic dehiscence: 0% vs. 30.8% (P = 0.035) Wound infection: 13.3% vs. 15.4% (P = 1) Reoperation rate: 0% vs. 30.8% (P = 0.035) Hospital mortality: 0% vs. 7.7% (P = 0.464) Median postoperative hospital stay: 8 vs. 10 days (P = 0.05) Median overall hospital stay: 13 vs. 10 days (P = 0.105) Costs: €6610 vs. €4930 (P = 0.009) Disease-free period: 25.5 vs. 27.1 months (P = 0.096) Tumor reappearance: 53.3% vs. 15.4% (P = 0.055)	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Pirlet, 2011 [30]	RCT	Emergency surgery compared with SEMS as bridge to surgery Bard uncovered SEMS	Patients with acute left-sided malignant large-bowel obstruction SEMS as bridge to surgery (n = 30), Emergency surgery (n = 30)	Efficiency and reduction of the stoma placement rate	Outcomes of SEMS placement Technical success rate: 47% Clinical success rate: 85.7% Bridge to elective colonic resection with primary anastomosis: 40% Median time to surgery: 7 days (5–19 days) No postoperative morbidity for all 12 successfully bridged patients Preoperative SEMS vs. emergency surgery Stoma placement: 43% vs. 57% ($P = 0.30$) Restoration of bowel continuity: 30% vs. 13% ($P = 0.12$) Median duration of stoma: 96 vs. 84 days ($P = 0.68$) Successful primary anastomosis: 53% vs. 43% ($P = 0.45$) Mortality rate: 10% vs. 3% Overall abdominal complications: 23% vs. 23% ($P = 1.000$) Anastomotic leakage: 7% vs. 7% Overall extra-abdominal complications: 27% vs. 33% ($P = 0.57$) Reoperation rate: 10% vs. 7% Median cumulative hospital stay: 23 vs. 17 days ($P = 0.13$) Colonic resection specimen showed 8 clinically silent bowel perforations by the stents	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Van Hooft, 2011 [31]	RCT	Colonic stenting as a bridge to elective surgery compared with emergency surgery Wallstent, WallFlex	Patients with acute left-sided colorectal obstruction SEMS as bridge to surgery (n = 47), Emergency surgery (n = 51)	Mean global health status, mortality, morbidity, other quality-of-life dimensions, and stoma rate	Outcomes of SEMS placement Technical success rate: 70.2% Clinical success rate: 70.2% Perforation rate: 12.8% Bridge to elective surgery: 93.9% (31/33) Successful primary anastomosis: 48.4% Operative specimens showed 3 silent perforations Preoperative SEMS vs. emergency surgery Global health status: 63.0 vs. 61.4 ($P = 0.36$) 30-day mortality rate: 10.6% vs. 9.8%; RR 0.92 (95%CI 0.28–2.98); $P = 0.89$ Overall mortality rate: 19.1% vs. 17.6%; RR 0.92 (95%CI 0.40–2.12); $P = 0.84$ Morbidity rate: 53.2% vs. 45.1%; RR 0.85 (95%CI 0.57–1.27); $P = 0.43$ – Anastomotic leak: 10.6% vs. 2.0% – Abscess: 6.4% vs. 7.8% – Wound infection: 4.3% vs. 2.0% Direct stoma rate: 51.1% vs. 74.5%; RR 1.46 (95%CI 1.06–2.01); $P = 0.016$ Stoma rate at latest follow-up: 57.4% vs. 66.7%; RR 1.16 (0.85–1.59); $P = 0.35$	Moderate
Cheung, 2009 [93]	RCT	SEMS placement followed by laparoscopic resection versus open emergency surgery Wallstent	Patients with an obstructing tumor between the splenic flexure and rectosigmoid junction (n = 48) SEMS as bridge to surgery (n = 24), Emergency surgery (n = 24)	Successful 1-stage operation, cumulative operative time, blood loss, hospital stay, pain score, and postoperative complications	Outcomes of SEMS placement Technical success rate: 83% Clinical success rate: 83% Median time to laparoscopic resection: 10 days (2–16 days) Preoperative SEMS vs. emergency surgery Successful 1-stage operation: 67% vs. 38% ($P = 0.04$) Permanent colostomy: 0% vs. 25% ($P = 0.03$) Anastomotic leakage: 0% vs. 8% ($P = 0.045$) Wound infection: 8% vs. 33% ($P = 0.04$) Intra-abdominal abscess: 0% vs. 4% ($P > 0.99$) Other morbidities: 0% vs. 21% ($P = 0.02$) Cumulative hospital stay: 13.5 vs. 14 days ($P = 0.7$)	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(b) Systematic reviews and meta-analyses on SEMS as bridge to surgery.						
Huang, 2014 [81]	Meta-analysis of RCTs	Preoperative colonic stents versus emergency surgery	Patients with acute left-sided malignant colonic obstruction 7 RCTs SEMS as bridge to surgery (n = 195), Emergency surgery (n = 187)	Efficacy and safety	Mean success rate of colonic stent placement: 76.9% (46.7%–100%) Preoperative SEMS vs. emergency surgery Permanent stoma ($P = 0.002$): OR 0.28 (95% CI 0.12–0.62); $I^2 = 36\%$ Primary anastomosis ($P = 0.007$): OR 2.01 (95%CI 1.21–3.31); $I^2 = 0\%$ Mortality ($P = 0.76$): OR 0.88 (95%CI 0.40–1.96); $I^2 = 17\%$ Overall complications ($P = 0.03$): OR 0.30 (95%CI 0.11–0.86); $I^2 = 77\%$ – Anastomotic leak ($P = 0.47$): OR 0.74 (95%CI 0.33–1.67); $I^2 = 27\%$ – Wound infection ($P = 0.004$): OR 0.31 (95%CI 0.14–0.68); $I^2 = 0\%$ – Intra-abdominal infection ($P = 0.57$): OR 0.62 (95%CI 0.12–3.19); $I^2 = 0\%$	High
Cennamo, 2013 [82]	Meta-analysis of RCTs	Colorectal stenting as palliation or bridge to surgery compared with emergency surgery	Patients with obstructing colorectal cancer (n = 353) 8 RCTs Palliative SEMS placement (n = 37), SEMS as bridge to surgery (n = 141), Emergency surgery (n = 175)	Morbidity, mortality, stoma rate	Outcomes of SEMS placement Technical and clinical success rate: 73.5% and 72% Stent-related complication rate: 10% – Perforation: 8.4% – Stent migration: 0.5% – Obstructions: 1.1% SEMS versus emergency surgery Mortality: 8.4% vs. 8%; OR 0.91 (95%CI 0.29–2.79) Morbidity: 36% vs. 46.3%; OR 2.05 (95%CI 0.67–6.29) Permanent stoma: 25% vs. 48.1%; OR 3.12 (95%CI 1.89–5.17) Preoperative SEMS vs. emergency surgery Primary anastomosis: 65.2% vs. 46.8%; OR 0.42 (95%CI 0.25–0.73) Stoma creation: 36.9% vs. 55.4%; OR 2.36 (95%CI 1.37–4.07)	High

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Cirocchi, 2013 [83]	Meta-analysis of RCTs	Colorectal stenting as a bridge to surgery versus emergency surgery	Patients with intestinal obstruction from left-sided colorectal cancer 3 RCTs SEMS as bridge to surgery (n = 97), Emergency surgery (n = 100)	Clinical success, 30-day mortality, overall complications, survival, permanent stoma	Preoperative SEMS vs. emergency surgery Clinical success rate ($P < 0.001$): 52.5% vs. 99%; OR 45.64 (95%CI 10.51–198.13) 30-day postoperative mortality ($P = 0.97$): 8.2% vs. 9%; OR 0.99 (95%CI 0.23–4.19) Overall complication rate ($P = 0.72$): 48.5% vs. 51%; OR 0.90 (95%CI 0.52–1.58) Overall survival: not analyzed in RCTs Primary anastomosis ($P = 0.003$): 64.9% vs. 55%; OR 2.82 (95%CI 1.43–5.54) Overall stoma rate ($P = 0.02$): 45.3% vs. 62%; OR 0.48 (95%CI 0.26–0.90) Permanent stoma ($P = 0.56$): 46.7% vs. 51.8%; OR 0.82 (95%CI 0.42–1.59) Anastomotic leakage ($P = 0.35$): 9% vs. 3.7%; OR 2.33 (95%CI 0.40–13.52) Intra-abdominal abscess ($P = 0.97$): 5.1% vs. 4.9%; OR 1.03 (95%CI 0.25–4.18) Wound infections ($P = 0.17$): 5.1% vs. 10%; OR 0.39 (95%CI 0.10–1.48) Chest infections ($P = 1.00$): 6.1% vs. 6%; OR 1.00 (95%CI 0.27–3.70) Urinary tract infections ($P = 0.33$): 4% vs. 10.2%; OR 0.45; (95%CI 0.09–2.24)	High

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
De Ceglie, 2013 [84]	Meta-analysis	Colonic stenting as bridge to surgery versus emergency surgery	Patients with left-sided colonic obstruction 5 RCTs 3 Prospective 5 Retrospective 1 Case-matched SEMS as bridge to surgery (n = 405), Emergency surgery (n = 471)	Treatment details, short-term adverse events, mortality and length of hospitalization	Outcomes of SEMS placement Median time to elective surgery: 10 days Technical success rate: 96.9% (95%CI 94.9%–98.9%) – RCTs: 75.8% (95%CI 55.4%–96.3%) Clinical success rate: 94.2% (95%CI 91.4%–97.0%) – RCTs: 73.4% (95%CI 51.0%–95.9%) Stent migration rate: 0% (95%CI 0.0%–0.4%) – Range: 0%–10.5% Perforation rate: 0.1% (95%CI 0.0%–0.4%) – Range: 0%–12.8% Silent perforation rate: 0.1% (95%CI 0.0%–0.5%) – Range: 0%–26.6% Preoperative SEMS vs. emergency surgery: Stoma creation ($P = 0.03$): ES −27.1% (95% CL −51.2, −3.0); $I^2 = 97.2\%$ Protective stoma ($P = 1.0$): ES 0% (95%CL −1.0%, 1.1%); $I^2 = 35.5\%$ Primary anastomosis ($P < 0.001$): ES 25.1% (95%CI 17.0%–33.2%); $I^2 = 94.9\%$ Successful primary anastomosis ($P < 0.001$): ES 23.7% (95%CI 13.6%–33.9%); $I^2 = 83.9\%$ Anastomotic leakage ($P = 0.1$): ES −2.4% (95%CL −5.6%, 0.8%); $I^2 = 51.2\%$ Infection ($P = 0.006$): ES −7.9% (95%CL −13.6%, −2.3%); $I^2 = 59.0\%$ Other morbidities ($P < 0.001$): ES −13.4% (95%CL −17.9%, −8.8%); $I^2 = 0\%$ Mortality: ES −1.9% (95%CL −4.0%, 0.3%); $I^2 = 34.1\%$ Hospital stay: ES −1.0% (95%CL −4.1%, 2.0%); $I^2 = 0\%$	High

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Tan, 2012 [85]	Meta-analysis of RCTs	SEMS as bridge to surgery versus emergency surgery	Patients with acute malignant left-sided large-bowel obstruction 4 RCTs SEMS as bridge to surgery (n = 116), Emergency surgery (n = 118)	Primary anastomosis, stoma and in-hospital mortality, anastomotic leak, 30-day reoperation and surgical site infection	Outcomes of SEMS placement Technical success rate 70.7% Clinical success rate 69.0% Clinical perforation rate: 6.9% Silent perforation rate 14% Preoperative SEMS vs. emergency surgery Primary anastomosis (I^2 = 87%): – Fixed-effect: RR 1.46 (95%CI 1.17–1.82); $P < 0.001$ – Random-effect: RR 1.40 (95%CI 0.84–2.35; $P = 0.20$ Overall successful primary anastomosis ($P < 0.001$): RR 1.58 (95%CI 1.22–2.04); $I^2 = 0\%$ Stoma rate ($P = 0.004$): RR 0.71 (95%CI 0.56–0.89); $I^2 = 0\%$ Permanent stoma ($P = 0.06$): RR 0.75 (95% CI 0.55–1.01); $I^2 = 47\%$ In-hospital mortality ($P = 0.74$): 6.9% vs. 5.9%; RR 1.17 (95%CI 0.46–2.99); $I^2 = 0\%$ Anastomotic leak ($P = 0.71$): RR 0.72 (95%CI 0.13–4.00); $I^2 = 51\%$ 30-day reoperation ($P = 0.82$): RR 0.82 (95% CI 0.15–4.57); $I^2 = 54\%$ Surgical site infection ($P = 0.05$): 12.9% vs. 22.9%; RR 0.56 (95%CI 0.31–0.99); $I^2 = 33\%$	High
Ye, 2012 [86]	Meta-analysis	Preoperative SEMS placement versus emergency surgery	Patients with acute left-sided malignant colonic obstruction 3 RCTs 5 Retrospective SEMS as bridge to surgery (n = 219), Emergency surgery (n = 225)	Primary anastomosis, stoma formation, short term mortality and morbidity	Preoperative SEMS vs. emergency surgery One-stage stoma rate ($P < 0.001$): RR 0.60 (95%CI 0.48–0.76); $I^2 = 37\%$ Permanent stoma rate ($P = 0.14$): RR: 0.80 (95%CI 0.59–1.08); $I^2 = 44\%$ Anastomosis rate ($P < 0.001$): RR 1.64 (95% CI 1.39–1.94); $I^2 = 9\%$ Mortality ($P = 0.77$): RR 0.91 (95%CI 0.50–1.66); $I^2 = 0\%$ Overall morbidity ($P < 0.001$): RR 0.57 (95% CI 0.44–0.74); $I^2 = 78\%$ Anastomotic leakage ($P = 0.19$): RR 0.60 (95%CI 0.28–1.28); $I^2 = 18\%$ Abscess ($P = 0.68$): RR 0.83 (95%CI 0.36–1.95); $I^2 = 0\%$ Extra-abdominal complications ($P = 0.13$): RR 0.67 (95%CI 0.40–1.12); $I^2 = 0\%$	High

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Zhang, 2012 [87]	Meta-analysis	Stent as a bridge to surgery versus emergency surgery	Patients with obstructive colorectal cancer 2 RCTs 6 Retrospective SEMS as bridge to surgery (n = 232), Emergency surgery (n = 369)	ICU usage, success rates of stenting, primary anastomosis, stoma, perioperative mortality and complications, survival	Overall technical success of stenting: 87.1% Preoperative SEMS vs. emergency surgery Need of intensive care (P = 0.03): RR 0.42 (95%CI 0.19–0.93); I^2 = 0% Primary anastomosis (p = 0.001): RR 1.62 (95%CI 1.21–2.16); I^2 = 75% Stoma creation (P = 0.04): RR 0.70 (95%CI 0.50–0.99); I^2 = 11% Permanent stoma (P = 0.52): RR 0.39 (95% CI 0.02–6.75); I^2 = 75% Mortality (P = 0.47): RR 0.73 (95%CI 0.31–1.71); I^2 = 0% Overall complications (P = 0.001): RR 0.42 (95%CI 0.24–0.71); I^2 = 64% Anastomotic leakage (P = 0.004): RR 0.31 (95%CI 0.14–0.69); I^2 = 0% 1-year overall survival (P = 0.51): RR 1.07 (95%CI 0.87–1.31); I^2 = 46% 2-year overall survival (P = 0.10): RR 1.14 (95%CI 0.98–1.34); I^2 = 0% 3-year overall survival (P = 0.39): RR 1.08 (95%CI 0.90–1.31); I^2 = 0%	High
Sagar, 2011 [88]	Cochrane systematic review	Colonic stenting (palliative and bridging) versus surgical decompression	Patients with obstructing colorectal cancers 5 RCTs Colorectal stenting (n = 102), Emergency surgery (n = 105)	Mortality, morbidity, technical and clinical success, hospital stay	Outcome of SEMS placement Technical success rate: 86.0% Stent-related perforation rate: 5.9% Stent migration rate: 2.1% Stent obstruction rate: 2.1% SEMS versus emergency surgery Clinical success rate (P = 0.001): 78.1% vs. 98.8%; OR 0.06 (95%CI 0.01–0.32); I^2 = 0% 30-day mortality (P = 0.53): OR 1.41 (95%CI 0.48–4.14); I^2 = 0% Complications rate (P = 0.38): 39.2% vs. 45.7%; OR 0.79 (95%CI 0.47–1.34); I^2 = 85% Wound complication rate (P = 0.62): 5.6% vs. 12%; OR 0.54 (95%CI 0.05–6.16); I^2 = 64% Mean hospital stay: 11.5 vs. 17.2 days Procedure/operating time: 114 vs. 144 min Median blood loss: 50 vs. 350 ml	High

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(c) Other literature on SEMS as bridge to surgery.						
Gianotti, 2013 [109]	Prospective	Preoperative SEMS placement, palliative SEMS placement or emergency surgery Hanarostent	Patients with colorectal obstruction Malignant (n = 121), Benign (n = 11) Preoperative SEMS placement (n = 49), Palliative SEMS placement (n = 32), Emergency surgery (n = 51)	Short-term and long-term outcomes of different treatment modalities	Overall success rate of stenting: – Technical 95.3% – Clinical 98.8% Median interval to elective surgery: 6 (2–20) days Short-term stent complications: 14.1% – Perforation rate: 1.2% – Stent migration: 4.9% – Stent occlusion: 4.9% – Tenesmus: 1.2% – Pain: 7.4% – Bleeding: 3.7% Preoperative SEMS vs. emergency surgery In-hospital mortality: 2.0% vs. 2.0% ($P = 1.0$) Overall morbidity: 32.7% vs. 60.8% ($P = 0.006$) Protective ileostomy: 14.3% vs. 21.6% ($P = 0.438$) Anastomotic leak: 12.2% vs. 19.6% ($P = 0.416$) Wound infection: 26.5% vs. 54.9% ($P = 0.005$) Intra-abdominal abscess: 14.3% vs. 39.2% ($P = 0.007$) Respiratory tract complication: 10.2% vs. 37.3% ($P = 0.002$) Postoperative ICU care: 10.2% vs. 33.3% ($P = 0.007$) Reoperation: 6.1% vs. 19.6% ($P = 0.052$) Median overall length of hospital stay: 18 (10–39) days vs. 19 (8–128) days ($P = 0.219$) Definitive stoma: 6.3% vs. 26% ($P = 0.012$) Multivariate logistic regression analysis of surgical morbidity: Preoperative SEMS placement ($P = 0.015$): RR 0.35 (95%CI 0.15–0.82) Kaplan–Meier survival curve showed significantly increased 36-month survival in the SEMS group	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Lee GJ, 2013 [102]	Retrospective	SEMS as bridge to elective surgery or emergency surgery Nitinol Taewoong stents	Patients with obstructive colorectal cancer (n = 77) SEMS as bridge to surgery (n = 49), Emergency surgery (n = 28)	Short-term morbidity and mortality	Preoperative SEMS vs. emergency surgery Mean number of harvested lymph nodes: 26 vs. 38 ($P = 0.048$) No significant difference for: – Hospital stay ($P = 0.109$) – Hartmann ($P = 0.467$) – Overall complications: 16.3% vs. 25% ($P = 0.355$) – Anastomotic leakage ($P = 0.297$) – Mortality ($P = 0.183$) 3-year overall survival rate: 68.8% vs. 51.3% ($P = 0.430$) Anastomotic leakage for patients operated within 10 days or after 10 days post-SEMS placement: 20% (3/15) vs. 0% (0/28); $P = 0.037$	Low
Cennamo, 2012 [126]	Prospective	Emergency surgery or surgery after SEMS placement as a "bridge to surgery" WallFlex stent	Patients with acute left-sided colorectal cancer obstruction (n = 86) SEMS as bridge to surgery (n = 47), Emergency surgery (n = 41)	Morbidity and mortality risks with P-POSSUM and CR-POSSUM predictive score models	Technical and clinical success of stenting: 95.7% and 95.7% Stent-related complications: 6.7% – Stool impaction: 2.2% – Rectal bleeding: 2.2% – Silent stent perforation: 2.2% Mean time to surgery in SEMS group: 19 days (range 6–80 days) Preoperative SEMS vs. emergency surgery Primary anastomosis: 100% vs. 87.8% ($P = 0.02$) 30-day mortality rate: 2.4% vs. 9.8% 30-day morbidity rate: 28.9% vs. 61.0 Reoperation: 0% vs. 12.2% ($P = 0.02$) P-POSSUM morbidity: 34.3% vs. 70.5% ($P = 0.001$) P-POSSUM mortality: 2.4% vs. 13.6% ($P = 0.001$) CR-POSSUM mortality: 4.9% vs. 15.1% ($P = 0.001$)	Moderate

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Cui, 2011 [101] *	RCT	Laparoscopic resection 3 or 10 days after SEMS placement versus emergency open surgery	Patients with obstructing left-sided colon cancer SEMS followed by surgery after 3 days (n = 15), SEMS followed by surgery after 10 days (n = 14), Open emergency surgery (n = 20)	1-stage operation rate, length of hospital stay, rates of permanent stoma, postoperative complications	Patients undergoing laparoscopic surgery had: – Less blood loss ($P < 0.001$) – Lower permanent stoma rate ($P = 0.024$) – Less pain ($P < 0.001$) – Lower incidence of postoperative complications – Higher rate of 1-stage operation ($P = 0.004$) Interval to surgery 3 versus 10 days Higher 1-stage operation rate after 10 days ($P = 0.001$) Lower conversion rate after 10 days (P = 0.046)	Moderate
Guo, 2011 [100]	Retrospective	SEMS insertion or primary surgery Uncovered endoprothesis Nanjing	Patients aged ≥70 years diagnosed with acute left-sided colonic obstruction SEMS (n = 34), Emergency surgery (n = 58)	Mortality, avoidance of stoma, and short-term survival in elderly patients	SEMS versus surgery Overall rate of successful bridging with SEMS: 79% Mean time to elective surgery: 9 days (range 4–16) Successful relief of obstruction: 91% vs. 100% ($P = 0.09$) Primary anastomosis rate: 79% vs. 47% ($P = 0.002$) Temporary stoma rate: 9% vs. 53% ($P < 0.001$) Permanent stoma rate: 6% vs. 12% ($P = 0.34$) Median length of hospital stay: 19 vs. 14 days ($P = 0.06$) Acute mortality rate: 3% vs. 19% ($P = 0.03$) Acute complication rate: 24% vs. 40% ($P = 0.11$)	Low

TABLE E3. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Jiménez-Pérez, 2011 [127]	Prospective	Preoperative WallFlex stent placement	Patients with malignant colorectal obstruction (n = 182)	Efficacy and safety of the WallFlex colonic stent as a bridge to surgery	Outcomes of SEMS placement Procedural success rate: 97.8% Major procedural complications: 3.3% – Perforation: 1.7% – Persistent obstruction: 1.1% – Self-limiting bleeding: 0.6% Minor procedural complications: 1.1% – Transient abdominal pain: 1.1% Major post-procedural complications: 4.2% (7/167) – Stent migration: 1.2% – Perforation: 1.2% – Fecal impaction: 1.2% – Persistent obstruction: 0.6% Minor post-procedural complications: 0.6% – Pain requiring analgesia: 0.6% Overall major stent complication rate: 7.8% (13/167) Clinical success until surgery: 94% (141/150) Bridge to elective surgery: 89.8% (150/167) – Clinical success: 97.3% – Median time to surgery: 14 days (IQR 8–20 days) – Stoma creation: 6% – Post-surgical complications: 16.7% – Post-surgical mortality: 2% – Overall stoma performance rate: 6.6% – Diverting stoma: 6%	Moderate
Kim S, 2009 [103] *	No description of study design	SEMS placement as bridge to surgery	Patients with obstructive colorectal cancer (n = 62) Operated <7 days (n = 26), Operated >7 days (n = 30)	Optimal time for elective radical surgery following colonic stent insertion	Technical and clinical success rate: 100% and 90.3% Surgery <7 days versus >7 days Comorbid diseases: 19.2% vs. 56.7% (P = 0.004) Postoperative morbidity: 7.7% vs. 16.7% (P = n.s.) Postoperative mortality: 0% vs. 3.3% No difference in operation time and postoperative recovery Adjusted with comorbid diseases, there was no significant difference for all the variables between the two groups	Low

CI, confidence interval; *CL*, confidence limits; *ES*, effect size; *ICU*, intensive care unit; *IQR*, interquartile range; *n.s.*, not significant; *RCT*, randomized controlled trial; *OR*, odds ratio; *POSSUM*, Physiological and Operative Severity Score for enUmeration of Mortality and Morbidity (*P*-, Portsmouth; *CR*-, colorectal); *RR*, relative risk; *SEMS*, self-expandable metal stent.
*Published in abstract form only.

TABLE E4. (a–d) Palliative placement of self-expandable metal stent (SEMS).

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(a) RCTs comparing palliative SEMS placement with emergency surgery.						
Van Hooft, 2008 [123]	RCT	Through-the-scope WallFlex colorectal stent insertion versus emergency surgery	Patients with incurable stage IV left-sided colorectal cancer Palliative SEMS placement (n = 11), Emergency surgery (n = 10)	Survival in good health out of hospital	SEMS versus surgery Median hospital-free survival in good health: 38 vs. 56 days (P = 0.68) Median total time in hospital: 12 vs. 11 days (P = 0.46) Median total time on ICU: 0 vs. 0 days (P = 0.30) Median total follow-up time: 360 vs. 173 days (P = 0.67) Number of adverse events: 11 vs. 1 (P = 0.001) Patients suffering adverse event: 73% (8/11) vs. 10% (1/10); P = 0.008; RR=7.2	Moderate
Fiori, 2004 [6] & 2012 [108]	RCT	Endoscopic Precision stent placement versus diverting proximal colostomy	Patients with stage IV unresectable rectosigmoid cancer and symptoms of chronic subacute obstruction (n = 22) Palliative SEMS placement (n = 11), Colostomy (n = 11)	Morbidity, mortality, canalization of gastrointestinal tract, restoration of oral intake, hospital stay	Outcomes of SEMS placement Technical and clinical success rate: 100% and 100% Hospital stay: range 2–4 days Median survival: 297 days (125–612 days) Late complications: – Fecal impaction: 18% (2/11) – Tumor ingrowth: 9% (1/11) Outcomes of colostomy No postoperative mortality Surgical revision because of partial prolapse of the colostomy: 9% (1/11) Mean hospital stay: 8 days (range 7–10 days) Median survival: 280 days (135–591 days) Late complications: – Stoma prolapse: 9% (1/11) – Skin inflammation around stoma: 9% (1/11)	Moderate
Xinopoulos, 2004 [128]	RCT	Palliative Wallstent colonic stent placement versus colostomy	Patients with inoperable malignant partial obstruction in the left colon originating from colorectal or ovarian cancer (n = 30) Palliative SEMS placement (n = 15), Colostomy (n=15)	Efficacy, safety, cost–effectiveness	Outcomes of SEMS placement Technical success rate: 93.3% Moderate tumor ingrowth: 43% (6/14), treated with Diomed laser, without reoccurrence of obstructive symptoms Stent migration: 7% (1/14) SEMS versus colostomy Total hospital stay: 28 vs. 60 days Median survival: 21.4 vs. 20.9 weeks (P = n.s.) Average total cost: €2224 vs. €2092 (P = n.s.)	Moderate

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(b) Systematic reviews and meta-analyses on palliative SEMS placement.						
Liang, 2014 [104]	Meta-analysis	SEMS versus surgery for palliative treatment of colorectal obstruction caused by advanced colorectal malignancy	Patients with malignant colorectal obstruction caused by advanced malignancy 3 RCTs 2 Prospective 4 Retrospective Palliative SEMS placement (n = 195), Emergency surgery (n = 215)	Short-term and long-term complications, mortality, and time of hospitalization	Major stent-related complications: – Short-term (<30 days) perforation rate: 3.7% – Long-term (≥30 days) perforation rate: 7.6% – Overall stent migration rate: 8.9% – Re-obstruction: not analyzed. Successful relief of obstruction: – Palliative SEMS: 94% – Surgery: 100% Short-term (<30 days) complication rate ($P = 0.22$): – Palliative SEMS: 26.2% (51/195) – Surgery: 34.5% (74/215) – OR 0.83 (95%CI 0.39–1.79) Long-term (≥30 days) complication rate ($P = 0.03$): – Palliative SEMS: 16.1% (25/155) – Surgery: 8.1% (14/173) – OR 2.34 (95%CI 1.07–5.14) Overall complication rate ($P = 0.56$): – Palliative SEMS: 43.9% (68/155) – Surgery: 45.1% (78/173) – OR 1.27 (95%CI 0.58–2.77) Overall mortality rate ($P = 0.22$): – Palliative SEMS: 7.1% (12/169) – Surgery: 11.6% (22/189) – OR 0.60 (95%CI 0.27–1.34) SEMS required significantly shorter hospitalization: weighted mean difference –6.07 days (95%CL –8.40, –3.74); $P < 0.01$	High

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Zhao, 2013 [105]	Meta-analysis	Palliative stent placement vs. palliative surgical decompression	Patients with malignant colorectal obstruction that was unresectable 3 RCTs 5 Prospective 4 Retrospective 1 Case-matched Palliative SEMS placement (n = 404), Palliative surgery (n = 433)	Hospital stay, intensive care unit admission, clinical success rate, 30-day mortality, stoma formation, complications and overall survival time	Mean length of hospital stay ($P < 0.001$): High – Palliative SEMS: 9.6 days – Surgery: 18.8 days, ICU admission rate ($P = 0.001$): – Palliative SEMS: 0.8% (1/119) – Surgery: 18.0% (22/122) – RR 0.09 (95%CI 0.02–0.38); $I^2 = 0\%$ Mean interval to chemotherapy: – Palliative SEMS: 15.5 days – Surgery: 33.4 days Clinical relief of obstruction ($P < 0.001$): – Palliative SEMS: 93.1% (375/403) – Surgery: 99.8% (433/434) – RR 0.96 (95%CI 0.93–0.98); $I^2 = 3\%$ In-hospital mortality rate ($P = 0.01$): – Palliative SEMS: 4.2% (14/334) – Surgery: 10.5% (37/354) – RR 0.46 (95%CI 0.25–0.85); $I^2 = 0\%$ Overall complication rate ($P = 0.60$): – Palliative SEMS: 34.0% (137/403) – Surgery: 38.1% (172/452) – RR 0.91 (95%CI 0.64–1.29); $I^2 = 66\%$ Early complication rate ($P = 0.03$): – Palliative SEMS: 13.7% (41/300) – Surgery: 33.7% (110/326) – RR 0.45 (95%CI 0.22–0.92); $I^2 = 66\%$ Late complication rate ($P < 0.001$): – Palliative SEMS: 32.3% (60/186) – Surgery: 12.7% (27/213) – RR 2.33 (95%CI 1.55–3.50); $I^2 = 0\%$ Stent complications: – Perforation rate: 10.1% – Stent migration: 9.2% – Stent obstruction: 18.3% Overall survival time (P = n.s.): – Palliative SEMS: 7.6 months – Surgery: 7.9 months Stoma formation rate ($P < 0.001$): – Palliative SEMS: 12.7% (38/299) – Surgery: 54.0% (170/315) – RR 0.26 (95%CI 0.18–0.37); $I^2 = 18\%$	

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(c) Other literature on palliative SEMS placement.						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent, Taewoong, Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Technical success rate: 97.3% Clinical success rate: 95.8% Early complication rate: 13.0% Late complication rate: 26.7% Overall complication rate: 39.7% – Perforation rate: 4.8% – Stent migration: 13.0% – Stent re-obstruction: 18.5% – Other complications: 3.4% 30-day procedural mortality rate: 2.7% Overall re-intervention rate: 30.8% – Endoscopic: 18.5% – Surgical: 14.4% Median post-procedure length of hospital stay: 2 days Median survival: 9.2 months (95%CI 8.2–10.2) Stoma rate: 11.0%	Low
Gianotti, 2013 [109]	Prospective	Preoperative SEMS placement, palliative SEMS placement or emergency surgery Hanarostent	Patients with colorectal obstruction Malignant (n = 121), Benign (n = 11) Preoperative SEMS placement (n = 49), Palliative SEMS placement (n = 32), Emergency surgery (n = 51)	Short-term and long-term outcomes of different treatment modalities	Overall technical success rate of stenting: 95.3% Overall clinical success rate of stenting: 98.8% Median interval to elective surgery: 6 (2–20) days Short-term stent complications: 14.1% Long-term outcome of SEMS (n = 32) Clinical success rate: 81.2% Overall long-term complication rate: 43.8% – Perforation: 3.1% – Stent migration: 12.5% – Occlusion: 9.4% – Tenesmus: 21.9% – Recurrent abdominal pain: 21.9% – Bleeding: 25% Hospital readmission: 34.4% Median survival (n = 29): 10 months (95%CI 4–16)	Moderate

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Huhtinen, 2013 [111]	Retrospective	Palliative SEMS insertion Ultraflex, Hanarostent	Patients with obstructive incurable colorectal cancer (n = 56)	Clinical outcomes of SEMS and factors associated with late complications	Technical and clinical success rate: 75% and 70% (39/56) Overall complication rate: 38% (16/42) – Perforation: 10% – Re-obstruction: 14% – Incontinence: 5% – Pain: 5% – Stent migration: 2% Stent-related mortality: 7% Late complications: 31% Re-intervention rate: 24% – Ostomy (n = 8) – Hartmann (n = 1) – Re-stenting (n = 1)	Low
Yoshida, 2013 [110]	Prospective feasibility study	Palliative Niti-S D-type uncovered stent insertion	Patients with malignant large-bowel obstruction (n = 33)	Efficacy and safety of the new uncovered Niti-S D-type stent	Technical success rate: 100% Clinical success rate: 97% Median follow-up: 126 days (range 20–750) Early complications: – Tenesmus: 6% Late complications: – Stent occlusion: 30% – Stent migration: 3% – Bleeding: 9% – Tenesmus: 3% Re-interventions: – Colostomy: 3% (1/33) – Endoscopic: 27% (9/33) Mean survival: 240 days	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Angenete, 2012 [112]	Prospective stent cohort and retrospective control group	Colorectal SEMS placement or emergency surgery	Patients with colonic obstruction due to rectal or colon cancer Palliative SEMS placement (n = 88), SEMS as bridge to surgery (n = 24), Control group (n = 60)	Morbidity, mortality and hospital stay	Overall technical success rate of SEMS: 96% Overall clinical success rate of SEMS: 90% Overall stent complications: – Stent migration: 5.4% – Perforation: 5.4% – Fistula: 2.7% – Bleeding: 1.8% – Sepsis: 0.9% – Other: 4.5% – Cardiopulmonary: 1.8% Re-stenting: 10% – Clinical failure (n = 1) – Tumor ingrowth (n = 7) – Stent displacement (n = 2) – Stent dysfunction (n = 1) Outcomes in palliative SEMS group Surgery due to complications: 18% – Poor technical success: 5% – Poor clinical success: 5% – Fistula: 2% – Perforation: 5% – Palliative resection: 2% Stoma formation: 8% (7/88) compared with 53% (32/60) in the surgery group	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Meisner, 2012 [113]	Prospective	WallFlex uncovered colonic stent placement	Patients with colorectal strictures secondary to malignant disease undergoing palliative stent placement (n = 255)	Procedural and clinical success, safety	Procedural success rate: 98.4% Follow-up visits and clinical success: – 30 days (n = 206): 87.8% – 3 months (n = 126): 89.7% – 6 months (n = 86): 92.8% – 12 months (n = 36): 96% Overall perforation rate: 5.1% (13/255) Overall stent migration rate: 5.5% (14/255) Cumulative complications: – Perforation rate: 13.8% (13/94) – Stent migration: 12.8% (12/94) – Tumor ingrowth/overgrowth: 17.0% (16/94) – Fecal impaction: 8.5% (8/94) – Second colonic obstruction: 2.1% (2/94) – Bleeding: 4.3% (4/94) – Pain: 4.3% (4/94) – Persistent obstruction: 1.1% (1/94) 12-month mortality rate: 48.6% Stent-related mortality: 0.8%	Moderate
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex, Wallstent, Ultraflex, Hanarostent, Bonastent, Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short-term and long-term efficacy of SEMS	Technical success rate: 91.5% Immediate clinical success rate: 89.7% Mean follow-up: 115 days (1–500 days) Sustained relief of obstruction until death: 77.0% (127/165) Stent patency at 6 and 12 months: 82.1% and 65.7% Overall major complications: 11.9% – Perforation: 6.0% – Stent migration: 5.5% – Stent re-obstruction: 0.5% Permanent colostomy (n = 9)	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Young, 2011 [122]	Prospective	Colonic SEMS insertion Wallstent, Ultraflex, WallFlex	Patients having an attempted SEMS insertion for large-bowel obstruction (n = 100) Palliative SEMS placement (n = 89), Preoperative SEMS placement (n = 11) Malignant obstruction (n = 93), Benign obstruction (n = 7)	Stent patency, morbidity and mortality	Median follow-up: 34.5 (1–64) months Median survival: 4 (95%CI 3.2–4.9) months Technical success rate: 87% 48-hour clinical success rate: 84% 72 patients were considered to have avoided a stoma 30-day mortality: 7% – Stent-related mortality: 1% Stent-related morbidity: 20% – Perforation: 5% – Dislodgement: 4% – Migration: 1% – Obstruction: 5% – Pain: 4% – Incontinence: 1% – Impaction: 1% Patent stent at last follow-up or death: 73%	Moderate
(d) Outcomes of palliative SEMS placement during chemotherapy and antiangiogenic therapy.						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent, Taewoong, Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146) Chemotherapy (n = 58)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Technical success rate: 97.3% Clinical success rate: 95.8% Overall complication rate: 39.7% Overall reintervention rate: 30.8% – Endoscopic: 18.5% – Surgical: 14.4% Predictors of early complications: – Chemotherapy: OR 0.92; $P = 0.974$ Predictors of late complications: – Chemotherapy: OR 5.52; $P = 0.003$ Predictors of endoscopic reintervention: – Chemotherapy: OR 4.30; $P = 0.018$ Predictors of surgical treatment: – Chemotherapy: OR 2.21; $P = 0.242$	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Di Mitri, 2014 [117]	Retrospective	Colorectal SEMS placement WallFlex, Evolution, Ultraflex	Patients with obstructive colorectal cancer (n = 204) Palliative SEMS placement (n = 143), SEMS as bridge to surgery (n = 61) Chemotherapy (n = 105)	Technical success, clinical efficacy, complications	Technical success rate: 99.0% Clinical success rate: 94.6% Median follow-up: 6 months (range 1–32) Overall complications: 15.2% – Tumor ingrowth: 8.3% – Stent migration: 4.9% – Perforation: 2.0% "None of the perforation cases were on bevacizumab" Survival at end of follow-up: 46.1% Univariable analysis of risk factors associated with complications: – Chemotherapy: OR 0.4; $P = 0.88$ Univariable analysis of risk factors associated with death: – Chemotherapy: OR 1.1; $P = 0.89$ Univariable analysis of risk factors associated with tumor ingrowth: – Chemotherapy: OR 0.26; $P = 0.016$ Multivariable analysis of risk factors associated with tumor ingrowth: – Chemotherapy: OR 0.44; $P = 0.009$	Low
Van Halsema, 2014 [51]	Meta-analysis	Colorectal SEMS placement	All patients who underwent colorectal stent placement (n = 4086)	Risk factors for perforation from colonic stenting	Pooled perforation rate for: Patients without concomitant therapy: – 9.0% (95%CI 7.2%–11.1%) Patients treated with chemotherapy: – 7.0% (95%CI 4.8%–10.0%) Patients treated with bevacizumab: – 12.5% (95%CI 6.4%–22.8%)	Moderate

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Canena, 2012 [119]	Retrospective	Palliative colorectal SEMS placement WallFlex, Wallstent, Ultraflex	Patients with inoperable malignant colorectal obstruction (n = 89) Chemotherapy (n = 24)	Long-term clinical efficacy and factors affecting stent patency, clinical success, and complications	Univariate analysis of factors associated with long-term clinical success: Chemotherapy (P = 0.45): – Yes: 70.8% (17/24) – No: 78.5% (51/65) Multivariate logistic analysis of risk factors for stent migration: – Chemotherapy (P = 0.06): OR 11.89 (95%CI 0.90–156.47) Multivariate logistic analysis of risk factors for obstruction: – Chemotherapy (P = 0.35): OR 2.48 (95%CI 0.50–13.08) Multivariate Cox regression analysis of factors associated with stent patency: – Chemotherapy (P = 0.07): HR 5.51 (95%CI 0.86–35.29)	Low
Lee HJ, 2011 [118]	Retrospective	Colorectal SEMS placement or surgery WallFlex, Comvi stent, Niti-S D-type	Patients with metastatic unresectable colorectal cancer with imminent obstruction Palliative SEMS placement (n = 71), Emergency surgery (n = 73)	Long-term outcomes of endoscopic stenting and surgery	Risk factors for late complications: Chemotherapy (P = 0.003): – Yes: 47.8% (22/46) – No: 10% (2/20) Bevacizumab (P = 0.645): – Yes: 20% (1/5) – No: 37.7% (23/61) Palliative chemotherapy was not significantly associated with perforation Multivariate analysis of risk factors for late complications: – Chemotherapy (P = 0.01): OR 10.43 (95%CI 1.75- 62.39) Prognostic factors for overall survival: Chemotherapy (P < 0.001): – Yes: 15.1 months – No: 4.5 months Target agent (P = 0.020): – Yes: 18.4 months – No: 9.6 months Multivariate analysis of factors associated with survival: – Chemotherapy (P = 0.002): HR 0.33 (95%CI 0.33–0.77)	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Luigiano, 2011 [76]	Prospective	Endoscopic WallFlex placement for palliation	Patients with malignant colorectal obstruction (n = 39) Chemotherapy (n = 13)	Outcomes of through-the-scope large-diameter SEMS placement for palliation	Technical success rate: 92.3% Clinical success rate: 89.7% Early complications: – Perforation: 5.6% – Bleeding: 2.8% Late complications: – Tumor ingrowth: 14.3% – Tumor ingrowth and bleeding: 2.8% – Stool impaction: 8.6% – Stent migration: 2.8% Overall median survival: 280 days (range 32–511) No correlation between chemotherapy and late complications ($P = 0.120$) Palliative chemotherapy was associated with longer survival ($P = 0.006$)	Low
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex, Wallstent, Ultraflex, Hanarostent, Bonastent, Evolution	Patients with incurable malignant colonic obstruction (n = 201) Chemotherapy (n = 74), Bevacizumab (n = 8)	Short-term and long-term efficacy of SEMS	Overall chemotherapy did not increase the risk of complications Perforation risk for bevacizumab ($P < 0.001$): – Yes: 50% (4/8) – No: 2.5% – OR 19.6 (95%CI 5.9–64.5)	Low
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered, Comvi stent, WallFlex, Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS placement (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Long-term clinical failure: 36.3% (73/201) – Tumor ingrowth/overgrowth: 22.9% – Stent migration: 9.0% – Perforation: 4.0% – Bleeding: 0.5% Multivariate analysis of risk factors for long-term clinical failure in palliation group: – Chemotherapy ($P = 0.015$): OR 0.52 (95%CI 0.31–0.88)	Low

TABLE E4. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Fernandez-Esparrach, 2010 [120]	Retrospective	Colorectal SEMS insertion Wallstent, WallFlex, Hanarostent	Patients with colorectal cancer of the left colon with obstructive symptoms (n = 47) – Palliative SEMS placement (n = 38), – SEMS as a bridge to surgery (n = 9) Chemotherapy (n = 28)	Long-term clinical success and factors predictive of development of complications	Technical success rate: 94% Clinical success rate: 94% Overall complication rate: 51% – Stent migration: 22% – Perforation: 7% – Re-obstruction: 17% – Tenesmus: 5% Complication-related death: 12% Long-term complication rate for chemotherapy vs. no chemotherapy: 62% (16/26) vs. 33% (5/15); $P = 0.082$ "8/9 patients with stent migration and 2/3 patients with perforation had been treated with chemotherapy"	Low
Small, 2010 [15]	Retrospective	Colonic SEMS placement Ultraflex, Wallstent, WallFlex	Patients with malignant colorectal obstruction (n = 233) – Palliative SEMS placement (n = 168), – SEMS as bridge to surgery (n = 65)	Long-term efficacy, incidence of complications, and risk factors of SEMS placement	Univariate analysis of risk factors for major complications: Palliative chemotherapy ($P = 0.054$): – Yes: 29.8% (25/84) – No: 19.0% (16/84) Bevacizumab therapy ($P = 0.107$): – Yes: 34.8% (8/23) – No: 22.8% (33/145) Univariate analysis of risk factors for perforation: Bevacizumab ($P = 0.064$): – Yes: 17.4% (4/23) – No: 7.6% (11/145)	Low
Cennamo, 2009 [116]	Case series	WallFlex colonic stent placement	Patients with occlusive colon cancer (n = 28) SEMS as bridge to surgery (n = 12) Chemotherapy (n = 9), Bevacizumab (n = 2)	Perforation risk after bevacizumab therapy	Median follow-up: 131 days Delayed colonic perforation occurred in the 2 patients treated with a combination of capecitabine and oxaliplatin plus bevacizumab	Low
Kim JH, 2009 [43]	Prospective nonrandomized	Radiologic dual-design SEMS insertion Flared ends (n = 69), Bent ends (n = 53)	Patients with malignant colorectal obstruction (n = 122) – Palliative SEMS placement (n = 80), – SEMS as bridge to surgery (n = 42)	Clinical safety and efficacy of dual-design stents	Flared-ends versus bent-ends Technical success rate: 94.2% vs. 96.2% Clinical success rate: 93.8% vs. 90.2% Overall complication rate: 18.5% vs. 25.5% Perforation rate: 6.2% vs. 5.9% Stent migration rate: 6.2% vs. 5.9% Stent migration was significantly related to chemotherapy ($P = 0.029$)	Moderate

CI, confidence interval; *CL*, confidence limits; *HR*, hazard ratio; *ICU*, intensive care unit; *n.s.*, not significant; *OR*, odds ratio; *RCT*, randomized controlled trial; *RR*, relative risk; *SEMS*, self-expandable metal stent.

TABLE E5. **(a, b)** Adverse events related to colonic stenting

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(a) Adverse events.						
Abbott, 2014 [11]	Retrospective	Palliative endoscopic SEMS insertion Wallstent, Taewoong, Schneider	Patients with colonic obstruction due to colorectal cancer or metastatic extracolonic disease (n = 146)	Technical success and complication rates of SEMS, and identifying any predictors of stent-related complications and re-intervention	Technical success rate: 97.3% Clinical success rate: 95.8% Median post procedure length of hospital stay: 2 days Early complication rate: 13.0% – Perforation: 4.8% – Stent migration: 3.4% – Re-obstruction: 2.1% – No resolution of symptoms: 2.1% – Ischemic colon: 0.7% Late complication rate: 26.7% – Perforation: 0% – Stent migration: 9.6% – Stent re-obstruction: 16.4% – Synchronous obstruction: 0.7% 30-day procedural mortality rate: 2.7% Overall re-intervention rate: 30.8% – Endoscopic: 18.5% – Surgical: 14.4% Median time to endoscopic reintervention: 4.6 months 4/27 patients required surgical treatment within 30 days of insertion of a second SEMS Median survival: 9.2 months (95%CI 8.2–10.2) Stoma rate: 11.0%	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Di Mitri, 2014 [117]	Retrospective	Colorectal SEMS placement WallFlex, Evolution, Ultraflex	Patients with obstructive colorectal cancer (n = 204) – Palliative SEMS placement (n = 143), – SEMS as bridge to surgery (n = 61)	Technical success, clinical efficacy, complications	Technical and clinical success rate: 99.0% and 94.6% Median follow-up: 6 months (range 1–32) Overall complication rate: 15.2% – Tumor ingrowth: 8.3% – Stent migration: 4.9% – Perforation: 2.0% Early (≤30 days) complications: 3.9% – Perforation: 1.9% – Stent migration: 1.5% – Stent ingrowths: 0.5% Late (>30 days) complications: 11.2% – Stent migration 3.4% – Tumor ingrowths 7.8% SEMS migration or neoplastic ingrowths were treated with a second stent Overall clinical benefit at end of follow-up: 79.4% Survival at end of follow-up: 46.1%	Low
Geraghty, 2014 [16]	Retrospective	Colonic stenting for large-bowel obstruction	Patients in whom SEMS placement was attempted for large-bowel obstruction (n = 334) – CRC palliation (n = 264), – CRC bridge to surgery (n = 52), – Benign (n = 9), – Extrinsic (n = 9)	Outcome of colonic stenting and factors associated with successful intervention	Overall technical success rate: 87.4% Overall clinical success rate: 83.5% Technical failure: – Inability to deploy SEMS: 6.0% – Perforation: 2.7% – Stent migration: 2.1% – Insufficient expansion: 1.2% – Incorrect stent positioning: 0.6% – Peri-interventional cardiorespiratory episode: 1.2% Additional complications: – Significant bleeds <48h (n = 3) – Colovaginal fistula (n = 1) – Rectal abscess (n = 1) Re-stenting for migration or tumor overgrowth: 7.5% Surgical re-intervention: 10.8% 30-day mortality: 13.2%	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Gianotti, 2013 [109]	Prospective	Preoperative SEMS placement, palliative SEMS placement or emergency surgery Hanarostent	Patients with colorectal obstruction Malignant (n = 121), Benign (n = 11) Preoperative SEMS placement (n = 49), Palliative SEMS placement (n = 32), Emergency surgery (n = 51)	Short-term and long-term outcomes of different treatment modalities	Overall technical success rate of SEMS: 95.3% Overall clinical success rate of SEMS: 98.8% Overall early (<30 days) complications: 14.8% – Perforation: 1.2% – Stent migration: 4.9% – Stool impaction: 4.9% – Tenesmus: 1.2% – Pain: 7.4% – Bleeding: 3.7% – Cardiac arrhythmia: 1.2% Long-term outcome of SEMS (n = 32) Clinically successful: 81.2% Overall long-term complications: 43.8% – Perforation: 3.1% – Stent migration: 12.5% – Occlusion: 9.4% – Tenesmus: 21.9% – Recurrent abdominal pain: 21.9% – Bleeding: 25% Treatment of complications: Stent migration: SEMS was immediately replaced successfully Stool impaction: endoscopically guided colon irrigation Tumor ingrowth: stent-in-stent Colorectal bleeding: short-term bleeding did not require endoscopic hemostasis or blood transfusion, while late bleeding required endoscopic hemostasis (n = 1) and blood transfusion (n = 3) Hospital re-admission rate: 34.4% Median survival (n = 29): 10 months (95%CI 4–16)	Moderate

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Zhao, 2013 [105]	Meta-analysis	Palliative stent placement vs. palliative surgical decompression	Patients with malignant colorectal obstruction that was unresectable 3 RCTs 5 Prospective 4 Retrospective 1 Case-matched Palliative SEMS placement (n = 404), Palliative surgery (n = 433)	Hospital stay, intensive care unit admission, clinical success rate, 30-day mortality, stoma formation, complications, and overall survival time	Stent complications: – Perforation rate: 10.1% – Stent migration rate: 9.2% – Obstruction rate: 18.3% Outcomes of palliative SEMS for subgroup of patients with colorectal cancer obstructions (n = 370): – 30-day mortality rate: 3.8% – Early complication rate: 11.2% – Total complication rate: 32.1%	High
Angenete, 2012 [112]	Prospective stent cohort and retrospective control group	Colorectal SEMS placement or emergency surgery	Patients with colonic obstruction due to rectal or colon cancer Palliative SEMS placement (n = 88), SEMS as bridge to surgery (n = 24), Control group (n = 60)	Morbidity, mortality, and hospital stay	Overall technical success rate: 96% Overall clinical success rate: 90% Overall stent complications: – Stent migration: 5.4% – Perforation: 5.4% – Fistula: 2.7% – Bleeding: 1.8% – Sepsis: 0.9% – Other: 4.5% – Cardiopulmonary: 1.8% Stent-related 30-day mortality: 7% Re-stenting: 10% – Clinical failure (n = 1) – Tumor ingrowth (n = 7) – Stent displacement (n = 2) – Stent dysfunction (n = 1) All cases of re-stenting were technically and clinically successful Outcome in palliative SEMS group Surgery due to complications: 18% – Poor technical success: 5% – Poor clinical success: 5% – Fistula: 2% – Perforation: 5% – Palliative resection: 2% Stoma formation: 8% (7/88)	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Cheung, 2012 [58]	RCT	Colonic SEMS placement Taewoong D-type uncovered stent (n = 52), Boston Scientific WallFlex stent (n = 71)	Patients with acute malignant colonic obstruction Palliative SEMS placement (n = 58), SEMS as bridge to surgery (n = 65)	Clinical outcome and safety of the D-type stent and the WallFlex stent	WallFlex versus Taewoong D-Type Outcomes in palliation group: Technical success rate: 100% vs. 100% Clinical success rate: 100% vs. 100% Perforation rate: 3.6% vs. 0% Migration rate: 3.6% vs. 3.3% Re-stenosis rate: 3.6% vs. 0% Median stent patency: – WallFlex: 343 days (range 0–343) – D-type: no events (range 9–218 days)	Moderate
Meisner, 2012 [113]	Prospective	WallFlex uncovered colonic stent placement	Patients with colorectal strictures secondary to malignant disease undergoing palliative stent placement (n = 255)	Procedural and clinical success, safety	Procedural success rate: 98.4% Follow-up visits and clinical success: – 30 days (n = 206): 87.8% – 3 months (n = 126): 89.7% – 6 months (n = 86): 92.8% – 12 months (n = 36): 96% Overall perforation rate: 5.1% (13/255) Overall stent migration rate: 5.5% (14/255) Cumulative complications: – Perforation rate: 13.8% (13/94) – Stent migration: 12.8% (12/94) – Tumor ingrowth/overgrowth: 17.0% (16/94) – Fecal impaction: 8.5% (8/94) – Second colonic obstruction: 2.1% (2/94) – Bleeding: 4.3% (4/94) – Pain: 4.3% (4/94) – Persistent obstruction: 1.1% (1/94) 12-month mortality rate: 48.6% Stent-related mortality: 0.8%	Moderate

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
de Gregorio, 2011 [48]	Retrospective	Colorectal stent placement Wallstent, SX-ELLA intestinal stent	Patients with total or partial large-bowel obstruction secondary to malignancy (n = 467) – SEMS as bridge to surgery: 75.5%, – Palliative SEMS placement: 24.5%	Procedure time, radiation dose, technical success, clinical success	Technical success rate: 92.5% Clinical success rate: 88.2% Overall complication rate: 19% 30-day mortality rate in bridge-to-surgery group: 4.3% Mean follow-up in palliation group: 15.6 months Primary stent patency without complications: 52.9% – Cumulative secondary patency: 100% Mean survival in palliation group: 234 days	Low
Manes, 2011 [55]	Retrospective	Colonic stent placement WallFlex, Wallstent, Ultraflex, Hanarostent, Bonastent, Evolution	Patients with incurable malignant colonic obstruction (n = 201)	Short-term and long-term efficacy of SEMS	Technical success rate: 91.5% Immediate clinical success rate: 89.7% Technical failures: – Inability to pass guidewire: 5% – Stent malposition: 2% – Perforation: 0.5% – Failed stent deployment: 1% Early stent failure – Early migration: 3.3% (6/184) – Stent malposition: 7.1% (13/184) – Early perforation: 1.1% (2/184) Mean follow-up: 115 days (1–500 days) Sustained relief of obstruction until death: 77.0% (127/165) Stent patency at 6 and 12 months: 82.1% and 65.7% Overall major complication rate: 11.9% – Perforation: 6.0% – Stent migration: 5.5% – Stent re-obstruction: 0.5%	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Meisner, 2011 [12]	Prospective cohort	WallFlex Colonic stent placement	Patients with malignant colonic obstruction (n = 463) – Palliative SEMS placement (n = 255), – SEMS as bridge to surgery (n = 182), – Indication not specified (n = 10)	Performance, safety, and effectiveness of colorectal stents	Overall procedural success rate: 94.8% – No stent could be placed: 3.5% – Poor stent position: 1.1% – Inability of stent to deploy: 0.2% – Perforation: 0.4% 25% of patients were not eligible for 30-day clinical success evaluation Intention-to-treat 30-day clinical success rate: 71.6% Per-protocol 30-days clinical success rate: 90.5% 30-days mortality rate: 8.9% – 3/40 deaths related to stent perforation 30-days cumulative adverse events: – Fecal impaction: 1.6% – Mucosal/bowel impaction into stent: 0.5% – Second colonic obstruction: 0.3% – Bleeding: 0.5% – Perforation: 3.9% – Stent migration: 1.8% – Pain: 1.8% – Persistent obstruction: 0.8%	Moderate
Park JK, 2011 [59]	Retrospective	Through-the-scope palliative SEMS insertion Uncovered: Wallstent, Niti-S, Bonastent, Hanarostent Covered: Niti-S, Bonastent	Patients with incurable malignant colorectal obstruction (n = 103) – Uncovered SEMS (n = 73), – Covered SEMS (n = 30)	Success rates and complication rates according to stent type	Uncovered versus covered SEMS Technical success rate: 100% vs. 100% Clinical success rate: 100% vs. 97% Overall complication rate: 26% vs. 20% Stent patency up to death: 74% vs. 80% Median stent patency: – Uncovered SEMS: 55 days (range 3–460) – Covered SEMS: 62 days (range 1–630)	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Van Hooft, 2011 [31]	RCT	Colonic stenting as a bridge to elective surgery compared with emergency surgery Wallstent, WallFlex	Patients with acute left-sided colorectal obstruction SEMS as bridge to surgery (n = 47), Emergency surgery (n = 51)	Mean global health status, mortality, morbidity, other quality-of-life dimensions, and stoma rate	Outcomes of SEMS placement Technical success rate: 70.2% Clinical success rate: 70.2% Perforation rate: 12.8% Bridge to elective surgery: 93.9% (31/33) Successful primary anastomosis: 48.4% Operative specimens showed 3 silent perforations	Moderate
Yoon, 2011 [8]	Retrospective	Colorectal SEMS insertion Niti-S covered, Comvi stent, WallFlex, Niti-S D-type	Patients with malignant colorectal obstruction (n = 412) – Palliative SEMS placement (n = 276) – SEMS as bridge to surgery (n = 136)	Rates and factors predictive of technical and clinical failure of SEMS	Palliation group: – Technical success: 87.0% – Clinical success: 83.8% Bridge-to-surgery group: – Technical success: 97.8% – Clinical success: 94.7% Overall technical failure: 9.5% (39/412) – Inability to pass guidewire: 7.3% – Technical difficulty because of colonic immobilization and severe pain: 1.9% – Nonexpansion of SEMS: 0.2% Immediate clinical failure in palliation group: 16.3% (39/240) – Perforation: 2.9% – Severe pain: 0.8% – Stent migration: 0.8% – No resolution of symptoms because of stent failure: 11.7% Long-term clinical failure: 36.3% (73/201) – Tumor ingrowth/overgrowth: 22.9% – Stent migration: 9.0% – Perforation: 4.0% – Bleeding: 0.5% Median duration to long-term clinical failure: 287 days (range 4–507)	Low

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Young, 2011 [122]	Prospective	Colonic SEMS insertion Wallstent, Ultraflex, WallFlex	Patients having an attempted SEMS insertion for large-bowel obstruction (n = 100) – Palliative SEMS placement (n = 89) – Preoperative SEMS placement (n = 11) – Malignant obstruction (n = 93) – Benign obstruction (n = 7)	Stent patency, morbidity, and mortality	Median follow-up: 34.5 months (range 1–64) Median survival: 4 months (95%CI 3.2–4.9) Technical success rate: 87% – Inability to pass guidewire: 7% – Inadequate stenting: 4% – Synchronous obstruction: 1% – Perforation: 1% Patency rate: – 48-hour: 84% – 30-day: 76% 30-day mortality rate: 7% – Stent-related mortality: 1% Overall stent-related morbidity rate: 20% Early (<30 days) complications: – Perforation: 4% – Dislodgement: 4% – Migration: 0% – Obstruction: 2% – Pain: 4% – Incontinence: 1% – Impaction: 0% Late (>30 days) complications: – Perforation: 1% – Dislodgement: 0% – Migration: 1% – Obstruction: 3% – Pain: 1% – Incontinence: 1% – Impaction: 1% Patent stent at last follow-up or death: 73%	Moderate

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
Van Hooft, 2008 [123]	RCT	Through-the-scope WallFlex colorectal stent insertion versus emergency surgery	Patients with incurable stage IV left-sided colorectal cancer Palliative SEMS placement (n = 11), Emergency surgery (n = 10)	Survival in good health out of hospital	Outcomes of palliative SEMS: Technical success: 9/10 – Inability to pass guidewire (n = 1) Early complications (<30 days): – Perforation (n = 2) – Severe diarrhea (n = 1) – Severe pain (n = 1) 30-day mortality: 2/10 Late (>30 days) complications: – Perforation (n = 4) – Fecal impaction (n = 1) – Tumor ingrowth (n = 1) – Stent migration (n = 1)	Moderate
Watt, 2007 [121]	Systematic review	Colorectal SEMS placement compared with surgical procedures	Patients with malignant colorectal obstruction 88 articles, of which 15 comparative Palliative SEMS placement (n = 762), SEMS as bridge to surgery (n = 363), Clinical pathway not clear (n = 660)	Efficacy and safety of SEMS	Median rate of technical success: 96.2% (range 66.6%–100%) Median rate of clinical success: 92% (range 46%–100%) Median stent patency: 106 days (range 68–288) Overall, 90.7% (118/130) of patients either died or ended follow-up with a patent stent Median stent migration rate: 11% (range 0%–50%) Median perforation rate: 4.5% (range 0%–83%) Median re-obstruction rate: 12% (range 1%–92%)	Moderate

TABLE E5. Continued

First author, year	Study design	Intervention	Participants	Outcomes	Results	Level of evidence
(b) Outcomes of secondary placement of self-expandable metal stent (SEMS) after initial stent failure.						
Yoon, 2013 [114]	Retrospective	SEMS reinsertion or palliative surgery Niti-S covered, Comvi covered, WallFlex uncovered, Niti-S D-type uncovered	Patients who underwent palliative SEMS insertion for the treatment of malignant colorectal obstruction, and had recurrence of obstructive symptoms for various reasons and required secondary interventions SEMS reinsertion (n = 79), Palliative surgery (n = 57)	Overall survival, progression-free survival, and luminal patency	Secondary SEMS outcomes Technical success rate: 97.5% Clinical success rate: 86.1% Median follow-up: 142 days Immediate complications: 13.9% – Migration (n = 8) – Perforation (n = 2) – Severe bleeding (n = 1) Late complications: 15.2% – Migration (n = 8) – Perforation (n = 4) No SEMS-related mortality SEMS (n = 58) versus surgery Median overall survival: 8.2 vs. 15.5 months (P = 0.895) 12-month survival: 42.1% vs. 46.3% Median progression-free survival: 4.0 vs. 2.7 months (P = 0.650) Median luminal patency: 3.4 vs. 7.9 months (P = 0.003) Immediate complications: 13.9% vs. 1.8% Late complications: 15.2% vs. 1.8% Immediate mortality: 0% vs. 7% Late mortality: 0% vs. 5.3%	Low
Yoon, 2011 [115]	Retrospective	Secondary SEMS placement as stent-in-stent Niti-S covered, Comvi covered, WallFlex uncovered, Niti-S D-type uncovered	Patients who underwent secondary SEMS because of the recurrence of obstructive symptoms (n = 36)	Immediate and long-term clinical success and complications	Median duration of primary stent patency: 81 days Immediate clinical success: 75% Long-term clinical failure: 51.9% – Migration (n = 7) – Perforation (n = 4) – Tumor ingrowth (n = 3) Median follow-up after clinical success: 105 days At end of follow-up, 44.4% remained free of obstruction symptoms until death Palliative bypass surgery: 33.3%	Low

n.s., not significant; *RCT*, randomized controlled trial.