

# Interdisciplinary Canadian Guidelines on the Use of Metal Stents in the Gastrointestinal Tract for Oncological Indications

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## Abstract

**Objective:** To provide evidence-based guidelines regarding the appropriate use of gastrointestinal stents for oncologic indications. This document describes the use of gastrointestinal stents by appropriately trained physicians.

**Methods:** This document is based on a review of the published evidence and supplemented by consensus expert opinion. Gastrointestinal stenting has been evaluated in terms of technical success, complications, patient satisfaction, clinical outcome, and cost-benefit analysis. This document was approved by the Canadian Interventional Radiology Association; approval from the other relevant Canadian societies is pending.

**Conclusion:** Gastrointestinal stenting has a valuable role in the management of gastrointestinal malignancy. The decision to use such devices should be taken after comprehensive multidisciplinary clinical, endoscopic, and radiologic evaluation.

**Disclaimer:** This interdisciplinary Canadian guideline on the use of metal stents in the gastrointestinal tract for oncological indications is based on a scientific literature review and relevant clinical experience. This guideline attempts to define principles of practice for most circumstances, though adherence to this guideline will not, of course, produce successful outcomes in every case.

## Abrégé

**Objectif :** Offrir des lignes directrices fondées sur des données probantes concernant l'usage approprié des stents gastro-intestinaux pour des indications oncologiques. Ce document décrit l'usage de stents gastro-intestinaux par des médecins ayant reçu une formation appropriée.

**Méthodes :** Ce document est basé sur une revue des données probantes publiées, et complété par l'opinion unanime d'experts. Le stenting gastro-intestinal a été évalué d'après le succès technique, les complications, la satisfaction du patient, le résultat clinique, et l'analyse coût-avantage. Ce document a été approuvé par l'Association canadienne de radiologie d'intervention; l'approbation d'autres sociétés canadiennes pertinentes est en instance.

**Conclusion :** Le stenting gastro-intestinal a un rôle valable dans le traitement de la malignité gastro-intestinale. La décision d'utiliser de tels instruments devrait se prendre après une évaluation complète multidisciplinaire clinique, endoscopique, et radiologique.

**Renoncement :** Ce guide canadien interdisciplinaire sur l'usage de stents de métal dans le tractus gastro-intestinal pour des indications oncologiques est basé sur une revue de la documentation scientifique et une expérience clinique pertinente. Ce guide tente de

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définir des principes de pratique dans la plupart des circonstances, mais l'observance de ces lignes directrices ne produira évidemment pas de résultats favorables dans chaque cas.

This guideline is not intended to dictate rules for patient management, nor should it be deemed to be inclusive of all proper methods of care or exclusive of other methods of care reasonably directed as gaining the appropriate results. Variations in practice are expected and can be appropriate. The ultimate judgment regarding the care of a particular patient must be made by the physician in an informed discussion with the patient, in light of all the circumstances presented by the patient, the diagnostic and treatment options available, and available resources. The syllabus is not intended to define or serve as a standard of medical care. Standards of medical care are specific to all the facts or circumstances involved in an individual case and can be subject to change as scientific knowledge and technology advance, and as practice patterns evolve.

There are various disease processes that result in intestinal luminal narrowing or obstruction, and approaches have been developed to treat these pathologies. Among these are gastrointestinal stenting, which mechanically bridges the obstructed segment. The first generation of devices were constructed of plastic and of fixed diameter. Expandable metal stents were subsequently developed to ease delivery and reduce complications while improving efficacy. This paper will focus on current-generation expandable metal stents.

With the continuing evolution of techniques and devices, there has been an increase in the use of biliary, esophageal, and enteral stents. At the same time, there is evidence of geographical variation in the application of this technology; one reason for this may be a lack of knowledge regarding its use. The most common indication for gastrointestinal stenting is in the oncology population, either as palliation or a bridge to surgery. Our goal is to summarize the current state of knowledge on gastrointestinal self-expandable metal stenting for malignant indications, including the following: indications, contraindications, patient work-up, devices and equipment, technique, complications, pre- and post-procedure care, training, and economic considerations.

We used an evidence-based approach in creating the document. Primary searches involved searches of the National Library of Medicine database. Secondary searches were then performed by examining the reference lists of recently published articles and texts. There were a limited number of prospective randomized controlled studies, all of which suffered from small sample sizes. The literature largely consists of single-centre case series reports.

A multidisciplinary team, including experienced clinicians in several of the relevant specialties—gastroenterology,

interventional radiology, surgical oncology, general surgery, and radiation oncology—reviewed the data and created a draft document that was subsequently circulated to practitioners for review. The recommendations have also been reviewed and approved by the Canadian Interventional Radiology Association. Approval is pending from the other relevant Canadian societies.

## Document Outline

The first section covers general issues. Thereafter, the paper is organized by anatomic location as follows: esophagus, gastro-duodenum, biliary tract, and colon and rectum. For each, there are 6 subsections as follows:

- Background, including indications and contraindications
- Patient evaluation
- Available devices
- Procedural techniques
- Post-procedure patient care
- Outcomes, including benefits and complications

## General Issues

### *Patient Assessment*

As these patients are commonly complex with multiple treatment options, a multi-disciplinary approach is essential. The exact make up of the team may vary between institutions, however, it will generally include a combination of gastroenterology, surgery, oncology, interventional radiology, and palliative care. Thorough and complete patient evaluation must include establishment of the diagnosis, full understanding of the extent of disease (stage), review of symptomatology, assessment of comorbidities, knowledge of previous therapies, and explicit discussion about patient goals, preferences, and life expectancy.<sup>1</sup> With the exception of bridge to surgery (pre-operative decompression of obstructed viscus), curative options must be considered prior to stenting. Other than benign biliary stricture, there are very few indications for gastrointestinal stenting in patients with benign disease.

A detailed knowledge of the patient's anatomy is required before a decision can be made regarding the patient's suitability for stenting, and to plan the procedure.

Imaging work-up may include endoscopy, computed tomography (CT), ultrasound (US), and (or) fluoroscopic barium studies. Laboratory investigations will depend on the clinical scenario.

## Recommendations

1. A multidisciplinary approach
2. Comprehensive clinical evaluation
3. Detailed knowledge of patient's anatomy

### Consent and Patient Information

Prior to obtaining consent, the referring physician should ensure that a full discussion has taken place regarding treatment options; this may involve the participation of several members of the treatment team. The physician who will place the stent must discuss the risks and benefits individualized to that patient, allowing sufficient time for due consideration.

There are many valuable resources that may assist the patient in understanding more about the procedure and the disease process, which may contribute to the consent process. For example, there are several websites maintained by various national and international societies that provide accurate information.<sup>2-4</sup>

### Devices

It is not the intent of this document to describe or recommend specific devices. It is the operator's responsibility to ensure appropriate device selection for specific patients. It is also essential that the operator is familiar with specific deployment instructions for each device.

There is an increasing trend for metal stents to be constructed from a nickel–titanium alloy. As the stents are nonferromagnetic, patients may undergo magnetic resonance imaging (MRI) at any time. Stainless steel stents may be ferromagnetic, and may be subject to migratory forces during MRI scanning in the immediate post-implantation period. Stents endothelialize in 3 to 6 weeks; after this time, there is no risk of device migration. Thus patients may undergo MRI after this time. Both stent types will result in mild local field inhomogeneity artifact on MRI (severity depends upon stent type) and to beam hardening artifact on CT; it is advised that diagnostic studies be performed prior to stent placement. These stents will not be detected by airport security screening systems.<sup>5</sup>

### Infrastructure Requirements and Clinical Interdependencies

To safely perform gastrointestinal stenting, there must be access to a well-equipped interventional radiology or endoscopy suite, which includes:

- Adequate room size for patient, equipment, and personnel
- High-quality fluoroscopic imaging chain (fixed C-arm is preferable)
- High-quality endoscopy equipment
- Intra-procedural ready access to an appropriate inventory of devices (wires, catheters, and more)
- Oxygen
- Suction
- Resuscitation equipment
- Patient monitoring equipment
- Nursing for patient- and procedural-support
- Medical radiography technologist
- Post-procedure room

- Ready access to relevant emergency services, including, respiratory technology, anesthesia, and surgery

### Training and Expertise

The placement of gastrointestinal stents is not the prerogative of any one specialty. Interventional radiologists, gastroenterologists, and surgeons with appropriate training and experience routinely perform these procedures. Currently, there are no training or accreditation standards in Canada. Development of such standards is recommended, which should include a minimum annual practice volume required to maintain expertise. Practitioners should be encouraged to maintain a logbook or database to monitor outcomes.

As a minimum, physicians considering performing stent placement must be knowledgeable and experienced in advanced interventional radiologic or endoscopic techniques. Strong consideration should be given to development of preceptor training.

## Malignant Esophageal Obstruction

### Background

Malignant esophageal obstruction may result from either primary esophageal carcinoma, or from extrinsic compression caused by metastatic disease in the mediastinum. A diagnosis of esophageal cancer carries a poor prognosis, with a 5-year survival rate of 5% to 20% among those amenable to surgery.

Prior to the 1970s, most esophageal cancers were squamous cell carcinomas; however, since then the incidence of esophageal adenocarcinoma has increased dramatically, particularly among Caucasian males in the United States.<sup>6</sup> Risk factors for esophageal cancer include tobacco use, alcohol consumption, obesity, and gastroesophageal reflux.<sup>7</sup>

The principal curative option is surgery; however, only 20% to 30% of patients are amenable at presentation. A second option with long-term disease-free survival is chemoradiotherapy, with long-term control in 20% to 30% of patients. Combinations of chemoradiotherapy and surgery are also used. Palliative options include chemotherapy, radiation, photodynamic therapy, endoscopic Nd:YAG laser therapy, and stent placement.

Stenting should be considered in the following situations: contraindication to traditional first-line therapy; failure of definitive therapy; total dysphagia; and established symptomatic fistula. Stents have been shown to improve patients' nutritional status and quality of life,<sup>8,9</sup> and are associated with rapid symptomatic improvement. In a long-term study of patients with severe malignant esophageal obstruction, Saxon et al<sup>10</sup> found stent placement to be safe and effective, providing immediate relief of dysphagia in 50/52 patients (96%). Long-term studies have also demonstrated low complication and mortality rates,

**Table 1: Indications and contraindications for placement of an esophageal expandable metal stent in the setting of symptomatic malignant esophageal obstruction**

<b>Indications</b>	
Recurrence following chemoradiotherapy	
Contraindication to chemoradiotherapy	
Actual or impending fistula	
Total dysphagia, including patients who may be candidates for multi-modality treatment	
<b>Contraindications</b>	
Curable by multimodality therapy, without total dysphagia <sup>a</sup>	
Yet to receive palliative multimodality treatment, without total dysphagia	
Within 2 cm of proximal esophageal sphincter	
Inability to tolerate procedure <sup>a</sup>	
Uncontrolled bleeding diathesis <sup>a</sup>	
Potential for significant tracheal compression	
High ECOG score	
<sup>a</sup> Indicates absolute contraindication	
ECOG = Eastern Cooperative Oncology Group Score	

and long-term efficacy in relieving obstructive symptoms in patients with malignant dysphagia.<sup>11</sup>

In a prospective randomized trial comparing laser therapy and stent placement, Adam et al<sup>12</sup> found that self-expandable metal stent placement was significantly superior to laser therapy, associated with a greater improvement in dysphagia score. An earlier study by Loizou et al<sup>13</sup> found that use of plastic stents were equal or superior to laser therapy in improving dysphagia scores, except in patients palliated over a longer period. Laser therapy is not widely available and has the disadvantage of an increased number of treatments, which can become a burden in patients with a short lifespan,<sup>13</sup> and increasingly difficult as the tumour progresses and the patient becomes debilitated.<sup>14</sup> Esophageal fistulae are a serious potential complication of esophageal cancer, occurring in up to 5% of cases.<sup>15</sup> These patients have few treatment options. Studies have demonstrated the efficacy of stent placement in eliminating the respiratory complications and in allowing the patient to swallow.<sup>11,16-19</sup>

Wenger et al<sup>20</sup> performed a randomized economic evaluation, comparing stent placement with endoluminal brachytherapy for palliation of 60 patients with incurable esophageal or gastro-esophageal cancer, and found that stenting was more cost-effective (median total lifetime costs of €17 690, compared with €33 171, for the stenting and brachytherapy groups, respectively;  $P = 0.005$ ) (Table 1).

### Patient Evaluation

The anatomic location and length of disease must be determined. As a minimum, this must include a pre-procedural CT scan, preferably with intravenous and intraluminal contrast administration. Additionally, endoscopic evaluation and a barium study may be valuable. If there is clinical suspicion of a fistula, an oral contrast study should be performed.

### Available Devices

A well-designed randomized controlled trial comparing silastic esophageal stents with expandable metal esophageal stents demonstrated that metal stents were associated with fewer complications, shorter post-procedure hospitalization stays, and lower costs, and may be placed during a single, outpatient treatment session.<sup>21</sup> Since this trial, metal stents have largely replaced plastic stents as the treatment of choice.

The choice of covered, compared with uncovered, metal stents has also been investigated. Initial stent designs were uncovered; however, tumour ingrowth was a frequent complication. The next generation of esophageal stents used various composite coverings, but these were associated with a high rate of migration, owing to lack of incorporation into the esophagus.<sup>22,23</sup> The more recent development of partially-covered stents has resulted in improved patency and reduced migration rates, compared with earlier designs.<sup>11</sup> A partially-covered stent leaves a portion of the proximal and distal aspects of the stent uncovered, to allow for better fixation.

Although there are numerous available devices, there are no clear studies indicating superiority. There are also specific device designs that are intended to reduce gastroesophageal reflux.<sup>24</sup>

Appropriate stent size must be chosen. As a general guide to stent selection, it is recommended that the covered portion of the stent be about 3 cm longer than the length of the esophageal abnormality. The vast majority of stents placed are of a standard diameter. In unusual circumstances, including tracheoesophageal fistula without stricture and anatomic variants, a larger diameter stent should be considered.

### Procedural Techniques

Patient safety and comfort must be considered at all times. A dedicated sedation nurse, resuscitation equipment, suction, and monitoring equipment must be in the room at all times.

Stent insertion should occur under real-time radiological guidance with or without endoscopic assistance. Endoscopic-only guidance without immediate availability of fluoroscopy is not recommended, if it is not possible to advance the endoscope through the lesion.



## Endoscopic

The procedure is usually performed with moderate sedation. The patient position is variable and based on physician preference. The proximal and distal dimensions of the tumour are measured endoscopically, and based on this information, an appropriately-sized stent is chosen, positioned, and deployed.

If the lesion cannot be traversed, blind advancement of the guidewire should not be attempted; fluoroscopic advancement of the guidewire is mandatory in these cases. Intraluminal location must be confirmed. The stent is then advanced and deployed according to the specific manufacturer's instructions for use.

Once the stent is deployed, the proximal end is assessed endoscopically. No attempt should be made to advance the endoscope through the area of stricture because of risk of stent migration. Post-deployment radiographs are obtained as baseline.

## Radiologic

The procedure is performed with moderate sedation. Patient position is typically right-lateral-decubitus, so that injected luminal contrast flows away from the gastroesophageal junction. A 5-French multipurpose catheter is advanced and directed into the esophagus over a guidewire, under fluoroscopic control. Dilute barium or nonionic water-soluble contrast is injected to demonstrate the upper and lower aspects of the stricture. It is essential not to inject water-soluble ionic contrast given the risk of aspiration and subsequent pulmonary edema. The stricture is traversed using standard guide wire technique. The stent is then advanced and deployed according to the specific manufacturer's instructions for use. Following deployment, contrast is injected to ensure luminal patency and free flow into the stomach. Post-deployment radiographs are obtained as baseline.

### Post-Procedure Patient Care

The procedure may be safely performed on an outpatient basis. Post-procedure, the patient is monitored according to standard moderate sedation guidelines. Afterwards, the patient may be discharged if stable, under the care of a responsible adult.

Patients should be counselled regarding pain control and reminded about benign typical post-stent symptoms, and potential complications (see below and Table 2). Patients should be warned that they may experience chest pain for several days post-stent insertion.

Swallowing may be initiated as soon as the effects of moderate sedation and topical anesthesia have abated. In general, patients should initiate a soft or liquid diet, and avoid fibrous and dense foods (Appendix I). Patients should be advised to eat in an upright position.

**Table 2: Complications of self-expandable metal esophageal stents for malignant esophageal obstruction<sup>a</sup>**

Complication	%
Immediate/procedural	5.4
Misplacement	0.3
Failed expansion	3.9
Failed deployment	0.8
Migration	0.3
Chest pain	12.2
Perforation	0.6
Death (related to stent placement)	1.4
Delayed	
Tumour over/ingrowth	11.3
Migration	6.8
Gastroesophageal reflux disease	3.7
Recurrent dysphagia	8.2
Tracheoesophageal fistula	2.8
Bleeding	3.9
Perforation	0.8
Death (within 30 days of stent placement)	7.4

<sup>a</sup>Modified from Ramirez et al<sup>27</sup>

If the stent is positioned across the gastroesophageal junction, the patient should be prescribed a proton-pump inhibitor and instructed to sleep with the bed elevated at a 30° angle.

There is no need for routine follow-up. Patients should be advised to return to their physician should any difficulties arise.

## Outcomes

### Benefits

The technical success rate of expandable metal stent deployment is generally between 90% to 100%,<sup>25-27</sup> and it is associated with rapid symptomatic improvement of dysphagia in as high as 96% of patients.<sup>10</sup> The mean improvement in dysphagia score in patients who have a stent successfully placed is typically between 1.28 and 2.5.<sup>26,28,29</sup>

### Complications

One of the most exhaustive literature evaluations of immediate and delayed complications was performed by Ramirez et al<sup>30</sup> (Table 2).

**Table 3: Indications and contraindications for placement of a gastroduodenal stent in the setting of malignant GDO**

<p><b>Indications</b></p> <p>Clinical gastric outlet obstruction caused by malignancy (for example, gastric, duodenal, pancreatic, biliary cancer, metastatic disease, or end-stage lymphoma)</p>
<p><b>Contraindications</b></p> <p>Curable disease<sup>a</sup></p> <p>High Eastern Cooperative Oncology Group Score</p> <p>Inability to tolerate procedure<sup>a</sup></p> <p>Uncontrolled bleeding diathesis<sup>a</sup></p>
<p><sup>a</sup>Indicates absolute contraindication</p>

There is some controversy whether previous radiation increases the risk of complications. Raijman et al<sup>31</sup> performed a retrospective analysis of 60 patients who had a stent placed for malignant dysphagia and (or) digestive-respiratory fistula. In the 21 patients with no previous chemotherapy or radiation therapy, 2 (9.5%) had life-threatening complications, compared with 3/39 (8%) of patients who had previous chemotherapy or radiation therapy. Contrary to these results, Kinsman et al<sup>32</sup> reported 8/22 (36.4%) of patients with prior radiation and (or) chemotherapy to have life-threatening complications, compared to 1/37 (2.5%) of patients without prior therapy.

**Key Messages**

1. Stent placement should be preceded by a multidisciplinary evaluation.
2. Once a decision to place a stent has been made, careful planning of the procedure with appropriate investigation is essential.
3. The stent must be placed under fluoroscopic guidance if it is not possible to cross the lesion with the endoscope.

**Malignant Gastroduodenal Obstruction**

*Background*

Malignant gastroduodenal outlet obstruction (GDO) occurs secondary to malignancies of the stomach and duodenum, pancreas, and biliary system, and as a result of nodal metastasis. It is usually a manifestation of advanced disease. Patients may require gastric decompression for comfort, and feeding for nutrition and fluid balance. Surgical resection and (or) bypass is the standard therapy for patients with GDO, however, given the relatively short life expectancy of these patients, it is not optimal in this patient population. The surgical treatment may be associated with significant rates of morbidity and mortality.

For patients with very short life expectancy, a nasogastric or nasojejunal tube is often first-line.

Self-expanding metal stenting is a therapeutic option that was first performed in 1993<sup>33</sup> and has been studied in numerous series. In a retrospective review of 176 patients who had undergone stent placement for malignant gastric outlet obstruction by Telford et al,<sup>34</sup> 84% of patients resumed oral uptake for a median time of 146 days. In a retrospective review comparing open surgical gastrojejunostomy to placement of self-expanding metal stents for patients with GDO, Del Piano et al<sup>35</sup> found that stents were associated with a greater clinical success rate (92%, compared with 56%, *P* = 0.0067), shorter hospital stay, lower mortality rate at 30 days, and lower morbidity rate. Further, the mean survival was longer in the stented patients and the out-of-hospital survival. Four other comparative studies, by Yim et al,<sup>36</sup> Wong et al,<sup>37</sup> Johnsson et al,<sup>38</sup> and Espinel et al,<sup>39</sup> found similar results, that stenting was either at least as good, or better, than surgery (Johnsson et al<sup>38</sup> found surgery to be associated with a longer survival; however, the difference was not statistically significant). Mehta et al<sup>40</sup> performed a prospective randomized trial comparing laparoscopic gastrojejunostomy with duodenal stenting in 27 patients, and found that patients who underwent stenting had a shorter hospital stay, quicker improvement in physical health, and fewer complications. Maire et al<sup>41</sup> found that stenting of patients with biliary and (or) duodenal stenoses, as a first-intention treatment in patients with unresectable adenocarcinoma of the head of the pancreas was safe and effective in the long term.

In a large systematic review of available evidence (*n* = 606), Dormann et al<sup>42</sup> reported the technical and clinical success rate of malignant gastric or duodenal obstruction as 97% and 87%, respectively. There was no procedural-related mortality, and severe complications such as bleeding and perforation were reported in 1.2% of all patients. Stent migration occurred in about 5% of patients.

There is also evidence that placement of gastroduodenal stents as opposed to palliative surgery results in cost-savings. For example, Yim et al<sup>36</sup> found that treatment involving stent placement totalled US\$9921 while that involving palliative surgery totalled US\$28 173. Johnsson<sup>38</sup> found the respective costs to be US\$7215 and US\$10 190 for stenting, compared with surgery, and Raikar et al<sup>43</sup> found similar results.

*Patient Evaluation*

A thorough anatomic evaluation must be performed to confirm safety and technical feasibility of metal gastroduodenal stent placement, and to assist in the selection of a device. This must include a pre-procedural CT scan, preferably with intravenous and intraluminal contrast administration, endoscopic evaluation, and a barium study, which may be valuable.

These patients should specifically be assessed for existing or impending biliary obstruction. Due to access concerns, if



biliary drainage will ultimately be required, it should be performed prior to placement of the duodenal stent.

### *Available Devices*

Metal stents for this indication are uncovered. There are a variety of diameters and lengths. It is recommended that the length of the stent be selected so that the stent is several centimetres longer than the underlying stricture. Special consideration must be given so that the proximal and distal aspects of the stent conform to the natural curves of the stomach and (or) duodenum.

### *Procedural Techniques*

Patient safety and comfort must be considered at all times. Resuscitation equipment, suction, monitoring equipment, a nurse dedicated to the patient's moderate sedation, and an additional assistant must be in the room at all times.

Stent insertion should occur under real-time radiological guidance with or without endoscopic assistance. Endoscopic-only guidance, without immediate availability of fluoroscopy is not recommended.

### **Endoscopic**

The procedure is usually performed with moderate sedation. The patient position is variable and based on physician preference. The proximal and distal dimensions of the tumour are measured endoscopically using a gastroscope with a 3.7-mm channel, and based on this information, an appropriately-sized stent is chosen and deployed.

If the lesion cannot be traversed with the endoscope, a triple-lumen endoscopy retrograde cholangiopancreatography (ERCP) catheter is used to obtain a water-soluble contrast study of the stricture. A 0.035-inch extra-stiff guidewire is advanced into the proximal jejunum. The enteral stent is then advanced through the endoscope channel over the guidewire and deployed under endoscopic and fluoroscopic guidance. Luminal patency is confirmed by injection of water-soluble contrast through the endoscope channel. Post-deployment radiograph(s) are obtained as baseline.

It is not recommended to perform immediate post-deployment dilatation, as many stents continue to expand throughout the first 24 to 48 hours. If after 48 hours stent stenosis persists and the patient has not improved symptomatically, balloon dilatation may be considered.

### **Radiologic**

Whenever possible, it is strongly advised to have a nasogastric tube positioned to decompress the stomach for several days prior to the procedure to reduce the size of the stomach and facilitate technical success.

The procedure is performed with moderate sedation. The patient is placed in a supine position. A 5-French multipurpose

catheter is advanced per os and directed down the esophagus and into the stomach over a guidewire, under fluoroscopic control. Water-soluble contrast is injected to demonstrate the upper and lower aspects of the stricture. The stricture is traversed using standard guidewire technique. For stent delivery it is essential to use a stiff guidewire to facilitate adequate stent tracking. In cases where tortuosity limits the ability to place the stent per os, placement by way of direct gastric puncture is an option. The stent is then advanced and deployed according to the specific manufacturer's instructions. Following deployment, contrast is injected to ensure luminal patency and free flow beyond the stent. Post-deployment radiographs are obtained as baseline.

It is not recommended to perform immediate post-deployment dilatation, as many stents continue to expand throughout the first 24 to 48 hours. If after 48 hours stent stenosis persists and the patient has not improved symptomatically, balloon dilatation may be considered.

### *Post-Procedure Patient Care*

The procedure may be safely performed on an outpatient basis. Post-procedure, the patient is monitored according to standard moderate sedation guidelines. Afterwards, the patient may be discharged if stable, under the care of a responsible adult.

Patients should be counselled regarding pain control and reminded about benign typical post-stent symptoms, and potential complications (see below and Tables). Patients should be warned that they may experience abdominal pain for several days post-stent insertion.

No routine post-stent care is necessary unless there are specific concerns. There are no specific recommendations regarding post-stent diet if the lumen of the stent is fully patent. If this is not the case, then the clinician may have to impose dietary restrictions.

### *Outcomes*

#### **Benefits**

Dormann et al<sup>42</sup> performed a systematic review on the use of self-expanding metal stents for gastroduodenal malignancies, which included 32 case series and 606 patients (Table 4).

#### **Complications**

Table 5 lists the complications as reported by Dormann et al.<sup>42</sup>

#### *Key Messages*

1. Evaluate for coexistent biliary obstruction.
2. Gastric decompression prior to radiological placement facilitates success.
3. Self-expanding metal stents should be the treatment of choice for palliative patients with gastroduodenal

**Table 4: Technical and clinical success rates of self-expandable metal stents for malignant GDO<sup>a</sup>**

	%	
Technical success	97%	
Clinical success (relief of symptoms and [or] improved food intake)	89%	
	Pre-stenting	Post-stenting
Oral intake		
Full diet	0%	48%
Soft solids	5%	39%
Liquids only	34%	13%
No oral intake	61%	0%

<sup>a</sup>Adapted from Dormann et al<sup>39</sup>

**Table 5: Complications of self-expandable metal stents for malignant GDO<sup>a</sup>**

Complication	%
Procedural mortality	0
Severe complications	1.2
Perforation	0.7
Bleeding	0.5
Nonsevere complications	26.7
Stent obstruction	17.2
Stent migration	5.1
Pain	2.5
Biliary	1.3
Other	0.7

<sup>a</sup>Adapted from Dormann et al<sup>39</sup>

obstruction owing to advanced, incurable, malignant disease.

## Biliary Obstruction

### Background

There are multiple etiologies of malignant biliary obstruction, including cholangiocarcinoma, gallbladder carcinoma, pancreatico-duodenal carcinoma, and regional nodal metastasis. Multiple factors must be considered prior to proposed intervention, including the patient’s symptoms (such as, degree of jaundice, pain, and presence of sepsis), location, and extent of disease. For example, patients who have multiple noncommunicating biliary strictures, typically have more complications and poorer outcomes than patients with a simple, single distal stenosis. A specific technical factor to consider is the presence of ascites.

It has been demonstrated that endoscopically-placed plastic biliary stents are preferable to biliary bypass surgery in the palliation of malignant biliary obstruction. Three randomized trials showed that plastic stent placement was either equal or superior to surgery in survival times, morbidity, quality of life, and hospitalization requirements.<sup>44-46</sup> However, there was at least one trial that suggested that surgical biliary bypass was the optimum treatment in patients surviving greater than 6 months, with a lower late morbidity rate.<sup>47</sup> All of these studies compared plastic rather than metal stents to surgery. Although metal stents have not been directly compared with surgery, subsequent studies comparing plastic with metal stents have shown superiority of metal stents.<sup>48-51</sup>

Endoscopic stent placement for the palliation of unresectable malignant biliary obstruction is associated with a technical success rate of 90% to 97%,<sup>52,53</sup> and a clinical success rate (resolution of jaundice, pruritus) of 80% to 90%.<sup>44,53-55</sup> Additional studies have demonstrated improvement in quality of life measures associated with stent placement, including not only pruritus and jaundice but also indigestion, anorexia and appetite, mood, physical health, and level of activity.<sup>56,57</sup> There has also been evidence that stenting is of significantly lower cost than surgery: Martin et al<sup>58</sup> found the median total lifetime cost for surgical therapy and endoscopic therapy to be US\$60 986 and US\$24 251, respectively.

ERCP is the preferred option for stenting of the biliary tree with a dominant stricture below the bifurcation. Above the bifurcation, local expertise and experience will dictate whether the procedure is performed radiologically or through ERCP.

### Patient Evaluation

Prior to placement of a stent, patients should undergo routine blood work, including electrolytes, leukocyte count, hemoglobin, platelet count, prothrombin time/international normalized ratio, and partial thromboplastin time. Adequate



imaging is important to determine anatomy and for treatment planning. US is a readily available bedside procedure that allows an overall assessment of dilatation. CT is an alternate modality that may also provide a detailed overview of ductal anatomy, multiplicity of strictures, location, and size of hepatic masses, that is not operator-dependent. Magnetic resonance cholangiopancreatography is an excellent noninvasive method to evaluate ductal anatomy and is particularly useful in the pre-operative assessment of cholangiocarcinoma.

### Available Devices

There is no difference in patient survival times when comparing plastic or metal stents in randomized trials.<sup>48,59</sup> While plastic stents are less expensive, studies have demonstrated a median occlusion time of about 3.5 to 4.0 months.<sup>48,60,61</sup> If the patient is predicted to have a lifespan greater than 4 months, metal stents are more cost-effective despite increased cost for each device, as the cost of reintervention in patients receiving plastic stents outweighs the initial cost-savings achieved by using a lower-cost device.<sup>49,61</sup> If the expected lifespan is less than 4 months, plastic stents are most cost-effective. Soderlund and Linder<sup>61</sup> suggested using the presence of metastases as an indication for use of plastic stents.

There is little current evidence available comparing covered and uncovered stents. Yoon et al<sup>62</sup> compared covered and uncovered stents for palliation of unresectable distal malignant biliary obstruction and found no significant difference between stent patencies. In general, use of uncovered stents is advocated if the gall bladder remains in situ or if the tumour is hilar in location, to avoid blockage of the other biliary radicles.<sup>63</sup> Covered stents are typically used in the setting of intraluminal extension of tumour.

A recent trial examined the difference between 3 types of metal stents, 2 types of balloon-expandable, and 1 self-expanding, and found one of the balloon-expandable types to have the longest patency.<sup>64</sup> However, the second type of balloon-expandable stent was found to have a shorter patency than the self-expanding stent. Therefore, it remains unclear whether balloon or self-expanding stents should be preferred.

Plastic stents tend to become occluded by a bacterial biofilm and typically require replacement every 3 to 4 months.<sup>65</sup> For this reason, larger stents (10-French or 11.5-French diameter) may be preferable, as they have been shown to remain patent 2 to 3 times longer than 7-French or 8-French stents.<sup>66,67</sup>

### Procedural Techniques

Patient safety and comfort must be considered at all times. Resuscitation equipment, suction, monitoring equipment, a nurse dedicated to the patient's moderate sedation, and an additional assistant must be in the room at all times.

Stent insertion should occur under real-time radiological guidance, with or without endoscopic assistance. Endoscopic-only

**Table 6: Indications and contraindications for placement of a metal biliary stent in the setting of malignant biliary obstruction**

<b>Indications</b>
Intractable pruritis
Jaundice
Chemotherapy requiring normalization of liver function
Cholangitis
<b>Contraindications</b>
Curable disease <sup>a</sup>
Multiple non-communicating strictures
High ECOG score
Inability to tolerate procedure <sup>a</sup>
Uncontrolled bleeding diathesis <sup>a</sup>

<sup>a</sup>Indicates absolute contraindication

ECOG = Eastern Cooperative Oncology Group Score

guidance without immediate availability of fluoroscopy is not recommended.

Prophylactic antibiotics are recommended by the Society of Interventional Radiology.<sup>68</sup>

### Endoscopic

The ERCP is performed with moderate sedation. The common bile duct is selectively cannulated and the cholangiogram is obtained. Endoscopic sphincterotomy is performed and guide wire and guide catheter are advanced across the stricture. Using a guide catheter, the length of the stricture is measured and a stent of appropriate length is selected (8 mm to 10 mm diameter). The stent is introduced over the guide wire through the endoscope channel and deployed under fluoroscopic and endoscopic control. Luminal patency is confirmed by free drainage of bile and contrast injection. Post-deployment radiographs are obtained as a baseline.

For very tight strictures, balloon dilatation may be performed to facilitate stent placement. It is not recommended to perform immediate post-deployment dilatation, as many stents continue to expand throughout the first 24 to 48 hours. If after 48 hours stent stenosis persists and the patient has not improved symptomatically, balloon dilatation may be considered.

### Radiologic

The procedure is performed with moderate sedation. The patient is placed in a supine position. Using fluoroscopic or real-time ultrasound guidance (recommended), access to an appropriate dilated intrahepatic bile duct is obtained using either a micropuncture 21- or 18-gauge needle. Following

placement of an appropriate catheter, ductal anatomy is confirmed with injection of nonionic contrast. The stenosis is traversed using standard guidewire technique. In cases of a very tight stricture, pre-dilatation may facilitate stent placement and reduce the incidence of stent migration. Otherwise, an appropriately sized expandable stent is placed through an introducer sheath, typically 8 to 10 mm in diameter by 6 to 8 cm in length. Luminal patency is confirmed with contrast injection. If there is significant stenosis, immediate balloon dilatation could be performed; however, many stents continue to expand throughout the first 24 to 48 hours. Depending upon various patient factors and contrast flow, the sheath may be removed or a small catheter may be left to facilitate subsequent imaging or intervention. Post-deployment radiographs are obtained as baseline.

### Post-Procedure Patient Care

Although most patients who have biliary stents placed at the time of ERCP will be discharged the same day, most often the patients undergoing percutaneous transhepatic stent placement will be admitted to hospital for overnight observation.

Patients undergoing percutaneous transhepatic placement of a stent commonly experience moderate post-procedure abdominal pain. This is easily controlled with analgesics, sometimes requiring narcotics.

Post-procedure antibiotics are seldom required other than in cases when there is grossly purulent bile at the time of the procedure. Blood work including aspartate aminotransferase, alkaline phosphatase, and bilirubin should be measured within one week post-procedure.

Prior to discharge, patients should be made aware of potential complications such as cholangitis and stent obstruction. The patient should be advised to return to a physician or the emergency department immediately, should any concerns arise.

### Outcomes

#### Benefits

The technical success rate for endoscopic stent placement for palliation of unresectable malignant biliary obstruction is typically from 90% to 98%.<sup>53,54,69</sup> The clinical success rate (resolution of jaundice, pruritus) ranges from 80% to 90%.<sup>44,54-56</sup> Other studies have demonstrated improvement in quality of life measures such as indigestion, anorexia and appetite, mood, physical health, and level of activity.<sup>57</sup>

#### Complications

Han et al<sup>69</sup> performed a review of recent literature for the treatment of malignant biliary obstruction with the use of covered biliary stents, and reported early and late migration rates of 4.8% (range 0% to 20%) and 1% (range 0% to 10%), respectively, and an incidence of cholangitis after stent deployment of 2.5% (range 0% to 11%). Others have reported the incidence of

cholangitis to occur within a range of 4.9% to 22% of cases.<sup>54,70-72</sup> Early stent occlusion may also occur, reported with an incidence of 3.2% by De Palma et al.<sup>54</sup>

Delayed complications include cholecystitis in 1.9% (range 0% to 12%), pancreatitis in 0.3% (range 0% to 3%), biloma in 1.1% (range 0% to 8%), stent dislocation in 1% (range 0% to 10%), and sludge formation in 2% (range 0% to 20%) of patients.<sup>69</sup>

In the study by Yoon et al,<sup>62</sup> stent occlusion occurred after a mean of 398 and 319 days in patients treated with a covered and uncovered stent, respectively. The stent patency rates at 100, 200, 300, and 400 days were 83%, 66% to 78%, 54% to 67%, and 36% to 54%, respectively, depending on type of stent (covered, compared with uncovered), although the differences were not significant.

### Key Messages

1. If expected survival is greater than 4 months, a metal stent is cost-effective, compared with a plastic stent.
2. Careful consideration of disease extent and symptoms is essential for appropriate decision making.
3. Multidisciplinary cooperation is essential in order to optimize treatment strategy and technical success.

## Malignant Colorectal Obstruction

### Background

Colonic stenting may be considered in 2 groups of patients: those who present with a curable, acute malignant obstruction (bridge to surgery), and those with advanced disease who require palliation.

Colorectal cancer presents as an emergency situation in which intervention is required in about 14% of cases to treat acute obstruction.<sup>73</sup> A Canadian study found that 18.7% of colon cancer patients with newly diagnosed colorectal cancer had an initial presentation of emergency obstruction, perforation, or admission.<sup>74</sup>

Current surgical practice in patients with an acute malignant obstruction usually involves a 2-stage procedure. This includes the creation of a stoma, which may be permanent. However, emergency surgery in cancer patients presenting with colonic obstruction has been shown to be associated with a mortality rate that is between 10% to 30%, whereas the same operation performed as an urgent or elective procedure has a lower complication and mortality rate (post-operative morbidity of 23.2% and 39.1% for elective and emergency surgery, respectively, and post-operative mortality of 3.4% and 11.6%, respectively<sup>75</sup>). Stenting as a bridge to surgery has been advocated; 70% of colonic obstructions occur in the left side of the colon,<sup>76</sup> and are thus accessible to endoluminal stenting.<sup>77,78</sup> Relief of obstruction prior to definitive surgery allows time for surgical preparation, including cancer staging. Ultimately, unnecessary

surgery may be avoided altogether if staging indicates advanced disease.<sup>79</sup>

In a systematic pooled analysis of 54 studies with 1198 patients, Sebastian et al<sup>80</sup> reported on the success and complication rates of using self-expanding metal stents in the management of colorectal obstruction as an alternative to emergency surgery. The median technical success rate was 94%, while the median clinical success rate (considered relief of obstruction) was 91%. The median clinical success rate when stenting was used specifically as a bridge to surgery was 76%. Major complications were stent migration (11.8%), reobstruction (7.3%), and perforation (3.8%), while the mortality rate was 0.58%.

In a Canadian study, Targownik et al<sup>81</sup> used decision analysis to show that colonic stent insertion as a bridge to elective surgery for acute malignant colonic obstruction was more effective and cheaper than emergency surgery. Other studies<sup>82,83</sup> found that stenting resulted in a cost-reduction (12% to 28.8%) in patients for whom curative surgery was planned. Cost-reductions were realized owing to decreases in complication rate, need for intensive care, length of stay, costs of stoma care, and need for subsequent surgery.

In the palliative patient, stent placement for the treatment of malignant colorectal obstruction also has advantages.<sup>80,84</sup> Avoiding colostomy formation and decrease in length of hospital stay may be even more critical in the palliative patient population. Further, stent placement does not preclude chemoradiotherapy.<sup>85</sup>

Stenting may be considered in patients with obstruction from extrinsic compression, for example secondary to ovarian cancer, and peritoneal carcinomatosis. In this circumstance, patients should be evaluated to exclude multiple sites of obstruction.

#### *Patient Evaluation*

A thorough anatomic evaluation must be performed to confirm safety and technical feasibility of metal colonic stent placement, and to assist in the selection of a device. Specifically, the anatomic location and length of disease must be determined. As a minimum, this must include a pre-procedural CT scan, preferably with intravenous and intraluminal contrast administration. Additionally, endoscopic evaluation and a barium study may be valuable. Multilevel obstruction must specifically be considered at the time of review of appropriate imaging studies.

#### *Available Devices*

Metal stents for this indication are uncovered, self-expanding, commonly 25 mm in diameter and 10 to 15 cm in length. It is recommended that the length of the stent be selected such that the landing points of the stent conform to the natural curves of the colon.

**Table 7: Indications and contraindications of placement of a gastrointestinal stent in the setting of malignant colonic obstruction**

Indications
Bridge to surgery
Palliation
Contraindications
Lesion of less than 2 cm above dentate line
Multilevel obstruction
High Eastern Cooperative Oncology Group Score
Inability to tolerate procedure <sup>a</sup>
Uncontrolled bleeding diathesis <sup>a</sup>

<sup>a</sup>Indicates absolute contraindication

#### *Procedural Techniques*

Patient safety and comfort must be considered at all times. A dedicated sedation nurse, resuscitation equipment, suction, and monitoring equipment must be readily available at all times.

Stent insertion should occur under real-time radiological guidance with or without endoscopic assistance. Endoscopic-only guidance, without immediate availability of fluoroscopy is not recommended.

#### **Endoscopic**

The procedure is performed with moderate sedation. The proximal and distal extent of the tumour is determined with a therapeutic channel gastroscope (for distal lesions), and based on this information, an appropriately sized stent is chosen and deployed. For proximal lesions, a regular colonoscope would be employed.

If the lesion cannot be traversed with the endoscope, a triple-lumen ERCP catheter is used to obtain a water-soluble contrast image of the stricture. A 0.035-inch extra-stiff guidewire is advanced into the proximal colon. The gastrointestinal stent is then advanced through the endoscope channel over the guidewire and deployed under endoscopic and fluoroscopic guidance. Luminal patency is confirmed by injection of water-soluble contrast through the endoscope channel. Post-deployment radiographs are obtained as baseline.

#### **Radiologic**

The procedure is performed under moderate sedation. The patient is typically placed in a left lateral decubitus position. A 5-French multipurpose catheter is advanced through the rectum under fluoroscopic control. The stricture is traversed using standard guidewire technique. Water-soluble contrast is

**Table 8: Technical and clinical success rates of self-expanding metal stent insertion in patients with malignant colonic obstruction<sup>a</sup>**

	Range, %	Median, %
Technical success - overall	64–100	94
Palliative	67–100	96
Bridge to surgery	33–100	84
Clinical success - overall	55–100	91
Palliative	62–100	93
Bridge to surgery	45–84	76

<sup>a</sup>Adapted from Sebastian et al<sup>77</sup>

injected to demonstrate the upper and lower aspects of the stricture. The stent is then advanced, typically over a super-stiff guidewire, and deployed according to the manufacturer's instructions. Following deployment, contrast is injected to ensure luminal patency and free flow beyond the stent. Post-deployment radiographs are obtained as baseline.

In a systematic review that included 29 published reports, Khot et al<sup>86</sup> found 8 reports in which the authors performed balloon predilatation. These reports identified a higher incidence of perforation than the 21 reports in which balloon predilatation was not performed. Therefore, balloon predilatation of the stricture is not recommended.

Given that these stents are self-expanding and temperature-sensitive, they will expand over time, reaching maximal endoluminal diameter over the subsequent 24 to 48 hours. Immediate post-stent deployment balloon dilatation has been associated with an increased risk of perforation<sup>80</sup> and is therefore contraindicated.

#### Post-Procedure Patient Care

The procedure may be safely performed on an outpatient basis. Post-procedure, the patient is monitored according to standard moderate sedation guidelines. Afterwards, the patient may be discharged if stable and their overall clinical condition allows, under the care of a responsible adult.

Patients should be reminded that it is common to experience mild post-procedural pain or discomfort. The quality of the pain may also be different than that just before the procedure. Patients should receive a post-procedure information sheet explaining potential complications and associated symptoms, and other general information (Appendix I). There is no specific post-procedure post-stent care necessary. It is recommended that patients adhere to a low-residue diet, to reduce the risk of stent occlusion.

#### Outcomes

##### Benefits

Sebastian et al<sup>80</sup> reported on the success and complication rates of using self-expanding metal stents in the management of colorectal obstruction as an alternative to emergency surgery in a systematic pooled analysis of 54 studies of 1198 patients. The technical and clinical success rates are shown in Table 8.

##### Complications

In a pooled analysis, Sebastian et al<sup>80</sup> found the major complications related to colorectal stents to be perforation (3.8%), migration (11.8%), and reobstruction (7.3%). The overall mortality rate was 0.58%.

A systematic review by Khot et al<sup>86</sup> reported on the incidence of less serious complications. The weighted mean for bleeding was 5% (severe 1%, not severe 4%), pain was 5% (severe 1%, not severe 5%), and migration was 10%.

#### Key Messages

1. Gastrointestinal stents should be considered in patients with acute malignant obstruction, both in bridge to surgery and palliative settings.
2. Comprehensive imaging to rule out multilevel obstruction should be performed.
3. Dilatation of malignant strictures prior to or following stent placement should not be performed.

#### Discussion

Gastrointestinal stents have a valuable role in the treatment of patients with malignant obstruction. Despite this, there is evidence of variation in their use at a population level suggesting underuse in many jurisdictions. Potential causes may include limited training, lack of manpower, lack of awareness, and budgetary restrictions.<sup>87,88</sup>

Given the currently limited frequency of these procedures, there may not be sufficient opportunity during residency or fellowship training programs to provide adequate experience for the trainee as the primary operator. Stent placement is essentially an extension of basic wire-and-catheter technique in which interventional radiologists and endoscopists are fully trained; it should therefore be possible to develop a system of mentoring and (or) preceptorship to provide the additional skills necessary to achieve competence and thereby increase the pool of appropriately skilled operators.

Within Canada, there is currently a perceived<sup>89</sup> shortage of physicians in general, and specialists, including gastroenterologists and interventional radiologists, in particular.<sup>90</sup> While there is no simple solution to this issue, this suggests a need to increase enrolment in medical schools and residency training programs.



Awareness among the medical community may be increased by numerous means, including hospital rounds and educational events. For specific patients, the appropriate application of gastrointestinal stents may also be promoted by participation of relevant practitioners at multidisciplinary cancer-care conferences (tumour boards).

Gastrointestinal stents may cost several thousands of dollars each to purchase, and their use usually incurs significant associated costs. As this is a relatively new field of activity, it is rare for sufficient resources to have been allocated for this technology. The relative inflexibility of most Canadian departmental- or program-based hospital budgets in which resources are allocated to specialty services, rather than disease processes, is an impediment to appropriately responsive resource-usage. The challenge is to develop evidence-based business cases for the various clinical situations in which gastrointestinal stents may be used, demonstrating their cost-benefit within the current Canadian medicoeconomic context.

## Future Directions

As with other medical procedures and devices, gastrointestinal stenting technology is constantly evolving. Some of the earlier studies referred to in this guideline used stents of smaller diameter or different design than are available today. As the relatively young field matures and new products are developed, it is expected that technical ease-of-use and clinical success will increase, and complications and costs decline.

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## References

- Rosenfeld K. Palliative care assessment: what are we looking for? *Gastroenterol Clin N Am.* 2006;35(1):23–39.
- Society of Interventional Radiology. Society of Interventional Radiology [Internet]. Fairfax (VA): SIR [cited 2008 May 26]. Available from: <http://www.sirweb.org>.
- The American College of Radiology, The Radiological Society of North America, ACR and RSNA. *RadiologyInfo* [Internet]. ACR [cited 2008 May 26]. Available from: <http://www.radiologyinfo.org>.
- American Society for Gastrointestinal Endoscopy. ASGE: American Society for Gastrointestinal Endoscopy [Internet]. Oak Brook (IL): ASGE [cited 2008 May 26]. Available from: <http://www.asge.com>.
- Shellock, FG. Reference manual for magnetic resonance safety, implants, and devices. Los Angeles (CA): Biomedical Research Publishing Group; 2005.
- Devesa SS, Blot WJ, Fraumeni JF. Changing patterns in the incidence of esophageal and gastric carcinoma in the United States. *Cancer.* 1998;83:2049–2205.
- Blot WJ, McLaughlin JK. The changing epidemiology of esophageal cancer. *Semin Oncol.* 1999;26(5 Suppl 15):2–8.
- Angueira CE, Kadakia SC. Esophageal stents for inoperable esophageal cancer: which to use? *Am J Gastroenterol.* 1997;92:373–376.
- Baron T. Expandable metal stents for the treatment of cancerous obstruction of the gastrointestinal tract. *N Engl J Med.* 2001;344:1681–1687.
- Saxon RR, Barton RE, Katon RM, et al. Treatment of malignant esophageal obstructions with covered metal Z stents: long-term results in 52 patients. *JVIR.* 1995;6(5):747–754.
- Rajman I, Siddique I, Ajani J, et al. Palliation of malignant dysphagia and fistulae with coated expandable metal stents: experience with 101 patients. *Gastrointest Endosc.* 1998;48:172–179.
- Adam A, Ellul J, Watkinson AF, et al. Palliation of inoperable esophageal carcinoma: a prospective randomized trial of laser therapy and stent placement. *Radiology.* 1997;202(2):344–348.
- Loizou LA, Grigg D, Atkinson M, et al. A prospective comparison of laser therapy and intubation in endoscopic palliation for malignant dysphagia. *Gastroenterology.* 1991;100:1303–1310.
- Rutgeerts P, Vantrappen G, Broeckaert L. Palliative Nd:YAG laser therapy for cancer of the esophagus and gastroesophageal junction: impact on the quality of remaining life. *Gastrointest Endosc.* 1988;34:87–90.
- Martini N, Goodner JT, D'Angio GJ, et al. Tracheoesophageal fistula due to cancer. *J Thorac Cardiovasc Surg.* 1970;49:319–324.
- Bethge N, Sommer A, Vakil N. Treatment of esophageal fistulas with a new polyurethane-covered, self-expanding mesh stent: a prospective study. *Am J Gastroenterol.* 1995;90:2143–2146.
- Miyayama S, Matsui O, Kadoya M, et al. Malignant esophageal stricture and fistula: palliative treatment with polyurethane-covered Gianturco stent. *J Vasc Interv Radiol.* 1995;6:243–248.
- Saxon RR, Barton RE, Katon RM, et al. Treatment of malignant esophagorespiratory fistulas with silicone-covered metal Z stents. *JVIR.* 1995;6:237–242.
- Dumonceau J-M, Cremer M, Lalmand B, et al. Esophageal fistula sealing: choice of stent, practical management, and cost. *Gastrointest Endosc.* 1999;49(1):70–78.
- Wenger U, Johnsson E, Bergquist H, et al. Health economic evaluation of stent or endoluminal brachytherapy as a palliative strategy in patients with incurable cancer of the oesophagus or gastro-oesophageal junction: results of a randomized clinical trial. *Eur J Gastroenterol Hepatol.* 2005;17(12):1369–1377.
- Knyrim K, Wagner H-J, Bethge N, et al. A controlled trial of an expansile metal stent for palliation of esophageal obstruction due to inoperable cancer. *NEJM.* 1993;329:1302–1307.
- Kozarek RA, Raltz S, Brugge WR, et al. Prospective multi-center trial of esophageal Z stent placement for malignant dysphagia and tracheo-esophageal fistula. *Gastrointest Endosc.* 1996;44:562–567.
- Vakil N, Gross U, Bethge N. Human tissue responses to metal stents. *Gastrointest Endosc Clin North Am.* 1999;9:359–365.
- Dua K, Kozarek R, Kim J, et al. Self-expanding metal esophageal stent with anti-reflux mechanism. *Gastrointest Endosc.* 2001;53:603–613.
- Siersema P, Schrauwen S, Blankenstein M, et al. Self-expanding metal stents for complicated and recurrent esophagogastric cancer. *Gastrointest Endosc.* 2001;54:579–586.
- Riccioni ME, Shah SK, Tringali A, et al. Endoscopic palliation of unresectable malignant oesophageal strictures with self-expanding metal stents: comparing Ultraflex and Esophacoil stents. *Dig Liver Dis.* 2002;34:356–363.
- Xinopoulos D, Dimitroulopoulos D, Moschandrea I, et al. Natural course of inoperable esophageal cancer treated with metallic expandable stents: quality of life and cost-effectiveness analysis. *J Gastroenterol Hepatol.* 2004;19(12):1397–1402.
- Sabharwal T, Hamady MS, Chui S, et al. A randomized prospective comparison of the Flamingo Wallstent and Ultraflex stent for palliation of dysphagia associated with lower third oesophageal carcinoma. *Gut.* 2003;52:922–926.
- Yang HS, Zhang LB, Wang TW, et al. Clinical application of metallic stents in treatment of esophageal carcinoma. *World J Gastroenterol.* 2005;11(3):451–453.

30. Ramirez F, Dennert B, Zierer S, et al. Esophageal self-expandable metal stents—indications, practice, techniques, and complications: results of a national survey. *Gastrointest Endosc.* 1997;45:360–364.
31. Rajjman I, Siddique I, Lynch P. Does chemoradiation therapy increase the incidence of complications with self-expanding coated stents in the management of malignant esophageal strictures? *Am J Gastroenterol.* 1997;92(12):2192–2196.
32. Kinsman KJ, DeGregorio BT, Katon RM, et al. Prior radiation and chemotherapy increase the risk of life-threatening complications after insertion of metal stents for esophagogastric malignancy. *Gastrointest Endosc.* 1996;43:196–203.
33. Song HY, Yang DH, Kuh JH, et al. Obstructing cancer of the gastric antrum: palliative treatment with covered metal stents. *Radiology.* 1993;187:357–358.
34. Telford JJ, Carr-Locke DL, Baron TH, et al. Palliation of patients with malignant gastric outlet obstruction with the enteral Wallstent: outcomes from a multicenter study. *Gastrointest Endosc.* 2004;60(6):916–920.
35. Del Piano M, Ballare M, Montino F, et al. Endoscopy or surgery for malignant GI outlet obstruction? *Gastrointest Endosc.* 2005;61(3):421–426.
36. Yim HB, Jacobson BC, Saltzman JR, et al. Clinical outcome of the use of enteral stents for palliation of patients with malignant upper GI obstruction. *Gastrointest Endosc.* 2001;53:329–332.
37. Wong YT, Brams DM, Munson L, et al. Gastric outlet obstruction secondary to pancreatic cancer. Surgical vs endoscopic palliation. *Surg Endosc.* 2001;16:310–312.
38. Johnsson E, Thune A, Liedman B. Palliation of malignant gastroduodenal obstruction with open surgical bypass or endoscopic stenting: clinical outcome and health economic evaluation. *World J Surg.* 2004;28:812–817.
39. Espinel J, Sanz O, Vivas S, et al. Malignant gastrointestinal obstruction: endoscopic stenting versus surgical palliation. *Surg Endosc.* 2006;20:1083–1087.
40. Mehta S, Hindmarsh A, Cheong E, et al. Prospective randomized trial of laparoscopic gastrojejunostomy versus duodenal stenting for malignant gastric outflow obstruction. *Surg Endosc.* 2006;20:239–242.
41. Maire F, Hammel P, Ponsot P, et al. Long-term outcome of biliary and duodenal stents in palliative treatment of patients with unresectable adenocarcinoma of the head of pancreas. *Am J Gastroenterol.* 2006;101:735–742.
42. Dormann A, Meisner S, Verin N, et al. Self-expanding metal stents for gastroduodenal malignancies: systematic review of their clinical effectiveness. *Endoscopy.* 2004;36(6):543–550.
43. Raikar GV, Melin MM, Ressa A, et al. Cost-effective analysis of surgical palliation versus endoscopic stenting in the management of unresectable pancreatic cancer. *Ann Surg Oncol.* 1996;3(5):470–475.
44. Shepherd HA, Royle G, Ross AP, et al. Endoscopic biliary endoprosthesis in the palliation of malignant obstruction of the distal common bile duct: a randomized trial. *Br J Surg.* 1988;75(12):1166–1168.
45. Andersen JR, Sorensen SM, Kruse A, et al. Randomized trial of endoscopic endoprosthesis versus operative bypass in malignant obstructive jaundice. *Gut.* 1989;30(8):1132–1135.
46. Smith AC, Dowsett JF, Russell RC, et al. Randomized trial of endoscopic stenting versus surgical bypass in malignant low bileduct obstruction. *Lancet.* 1994;344(8938):1655–1660.
47. van den Bosch RP, van der Schelling GP, Klinkenbijn JH, et al. Guidelines for the application of surgery and endoprostheses in the palliation of obstructive jaundice in advanced cancer of the pancreas. *Ann Surg.* 1994;219(1):18–24.
48. Davids HP, Groen AK, Rauws E, et al. Randomized trial of self-expanding metal stents versus plastic stents for distal malignant biliary obstruction. *Lancet.* 1992;340:1488–1492.
49. Wagner HJ, Knyrim K, Vakil N, et al. Plastic endoprostheses versus metal stents in the palliative treatment of malignant hilar biliary obstruction. A prospective and randomized trial. *Endoscopy.* 1993;25(3):213–218.
50. Knyrim K, Wagner HJ, Vakil N, et al. A prospective, randomized, controlled trial of metal stents for malignant obstruction on the common bile duct. *Endoscopy.* 1993;25:207–212.
51. Schmassmann A, von Gunten E, Knuchel J, et al. A randomized trial of endoscopic drainage methods for inoperable malignant strictures of the common bile duct. *Gastrointest Endosc.* 1993;47:1–7.
52. Chang WH, Kortan P, Haber GB. Outcome in patients with bifurcation tumors who undergo unilateral versus bilateral hepatic duct drainage. *Gastrointest Endosc.* 1998;47(5):354–362.
53. De Palma GD, Pezzullo A, Rega M, et al. Unilateral placement of metal stents for malignant hilar obstruction: a prospective study. *Gastrointest Endosc.* 2003;58(1):50–53.
54. Polydorou AA, Chisholm EM, Romanos AA, et al. A comparison of right versus left hepatic duct endoprosthesis insertion in malignant hilar biliary obstruction. *Endoscopy.* 1989;21(6):266–271.
55. Polydorou AA, Cairns SR, Dowsett JF, et al. Palliation of proximal malignant biliary obstruction by endoscopic endoprosthesis insertion. *Gut.* 1991;32(6):685–689.
56. Ballinger AB, McHugh M, Catnach SM, et al. Symptom relief and quality of life after stenting for malignant bile duct obstruction. *Gut.* 1994;35(4):467–470.
57. Luman W, Cull A, Palmer KR. Quality of life in patients stented for malignant biliary obstruction. *Eur J Gastroenterol Hepatol.* 1997;9:481–484.
58. Martin RC 2nd, Vitale GC, Reed DN, et al. Cost comparison of endoscopic stenting vs surgical treatment for unresectable cholangiocarcinoma. *Surg Endosc.* 2002;16:667–670.
59. Moss AC, Morris E, Mac Mathuna P. Palliative biliary stents for obstructing pancreatic carcinoma. *Cochrane Database Syst Rev.* 2006;2:CD004200.
60. Schmassmann A, Gunten EV, Knuchel J, et al. Wallstents versus plastic stents in malignant biliary obstruction: effects of stent patency of the first and second stent on patient compliance and survival. *Am J Gastroenterol.* 1996;91:654–659.
61. Soderlund C, Linder S. Covered metal versus plastic stents for malignant common bile duct stenosis: a prospective, randomized controlled trial. *Gastrointest Endosc.* 2006;63(7):986–995.
62. Yoon WJ, Lee JK, Lee KH, et al. A comparison of covered and uncovered Wallstents for the management of distal malignant biliary obstruction. *Gastrointest Endosc.* 2006;63(7):996–1000.
63. Costamagna G, Tringali A, Petruzzello L, et al. *Can J Gastroenterol.* 2004;18(7):451–454.
64. Tesdal IK, Roeren T, Weiss C, et al. Metal stents for treatment of benign biliary obstruction: a long-term study comparing different stents. *JVIR.* 2005;16(11):1479–1487.
65. Adler DG, Merwat SN. Endoscopic approaches for palliation of luminal gastrointestinal obstruction. *Gastroenterol Clin N Am.* 2006;35(1):65–82.
66. Speer AG, Cotton PB, MacRae KD. Endoscopic management of malignant biliary obstruction: stents of 10 French gauge are preferable to stents of 8 French gauge. *Gastrointest Endosc.* 1988;34:412–417.
67. Pedersen FM. Endoscopic management of malignant biliary obstruction. Is stent size of 10 French gauge better than 7 French gauge? *Scand J Gastroenterol.* 1993;28:185–189.
68. Burke DR, Lewis CA, Cardella JF, et al. Quality improvement guidelines for percutaneous transhepatic cholangiography and biliary drainage. *JVIR.* 2003;14:S243–S246.
69. Han YM, Jin GY, Lee SO, et al. Flared polyurethane-covered self-expandable nitinol stent for malignant biliary obstruction. *JVIR.* 2003;14:1291–1301.
70. Nicholson AA, Royston CMS. Palliation of inoperable biliary obstruction with self-expanding metallic endoprostheses: a review of 77 patients. *Clin Radiol.* 1993;47:245–250.

71. Boguth L, Tatalovic S, Antonucci F, et al. Malignant biliary obstruction: clinical and histopathologic correlation after treatment with self-expanding metallic prostheses. *Radiology*. 1994;192:669–674.
72. Hatzidakis AA, Tsetis D, Chrysou E, et al. Nitinol stents for palliative treatment of malignant obstructive jaundice: should we stent the sphincter of Oddi in every case? *Cardiovasc Intervent Radiol*. 2001;24:245–248.
73. Minopoulos GI, Lyratzopoulos N, Efremidou HI, et al. Emergency operations for carcinoma of the colon. *Tech Coloproctol*. 2004;(8 Suppl 1):s235–s237.
74. Rabeneck L, Paszat LF, Li C. Risk factors for obstruction, perforation, or emergency admission at presentation in patients with colorectal cancer: a population-based study. *Am J Gastroenterol*. 2006;101(5):1098–1103.
75. Riedl S, Wiebelt H, Bergmann U, et al. Post-operative complications and fatalities in surgical therapy of colon carcinoma. Results of the German multicenter study by the Colorectal Carcinoma Study Group [German]. *Chirurg*. 1995;66:597–606.
76. Fielding LP, Phillis RKS, Fry JS, et al. Prediction of outcome after emergency curative resection for large bowel cancer. *Lancet*. 1986;18:904–907.
77. Mainar A, Tejero E, Maynar M, et al. Colorectal obstruction: treatment with metal stents. *Radiology*. 1996;198:761–764.
78. Farrell JJ, Carr-Locke DC. Metal enteral stents: an endoscopist's perspective. *Seminars in Interventional Radiology*. 2001;18:327–337.
79. Martinez-Santos C, Lobato R, Fradejas JM, et al. Self-expandable stent before elective surgery vs emergency surgery for the treatment of malignant colorectal obstructions: comparison of primary anastomosis and morbidity rates. *Dis Colon Rectum*. 2002;45(3):401–406.
80. Sebastian S, Johnston S, Geoghegan T, et al. Pooled analysis of the efficacy and safety of self-expanding metal stenting in malignant colorectal obstruction. *Am J Gastroenterol*. 2004;99:2051–2057.
81. Targownik LE, Spiegel BM, Sack J, et al. Colonic stent vs emergency surgery for management of acute left-sided malignant colonic obstruction: a decision analysis. *Gastrointest Endosc*. 2004;60(6):865–874.
82. Binkert CA, Ledermann H, Jost R, et al. Acute colonic obstruction: clinical aspects and cost-effectiveness of preoperative and palliative treatment with self-expanding metal stents—a preliminary report. *Radiology*. 1998;206:199–204.
83. Osman HS, Rashid HI, Sathanathan N, et al. The cost effectiveness of self-expanding metal stents in the management of malignant left sided large bowel obstruction. *Colorectal Dis*. 2000;2:233–237.
84. Xinopoulos D, Dimitroulopoulos D, Theodosopoulos T, et al. Stenting or stoma creation for patients with inoperable malignant colonic obstructions? *Surg Endosc*. 2004;18:421–426.
85. Harris GJC, Senagore AJ, Lavery IC, et al. The management of neoplastic colorectal obstruction with colonic endoluminal stenting devices. *Am J Surg*. 2001;181:499–506.
86. Khot UP, Lang W, Murali K, et al. Systematic review of the efficacy and safety of colorectal stents. *Br J Surg*. 2002;89:1096–1102.
87. O'Brien J, Baerlocher MO, Asch MR, et al. Limitations influencing interventional radiology in Canada: results of a national survey by the Canadian Interventional Radiology Association (CIRA). *Cardiovasc Intervent Radiol*. 2007;30(5):847–853.
88. Baerlocher MO, Stewart B, Asch MR, et al. Performance of carotid stenting, vertebroplasty, and EVAR: how many are we doing, and why aren't we doing more? A survey study by the Canadian Interventional Radiology Association (CIRA). *Can Assoc Radiol J*. 2008;59(1):22–29.
89. Chan BTB. From perceived surplus to perceived shortage: what happened to Canada's physician workforce in the 1990s? Ottawa (ON): Canadian Institute for Health Information; 2002.
90. Baerlocher MO, Asch MR, Hayeems E. Current issues of interventional radiology in Canada: a national survey by the Canadian Interventional Radiology Association. *Can Assoc Radiol J*. 2005;56(3):129–39.

## Appendix I:

### Gastrointestinal Stent Placement: Information for Patients (example shown for expandable esophageal stent)

#### Background

Your doctor has explained that you have a tumour that is blocking your esophagus (food pipe) or causing a tight narrowing called a stricture. As a result, food and possibly liquids are difficult to swallow. Your doctor has discussed your treatment options with you. Your doctor has suggested that a special tube called an expandable metal stent be placed inside your esophagus at the narrowing or stricture.

The expandable metal stent is designed to keep the passageway open in your esophagus. It is designed to remain permanently in the esophagus and its presence in the esophagus is normally not felt.

The stent will act like a funnel to allow food and liquids to run through into your stomach. This procedure is not aimed at cure, but instead it is intended to improve your swallowing so that you can manage a soft diet. It will still be difficult to swallow meat and other firm pieces of food.

#### Procedures

##### *Prior to Stent*

You will undergo a gastroscopy to measure and dilate the stricture in your esophagus. This procedure is done with sedation in the endoscopy unit. You may also require a barium swallow, which is an x-ray of your esophagus taken after swallowing barium or special dye.

##### *Stent Insertion*

The stent is inserted into your esophagus during a gastroscopy with sedation in the endoscopy unit. The stent is attached to a thin introducer and is passed down into your esophagus and placed at the site of the stricture. The stent is then released and expands inside the esophagus to open the stricture. A balloon may be used to help open the stent. X-rays of the stent will be taken during the procedure.

The procedure is similar to having the gastroscopy and dilation, and will take about 45 minutes. You may experience some local pain or discomfort during and immediately following the procedure for which medication will be provided. There is a very small risk of bleeding or perforation of the esophagus.

*After Stent Insertion*

**Same Day**

You will not be able to eat or drink for one hour after the procedure until sensation at the back of your throat returns after having been numbed with a spray for the procedure.

You may try to drink liquids later in the day.

**Next Day**

You may try to swallow liquids and pureed soft foods with plenty of liquids, or follow the diet as directed by your doctor.

You may feel pain under your breastbone for 2 to 3 days after stent insertion while the stent is still in the process of expanding. Your doctor can prescribe pain medication for you. If the pain is severe, you should notify your doctor.

**1 Week**

If your swallowing has not improved satisfactorily, a gastroscopy may be repeated to view the stent inside your esophagus to ensure it is open and in the correct position. Alternately, a barium swallow x-ray may be done to check the stent. Your doctor will let you know if this is necessary.

*Problems*

If you have any concerns about your health, or experience greater difficulty swallowing, you should notify your physician or go to an emergency department. A repeat gastroscopy may be necessary to check stent position, and possible blockage from food or tumour. If food is stuck in the stent, try drinking carbonated liquids to flush the food down. If this does not help, you should go to an emergency department.

**Suggestions**

Use gravies and cream sauces.

Drink plenty of liquids with food, particularly carbonated drinks.

Drink a small amount of alcohol: a bit of brandy or wine may help your appetite.

Remember, if you take pain medication, the effect of alcohol will be greater.

Diet Recommendations	
Allowed	Avoid
All liquids: warm	Rice
Carbonated drinks (7-UP, ginger ale, soda water, champagne, beer)	Bread (plain, untoasted)
Soups with small bits of vegetables	Dry solid foods (steak, chips)
Porridge	Raw vegetables or fruit
Pasta and sauce	Lettuce, celery
Mashed potatoes	
Tender chicken, minced meat with gravy	The following foods may increase heartburn:
Fish: cooked or canned	• Hot or cold temperatures
Eggs: soft-boiled, well-cooked	• Spicy foods
Vegetables: boiled, well-cooked	• Acidic foods (oranges, tomatoes)
Fruit: bananas, canned fruit, except the skin	
Ice cream, shakes, yogurt	
Crackers or dry toast	

Take small portions several times a day, instead of a larger meal.

Chew all food very well; eat slowly.

If you experience a feeling of fullness when eating, you can try carbonated beverages and walking around for a minute.

If you have difficulty preparing meals, there are resources that provide and deliver pureed foods for a cost. You can request this information from a doctor or nurse listed under contacts.

**Activity Instructions**

Never lie down flat.

Always keep your head elevated higher than your stomach.

Use 2 or 3 pillows for sleeping and raise the head of the bed 6 inches with blocks.

Sit upright for meals. Do not lie down or recline for at least 1 hour after meals.

**Medication Instructions**

Use liquid forms of medications whenever possible.

Crush tablet medications between 2 spoons, and take with food (for example, applesauce or yogurt) or with plenty of liquids.