

Complications of diagnostic upper Gastrointestinal endoscopy: common and rare – recognition, assessment and management

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ABSTRACT

A clear understanding of the potential complications or adverse events (AEs) of diagnostic endoscopy is an essential component of being an endoscopist. Creating a culture of safety and prevention of AEs should be part of routine endoscopy practice. Appropriate patient selection for procedures, informed consent, periprocedure risk assessments and a team approach, all contribute to reducing AEs. Early recognition, prompt management and transparent communication with patients are essential for the holistic and optimal management of AEs. In this review, we discuss the complications of diagnostic upper gastrointestinal endoscopy, including their recognition, treatment and prevention.

INTRODUCTION

Delivering safe, high-quality endoscopy requires endoscopists to clearly understand potential procedural complications, to both minimise their incidence and optimise their management. In this review, we cover common and rarer complications of diagnostic endoscopy, detailing their recognition, early management and strategies to minimise the complication risk.

Oesophagogastroduodenoscopy (OGD) is the gold standard test for investigating upper gastrointestinal (GI) symptoms, and allows direct visualisation and sampling of the mucosa, for the purposes of diagnosis, therapy and surveillance.¹ Endoscopy activity is rapidly increasing, in the UK in 2019, the annual number of adult GI endoscopies increased by 13.5% from 2017 to 2,133,541.² Despite efforts to increase the endoscopy workforce and capacity, there is an increasing strain on endoscopy services with fewer units able to meet national waiting time targets.² This pressure has been profoundly exacerbated by the COVID-19 pandemic. For clinicians practising in this pressured

KEY POINTS

- ⇒ Prevention of complications can be optimally achieved through appropriate patient selection and fostering a safe team working environment.
- ⇒ Cardiopulmonary-related events account for over 60% of unplanned events during endoscopy and can be minimised by safe sedation and preprocedure risk assessment.
- ⇒ Early recognition and prompt management is essential to minimise downstream harm once a complication has occurred.
- ⇒ Management of a complication is often multidisciplinary requiring early involvement of surgical and radiological teams.
- ⇒ Reporting of complications through departmental meetings and audits is essential and includes a timely apology and duty of candour letter.
- ⇒ Mechanisms for debriefing, learning and professional support should be available to clinicians involved in a procedure-related complication.

environment, this review can serve as a useful reference for updating knowledge on events that are hopefully rarely encountered.

GENERAL PRINCIPLES: PREVENTING COMPLICATIONS

In the UK, the implementation of quality and safety standards in endoscopy through JAG accreditation (Joint Advisory Group on GI Endoscopy) and the Global Rating Scale standardises the approach to quality and safety in endoscopy.^{3 4} Additional specific guidelines provide quality and safety performance indicators for both upper^{1 5} and lower⁶ GI procedures.

The prevention of complications should be embedded in endoscopy practice and the culture of endoscopy units. General principles to reduce and manage complications include⁷:



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- ▶ Procedures performed by competent and experienced endoscopists.
- ▶ Adequate supervision of trainees and less experienced endoscopists.
- ▶ Appropriate patient selection for endoscopic procedures, this may include a vetting process for referrals.
- ▶ Appropriately resourced setting, including trained nursing staff, assistants and appropriate equipment.
- ▶ Ensuring a safe team culture, with a prelist team briefing, non-rush ethos and use of the WHO checklist as a standard.
- ▶ Accessibility to Intensive Care Unit (ITU), radiology and surgery for management of emergencies.
- ▶ Provision of out of hours endoscopy services for timely management of emergencies.
- ▶ Risk stratification and triaging of the appropriateness of procedures.
- ▶ JAG outlined audits with regular review in morbidity and mortality meetings.
- ▶ Developing a 'no-blame' culture with constructive feedback to promote learning objectives from adverse events (AEs).

AE OR COMPLICATION?

In many Western centres, complication is the term used on consent forms. In the UK, the JAG on GI endoscopy includes both AE and complication interchangeably when describing how these events should be monitored.³ In American endoscopy guidelines, the term AE is defined as an event that prevents completion of the planned procedure and/or results in unplanned admission to hospital, prolongation of existing hospital stay, another procedure (needing sedation/anaesthesia) or subsequent medical consultation.⁸ The term complication, to some carries an implication of direct causality between medical care and the occurrence of an AE.⁹ The distinction between avoidable errors and events that are expected complications occurring in a high-quality endoscopy is an important part of the postevent analysis. It is our view that either term can be used to describe endoscopy-related events, but consistent use of terminology within units is key to standardise recording and auditing of endoscopy-related events.

CARDIOPULMONARY AND SEDATION-RELATED AEs

In adult patients, cardiopulmonary AEs are the the most common type of endoscopy-related events, accounting for over 60% of unplanned events during endoscopy,¹⁰ and occur in up to 0.6% of OGDs.¹¹ The risk profile for sedation-related or cardiopulmonary AEs in paediatric cases is different due to patient-related factors, and procedures typically being carried out under general anaesthesia. Cardiopulmonary AEs range from minor and inconsequential, such as transient hypotension, hypoxia or vasovagal episodes, to more significant events such as respiratory distress, cardiac dysrhythmias and

vascular-related diseases. Patient-related risk factors include advancing age or an American Society of Anaesthesiologists (ASA) grade of 3 or above.¹¹ Procedure-related risk factors for hypoxia or respiratory compromise include difficulty intubating the oesophagus, a prolonged procedure and the prone position.¹⁰

The majority of diagnostic endoscopy is performed under conscious sedation, with the patient able to maintain ventilatory function and follow simple commands.¹² However, there is considerable variability in practice, both in choice of sedatives, doses used and personnel responsible for administration and monitoring. A recent meta-analysis analysed 19 guidelines and 7 position statements, and highlights the lack of consensus and variation between national/international guidelines that exists in this area.¹³ Following the publication of guidelines for standards of endoscopy training and practice, the safety of sedation for endoscopy has improved, with a national audit reporting the use of reversal agents during colonoscopy in only 0.1% in 2011, compared with 14% in 2004.¹⁴ A German multicentre study found the overall sedation-related AE rate to be 0.3%, with major complications in 0.01%, and sedation-related mortality of 0.004%.¹⁵ Sedation-related AEs include oversedation, that is, excessive or prolonged reduction in conscious level, which may be inconsequential, or may involve respiratory depression, hypoxia and the need for reversal agents, recorded as never events. Paradoxical restlessness or agitation (especially with benzodiazepines), transient hypotension, cardiac dysrhythmias and aspiration pneumonia are also potential sedation-related AEs.

An unsedated upper GI endoscopy typically involves the use of pharyngeal anaesthesia with topical local anaesthetic (eg, lidocaine spray). Patient selection is key for a successful unsedated upper GI endoscopy and high levels of patients' anxiety will limit the ability to perform a high-quality examination. The use of pharyngeal anaesthesia is associated with a rare risk of anaphylactoid reactions or aspiration.

Prevention and treatment

Preprocedure risk assessment is key to preventing cardiopulmonary and sedation-related AEs, this should include a discussion with the patient of the risks, benefits and alternatives (box 1). The ASA grade uses physical status to help predict operative risk.¹⁶ Higher ASA grade of 3 or above increases the risk of AEs in GI endoscopy,¹⁷ the

Box 1 The consent process

1. Process of the procedure.
2. Risks, benefits, limitations and alternatives.
3. Capacity assessment if relevant.
4. Options in case of failure.
5. Options for sedation and analgesia.
6. Tissue samples.
7. Supervision/presence of trainees (where relevant).
8. Contact details if further information needed.⁴⁵

risk benefit of using conscious sedation in ASA grade 4 patients should be carefully considered. Additional specific questioning regarding previous adverse reactions to sedatives, potential drug interactions and cardiorespiratory comorbidities, for example, sleep apnoea, Chronic Obstructive Airways Disease (COPD), cardiac dysrhythmias, ischaemic or structural heart disease, should all form part of a preprocedure risk assessment.¹² Other specific situations that warrant extra care include neuromuscular conditions affecting respiratory function or swallowing, morbid obesity or learning disabilities where behavioural issues may affect safety.

A minimum fast of 2 hours¹⁸ for clear liquids and 6 hours¹⁹ for food has been shown to be safe, and is essential to minimise aspiration risk. In situations of known or suspected delayed gastric emptying or oesophageal motility disorders, this fasting period for food should be extended to at least 12 hours (48 hours in achalasia) and prokinetics may help minimise the aspiration risk. If the aspiration risk is felt to be especially high, or the procedure is likely to be prolonged or technically challenging, general anaesthesia with or without endotracheal intubation should be considered. Careful titration of sedation to the lowest effective dose is essential for higher risk patients, including the elderly and comorbid.

Early recognition of cardiopulmonary or sedation-related AEs is best achieved through careful intraprocedural monitoring of oxygen saturations, respiratory rate, pulse, blood pressure and responsiveness, with clear communication between nursing colleagues and endoscopists. Reversal agents such as flumazenil (benzodiazepines) or naloxone (opiates) should be readily available and staff familiar with their location, dosing and administration.

MISSED PATHOLOGY

Missed upper GI cancers at endoscopy are sufficiently common to be included in preprocedure consent as a potential AE (box 2). Units should have a system in place for capturing and reporting missed cancers.^{6,20} A missed cancer is defined as when a previous negative endoscopy for cancer is noted within 3 years of the cancer diagnosis. A recent meta-analysis found a miss rate of 9.4% for cancer at upper GI endoscopy.²¹ Careful washing (including the use of mucolytics, eg, simeticone) and insufflation, with adequate mucosal inspection time and

interrogation of high-risk areas, 'blind spots', are all necessary components of high-quality upper GI endoscopy to minimise the chance of missing subtle malignant and premalignant lesions.^{1,6,20}

INFECTIVE AES

The principal mechanism of transmission of infections through endoscopy, is translocation of endogenous bacterial flora. The most common endogenous infections include *Escherichia coli*, Klebsiella, other Enterobacteriaceae and enterococci.²² The reported incidence of transient bacteraemia ranges from 0% to 8% after diagnostic upper GI endoscopy, and 0% to 25% after sigmoidoscopy and colonoscopy.^{22,23} However, this is usually asymptomatic, and no causal link has been found with clinical infection. There is no role for routine prophylactic antibiotics before diagnostic endoscopy, including in patients with prosthetic cardiac valves.²⁴ In the setting of severe neutropenia (neutrophils $<0.5 \times 10^9/L$), haematological advice should be sought. There is some evidence of an increased incidence of peritonitis following colonoscopy in patients on continuous ambulatory peritoneal dialysis and the international society of peritoneal disease recommends antibiotic prophylaxis in this group.²⁵ Antibiotic use in the setting of therapeutic endoscopy is covered by specific British Society of Gastroenterology (BSG) guidelines.²⁴

INFECTION CONTROL: AEROSOL GENERATION IN ENDOSCOPY

In response to the COVID-19 pandemic, guidelines were rapidly developed around clinical practice for aerosol generating procedures (AGPs), that is, procedures carrying a high risk of aerosol generation. Upper GI endoscopy was designated as an AGP, with recommendations made regarding infection control precautions, including decontamination of endoscopy rooms and the use of personal protective equipment (PPE). This topic continues to evolve, at the latest evidence review from National Health Service England in 2022²⁶ awake upper GI endoscopy was advised to remain on the AGP list, while anaesthetised patients with a secured airway are no longer considered an AGP. This came after review of three studies which found detectable aerosol levels during standard upper endoscopy, although no absolute risk data were quoted for transmission of COVID-19 at endoscopy. Similar for patients with pulmonary tuberculosis respiratory precautions should be taken, including the use of a negative pressure room, FFP3 grade PPE and enhanced room decontamination post procedure.²⁷

COMMON POSTPROCEDURAL SYMPTOMS

Patients may report symptoms such as sore throat, abdominal pain and nausea after upper GI endoscopy.

Box 2 Consent for diagnostic upper gastrointestinal endoscopy—risks

1. Sore throat.
2. Risks of sedation.
3. Cardiopulmonary events.
4. Bleeding.
5. Perforation (<1:2500).
6. Missed lesions.
7. Dental trauma.

Although these symptoms are considered minor and managed conservatively, up to 2.5% of patients seek medical advice after upper GI endoscopy for such symptoms,²⁸ appropriate counselling prior to the procedure regarding postendoscopic symptoms is therefore important.

DENTAL TRAUMA AND TEMPOROMANDIBULAR JOINT DISLOCATION

With appropriate use of mouth guards, dental trauma should be rare following upper GI endoscopy. In patients with poor dentition and loose teeth this should be specifically consented for, and the endoscopy nurses alerted. Temporomandibular joint dislocation has rarely been described as a consequence of upper GI endoscopy.²⁹ Clues are the presence of jaw pain, or difficulty closing the mouth post procedure. Plain X-ray should be obtained and consultation with maxillo-facial surgeons for reduction of the dislocation.

PERFORATION

Perforation at upper GI endoscopy is a potentially life-threatening complication, with mortality rates of 2%–36% for oesophageal perforation.¹⁰ Prospective, multicentre studies report perforation rates of between 1 in 2500 and 1 in 11 000 for diagnostic upper GI endoscopy.^{30 31} Factors conferring an increased risk of perforation include the presence of anterior cervical osteophytes, Zenker's diverticulum, oesophageal stricture, malignancies of the upper GI tract and duodenal diverticula.¹⁰ Forceful blind intubation should be discouraged with a low threshold to abandon the procedure if intubation remains challenging.

Diagnosis

Perforation during diagnostic endoscopy may occur at any stage of the procedure. However, it is typically seen in the context of a difficult intubation or traversing a tight stricture within the oesophagus. Visualisation of extraluminal structures, for example, mediastinal structures such as the lung, retropharyngeal structures or even intraperitoneal structures for example, liver or spleen are diagnostic. However, more common smaller perforations can be subtle and bubbling of gas around the perforation or seepage of saliva or secretions through the defect may be seen on careful inspection. The use of a clear distal extension may improve visualisation of small perforations.

An early search for iatrogenic perforations should be prompted by the clinical features listed in [box 3](#).

Later, the perforation may lead to mediastinitis or empyema, if the mediastinal pleura is breached. Features may include tachyarrhythmias, hypotension and hypoxia, and untreated this can progress to life-threatening multi-organ failure. A high index of suspicion with immediate investigation and prompt management is essential to improve outcomes for oesophageal perforations.³² The

investigation of choice is CT scanning ([figure 1](#)) of the neck, chest and abdomen with oral and intravenous contrast. This has a high sensitivity for locating the site of the perforation and allows characterisation of additional complications.^{33–35} A plain chest X-ray may show pneumomediastinum, pneumothorax or pleural effusion,³³ but adds little information and may delay more sensitive and specific investigations. Contrast swallow is less able to define complications than CT scanning ([figure 1](#)).

Treatment of perforation: general approach

There is a lack of prospective evidence on the optimal approach to managing upper GI perforations. As a general principle, the degree of contamination caused by the perforation dictates management and outcomes. Because of the complexity of managing iatrogenic perforations, a multidisciplinary approach with endoscopist, radiologist and upper GI surgeon is advocated at an early stage. The majority of perforations occur in the context of therapeutic endoscopic procedures, and are often identified or at least suspected intraprocedurally and an attempt at endoscopic closure is often made. Reporting the perforation size, location and endoscopic therapy applied including photodocumentation is recommended by the European Society of Gastrointestinal Endoscopy (ESGE).²⁷ Critical to decisions regarding conservative or surgical management are:

1. Perforation size.
2. Pathology at the site of perforation, for example, malignancy.
3. The time to diagnosis (intraprocedure or postprocedure).
4. Evidence of additional sequelae.
5. Patient factors, for example, age and comorbidities.
6. Success of endoscopic closure if attempted.

Conservative management includes nil by mouth, broad-spectrum intravenous antibiotics, nutritional support, analgesia, cautious nasogastric drainage and the addition of percutaneous drainage of effusions or pneumothoraces where necessary.³⁴ The ESGE recommends attempting endoscopic closure of iatrogenic perforations depending on the site, size and expertise of available endoscopists. Endoscopic suturing should only be attempted by those with sufficient expertise. Attempts at

Box 3 Signs and symptoms of upper gastrointestinal perforation

1. Disproportionate and persistent chest/abdo pain with distension.
2. Sore throat.
3. Chest pain.
4. Dysphagia.
5. Odynophagia.
6. Subcutaneous emphysema.
7. Voice changes (dysphonia).
8. Shortness of breath.
9. Tachycardia and sustained vasovagal episode.
10. Systemic inflammatory response syndrome.³⁴

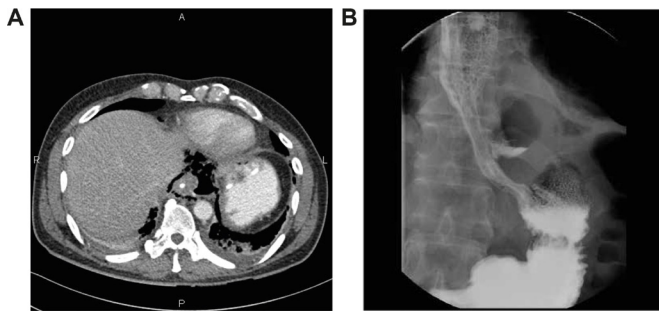


Figure 1 (A) Axial CT showing free air suspicious of an oesophageal perforation after endoscopic dilatation for achalasia. (B) Later a barium showing a sealed off leak of contrast from the oesophagus.

endoscopic closure should be undertaken using carbon dioxide insufflation, with diversion of digestive luminal content.³⁵ Further management should be based on the estimated success of the closure and on the general clinical condition of the patient. In the case of no or failed endoscopic closure, or patients whose clinical condition is deteriorating, surgical consultation is recommended and transfer to a tertiary centre if indicated.³⁵

Treatment: oesophageal perforation

Cervical perforations carry the highest chance of successful conservative management, due to the reduced chance of mediastinal contamination.³⁵ Early treatment of an oesophageal perforation must not only address the oesophageal defect, but also consider the extent of mediastinal contamination. Through the scope (TTS) clips can be used for perforations <10 mm, and over the scope (OTS) clips are recommended for selected perforations >10 mm. Although fully covered self-expandable metal stents (SEMSs) can be used for larger defects (>20 mm), the radial expansile force of a SEMS may worsen the defect and rarely seal the leak. Early surgical intervention with either closure of the defect or T-tube drainage reduces the risk of mediastinitis and infected collections. Use of mesh in the mediastinum may result in strictures and excessive fibrosis. Once collections develop, drainage tubes are often required to reduce septic sequelae. A newer approach to the treatment of these perforations is negative pressure therapy through an Endovac.³⁶ This is a highly effective method of gradual closure of the oesophageal defect with negative pressure applied into the mediastinal cavity beyond the defect. Regardless of the method used to treat the perforation, we would recommend early involvement of an oesophagogastric surgeon with expertise in managing such difficult cases.

Treatment: gastric perforation

Gastric perforation predominantly occurs in the context of therapeutic procedures (eg, ESD) and is very rare following diagnostic upper endoscopy. Treatment of small gastric defects (≤ 10 mm) has a high chance of success of up to 99% using TTS clips.³⁵ As long as treatment is early, larger defects (10–30 mm) can be closed with OTS clips, with success rates up to 88%.³⁵ In the event of delayed

diagnosis of gastric perforation surgical management is strongly advocated.

Treatment: duodenal perforation

Endoscopic treatment of iatrogenic duodenal perforation is recommended if recognised immediately or early (<12 hours) post procedure.³⁵ In the case of failed endoscopic treatment, the patient requires immediate surgery. If the duodenal perforation is diagnosed late (>12 hours), management should be surgical in the case of contrast medium extravasation at CT scan and/or deterioration of the patient's condition.³⁵ If the patient is clinically well, without contrast extravasation, the patient may be treated conservatively.

Prevention

Appropriate training of endoscopists is key to preventing and managing perforations. Endoscopes should not be passed through a closed upper oesophageal sphincter using force, and the lumen of the oesophagus should be kept under direct vision when passing the endoscope. In the context of dysphagia, contrast swallows or other imaging may help characterise the likely site of narrowing.^{33 34} If intubation proves difficult, barium swallow should be considered to provide further information prior to further attempts at endoscopy. In the event of a difficult intubation, passing a guidewire or soft catheter through the cricopharynx may aid easy passage of the scope into the proximal oesophagus.

BLEEDING

Minor bleeding is not uncommon after taking mucosal biopsies but this is almost always self-limiting and requires no therapy. The risk of clinically significant bleeding after diagnostic upper GI endoscopy is exceedingly low, even in the setting of taking multiple biopsies. There are rare case reports of bleeding after biopsy,^{37 38} and as such this should be included in pre-procedure consent (box 2). The ability of the endoscopist to confidently diagnose lesions optically is important to prevent avoidable bleeding, for example recognition of vascular lesions such as varices or angiodysplasia to avoid unnecessary and potentially dangerous biopsy. Guidelines provide advice for performing endoscopy in patients taking antiplatelets and anticoagulants, including direct acting oral anticoagulants.³⁹ It should be borne in mind that there is a small increased risk of post procedure bleeding for patients taking such drugs.

Treatment of bleeding

The management of iatrogenic postendoscopy bleeding includes general resuscitative measures, and correction of any identified coagulopathy with appropriate blood products. Often conservative management is sufficient, however, in the context of bleeding after a diagnostic endoscopy, a repeat endoscopy may be appropriate if there is continued bleeding. Patients who are taking antiplatelets or anticoagulants may require specific reversal



agents and liaison with haematology, detailed recommendations are covered in BSG guidelines.^{39 40}

TRANSNASAL ENDOSCOPY

Transnasal endoscopy (TNE) has an increasing role in diagnostic upper GI endoscopy and is generally well tolerated in unsedated patients, reducing the potential for sedation-related AEs. Nasal local anaesthetic and ephedrine are used to improve tolerance and reduce nasal congestion. The risks of perforation and bleeding are the same as for standard diagnostic gastroscopy.⁴¹ Additionally, consent should include the risk of epistaxis (0.85%–2%), which is usually self-limiting.⁴² Avoiding TNE is advisable in patients with previous severe or recurrent epistaxis, or a history of nasal surgery or trauma. Patients with hereditary haemorrhagic telangiectasia may be particularly prone to epistaxis and TNE should be avoided.⁴²

DUTY OF CANDOUR

It is our responsibility as practising clinicians, to ensure serious complications or AEs are transparently disclosed, with a full explanation to the patient and/or the patient's family.⁴³ In the UK this is legislated in the Health and Social Care Act of 2008 (and 2014 regulation 20), with an acknowledgement that the lack of a timely apology is often the cause of patients pursuing legal action. This process should include a duty of candour letter to the patient and in many cases a consultation with the patient and or relatives to provide an explanation of the events and answer questions. Endoscopy units should have internal policies in place to facilitate and advocate this process, and where trainees or junior clinicians are involved, the endoscopy lead or a senior clinician should take a supervising role.

IMPACT OF COMPLICATIONS ON STAFF

In addition to the impact on patients, AEs can be traumatic for the healthcare professionals involved. Coping with human error is an inherent part of medicine, however, healthcare workers are often unprepared to deal with the aftermath of an AE occurring and the subsequent emotional impact. For some, AEs may also have a longer lasting negative impact on clinician's performance including future decision making and procedure avoidance.⁴⁴ As such the opportunity for a post hoc debrief for all staff involved is important, as well as the opportunity for psychological and professional support, this is an important part of a well-functioning endoscopy unit.

SUMMARY

AEs are an inherent but uncommon part of performing endoscopy. It is essential that endoscopists have a clear understanding of what the potential AEs are for the procedures they perform, what steps are needed to reduce the risk of their occurrence, how to recognise them and how to manage them appropriately. This review provides an

overview of this topic and hopefully facilitates continued learning on this important topic.

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REFERENCES

- Beg S, Ragnath K, Wyman A, *et al*. Quality standards in upper gastrointestinal endoscopy: a position statement of the British society of gastroenterology (Bsg) and association of upper gastrointestinal surgeons of great britain and ireland (AUGIS). *Gut* 2017;66:1886–99.
- Ravindran S, Bassett P, Shaw T, *et al*. National census of UK endoscopy services in 2019. *Frontline Gastroenterol* 2021;12:451–60.
- JAG. *JAG accreditation programme: guide to meeting the quality and safety standards*, 2019: 14–17.
- JAG accreditation global rating scale (GRS) for UK services, 2021
- Bisschops R, Areia M, Coron E, *et al*. Performance measures for upper gastrointestinal endoscopy: a European society of gastrointestinal endoscopy quality improvement initiative. *United Eur Gastroenterol J* 2016;4:629–56.
- Kaminski MF, Thomas-Gibson S, Bugajski M, *et al*. Performance measures for lower gastrointestinal endoscopy: a European society of gastrointestinal endoscopy (ESGE) quality improvement initiative. *United Eur Gastroenterol J* 2017;5:309–34.
- Green J. Complications of gastrointestinal endoscopy. *BSG Guidel Gastroenterol* 2006:1–30.
- Cotton PB, Eisen GM, Aabakken L, *et al*. A lexicon for endoscopic adverse events: report of an ASGE workshop. *Gastrointest Endosc* 2010;71:446–54.
- Richter JM, Kelsey PB, Campbell EJ. Adverse event and complication management in gastrointestinal endoscopy. *Am J Gastroenterol* 2016;111:348–52.
- ASGE Standards of Practice Committee, Ben-Menachem T, Decker GA, *et al*. Adverse events of upper GI endoscopy. *Gastrointest Endosc* 2012;76:707–18.
- Sharma VK, Nguyen CC, Crowell MD, *et al*. A national study of cardiopulmonary unplanned events after GI endoscopy. *Gastrointest Endosc* 2007;66:27–34.
- Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy, Lichtenstein DR, Jagannath S, *et al*. Sedation and anesthesia in GI endoscopy. *Gastrointest Endosc* 2008;68:815–26.
- Dossa F, Megetto O, Yakubu M, *et al*. Sedation practices for routine gastrointestinal endoscopy: a systematic review of recommendations. *BMC Gastroenterol* 2021;21:1–18.
- Colleges A M R. Safe sedation practice for healthcare procedures; 2013.

- 15 Behrens A, Kreuzmayr A, Manner H, *et al.* Acute sedation-associated complications in GI endoscopy (ProSed 2 study): results from the prospective multicentre electronic registry of sedation-associated complications. *Gut* 2019;68:445–52.
- 16 Hocevar LA, Fitzgerald BM. *American Society of Anesthesiologists staging*, 2022.
- 17 ASGE Standards of Practice Committee, Early DS, Lightdale JR, *et al.* Guidelines for sedation and anesthesia in GI endoscopy. *Gastrointest Endosc* 2018;87:327–37.
- 18 Koepe AT, Lubini M, Bonadeo NM, *et al.* Comfort, safety and quality of upper gastrointestinal endoscopy after 2 hours fasting: a randomized controlled trial. *BMC Gastroenterol* 2013;13:158.
- 19 De Silva AP, Amarasiri L, Liyanage MN, *et al.* One-hour fast for water and six-hour fast for solids prior to endoscopy provides good endoscopic vision and results in minimum patient discomfort. *J Gastroenterol Hepatol* 2009;24:1095–7.
- 20 Rees CJ, Thomas Gibson S, Rutter MD, *et al.* Uk key performance indicators and quality assurance standards for colonoscopy. *Gut* 2016;65:1923–9.
- 21 Menon S, Trudgill N. How commonly is upper gastrointestinal cancer missed at endoscopy? A meta-analysis. *Endosc Int Open* 2014;2:E46–50.
- 22 Kovaleva J. Infectious complications in gastrointestinal endoscopy and their prevention. *Best Pract Res Clin Gastroenterol* 2016;30:689–704.
- 23 Kovaleva J, Peters FTM, van der Mei HC, *et al.* Transmission of infection by flexible gastrointestinal endoscopy and bronchoscopy. *Clin Microbiol Rev* 2013;26:231–54.
- 24 Allison MC, Sandoe JAT, Tighe R, *et al.* Antibiotic prophylaxis in gastrointestinal endoscopy. *Gut* 2009;58:869–80.
- 25 Li PK-T, Szeto CC, Piraino B, *et al.* ISPD peritonitis recommendations: 2016 update on prevention and treatment. *Perit Dial Int* 2016;36:481–508.
- 26 NHS England. *A rapid review of aerosol generating procedures (AGPs)*, 2022: 1–68.
- 27 ASGE Quality Assurance in Endoscopy Committee, Calderwood AH, Day LW, *et al.* ASGE guideline for infection control during GI endoscopy. *Gastrointest Endosc* 2018;87:1167–79.
- 28 Zubarik R, Eisen G, Mastropietro C, *et al.* Prospective analysis of complications 30 days after outpatient upper endoscopy. *Am J Gastroenterol* 1999;94:1539–45.
- 29 Jindal M, Jindal R, Onu IA. Bilateral temporomandibular joint dislocation following upper GI endoscopy. *Am J Gastroenterol* 2009;104:S385.
- 30 Sieg A, Hachmoeller-Eisenbach U, Eisenbach T. Prospective evaluation of complications in outpatient GI endoscopy: a survey among German gastroenterologists. *Gastrointest Endosc* 2001;53:620–7.
- 31 Quine MA, Bell GD, McCloy RF, *et al.* Prospective audit of perforation rates following upper gastrointestinal endoscopy in two regions of England. *Br J Surg* 1995;82:530–3.
- 32 Abbas G, Schuchert MJ, Pettiford BL, *et al.* Contemporaneous management of esophageal perforation. *Surgery* 2009;146:749–56.
- 33 Søreide JA, Viste A. Esophageal perforation: diagnostic work-up and clinical decision-making in the first 24 hours. *Scand J Trauma Resusc Emerg Med* 2011;19:66.
- 34 Chen S, Shapira-Galitz Y, Garber D, *et al.* Management of iatrogenic cervical esophageal perforations: a narrative review. *JAMA Otolaryngol Head Neck Surg* 2020;146:488–94.
- 35 Paspatis GA, Arvanitakis M, Dumonceau J-M, *et al.* Diagnosis and management of iatrogenic endoscopic perforations: European society of gastrointestinal endoscopy (ESGE) position statement - update 2020. *Endoscopy* 2020;52:792–810.
- 36 Möschler O, Nies C, Mueller MK. Endoscopic vacuum therapy for esophageal perforations and leakages. *Endosc Int Open* 2015;3:E554–8.
- 37 Vu CK, Korman MG, Bejer I, *et al.* Gastrointestinal bleeding after cold biopsy. *Am J Gastroenterol* 1998;93:1141–3.
- 38 Mannath J, Subramanian V, Kaye PV, *et al.* Life-Threatening bleeding following barrett's surveillance biopsies. *Endoscopy* 2010;42 Suppl 2:E211–2.
- 39 Veitch AM, Vanbiervliet G, Gershlick AH, *et al.* Endoscopy in patients on antiplatelet or anticoagulant therapy, including direct oral anticoagulants: British society of gastroenterology (Bsg) and European society of gastrointestinal endoscopy (ESGE) guidelines. *Gut* 2016;65:374–89.
- 40 Veitch AM. Endoscopy in patients on antiplatelet or anticoagulant therapy: British Society of gastroenterology (Bsg) and European Society of gastrointestinal endoscopy (ESGE) guideline update. *Endoscopy* 2021;53.
- 41 Royal College of Physicians. *JAG accreditation scheme JAG guidance: transnasal endoscopy*. 3, 2021: 3.
- 42 Parker C, Alexandridis E, Plevris J, *et al.* Transnasal endoscopy: no gagging no panic! *Frontline Gastroenterol* 2016;7:246–56.
- 43 Jacob H, Raine J. Openness and honesty when things go wrong: the professional duty of candour (GMC guideline). *Arch Dis Child Educ Pract Ed* 2016;101:243–5.
- 44 Helo S, Moulton C-AE. Complications: acknowledging, managing, and coping with human error. *Transl Androl Urol* 2017;6:773–82.
- 45 Everett SM, Griffiths H, Nandasoma U, *et al.* Guideline for obtaining valid consent for gastrointestinal endoscopy procedures. *Gut* 2016;65:1585–601.